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KALINDI COLLEGE

PROCEEDINGS OF

सक्षममहिला, सक्षमसमाज: एकवैज्ञानिकदृष्टिकोण–

A PARADIGM SHIFT TOWARDS EMPOWERMENT OF WOMEN

(NSSC-2017)

3–4 February, 2017.

Sponsored by

Department of Science & Technology

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Message From Principal's Desk

Kalindi College, an institution of academic excellence and achievement, is in the process of incarnating its legacy as the foremost educational institution amongst the emergent colleges of University of Delhi. I am delighted to observe the promising progress the college has made on the frontiers of research and innovation.

In the gala event of the Golden Jubilee Year, all the Science Departments of the College are organizing a DST, sponsored Two-day National Seminar on ***"सक्षम महिला-सक्षम समाज-एक वैज्ञानिक दृष्टिकोण-A PARADIGM SHIFT TOWARDS EMPOWERMENT OF WOMEN (NSSC-2017)"*** on 3rd and 4th February, 2017. It gives me immense pleasure to pen a few words as prologue to this Seminar, exclusively meant for churning out skill based talks focusing on entrepreneurship in the field of sciences and supplementing as a part of overall development of students.

I feel contented to say that this seminar is a blend of traditional science and the recent innovative tools for entrepreneurship, with the acquisition of knowledge, skills and employability of our young talent, for the future leadership. I am convinced that the science departments painstakingly and gainfully developed this seminar-cum-workshop with the theme ***"सक्षम महिला-सक्षम समाज-एक वैज्ञानिक दृष्टिकोण"*** reflects that when all the constituents come together and work in unison, the expected results are bound to flow.

I appreciate the utmost relevant theme aiming at women empowerment and entrepreneurship. I congratulate all the science departments for bringing out such a meaningful event and wish the seminar all the success !

Dr. Anula Maurya
Principal

Message from Convener

Kalindi College, a premium constituent College of University of Delhi, is celebrating its Golden Jubilee Year in the academic session 2016-17. In order to celebrate the gala event of the golden Jubilee year celebrations, under the guidance and unending support of our able Principal, Dr. Anula Maurya, the Science departments of Kalindi College joined hands together to provide a platform for promoting science based skill enhancement in women and organized this two day DST sponsored National Seminar on ***"सक्षम महिला-सक्षम समाज-एक वैज्ञानिक दृष्टिकोण" -*** *A PARADIGM SHIFT TOWARDS EMPOWERMENT OF WOMEN*. This was an endeavor chosen for the interactive seminar on Alternative sources of energy, Digital India, Green Chemistry, Sustainable environment management on the principle of 4R's: Reduce, Reuse, Recycle & Recreate and Conservation of Medicinal Plants in India.

A series of interactive workshops cum hands on training sessions along with lectures by experts in the College premises formed an integral part of the seminar. The emphasis of lectures and hands on training was focused to equip young students of our and other colleges with information like how to go for start-ups, digitally market products, make herbal shampoos and other such products at home, make them aware about use and conservation of medicinal plants etc. I thank all the dignitaries for sparing their precious time to grace the occasion. I thank all members of advisory board, resource persons and chairmen for contributing to content of this seminar. I profusely thank Department of Science and Technology for funding this seminar. I sincerely thank all co-conveners and other members of organizing committee for all collective hard work put in for organizing this seminar. I hope all delegates enjoy the lectures and workshops of this seminar.

Dr. Pushpa Bindal
Associate professor
Department of Physics

Editorial

The endeavors chosen for NSSC-2017 were -Alternative sources of energy, Digital India, Green Chemistry, Sustainable environment management on the principle of 4R's: Reduce, Reuse, Recycle & Recreate and Conservation of Medicinal Plants in India. Thus this issue of academic journal on the proceedings of this seminar covers a wide range of topics ranging from green energy, optical fibers, spectrometry, thermocouples, LISICON and graphene to the Medicinal Plants and further to search engine optimization and analysis of impact of digitalization on Microfinance institutions.

This issue begins with an invited article by R. K. Kotnala et. al. featuring the future of power generation using Hydroelectric Cell (HEC) systems. It is foreseen that the energy produced by HEC can be utilized in domestic residential applications in decentralized mode at low cost because conventional usage of electrical energy is associated with huge expense of electrical transmission and distribution. T. Srivastava et. al. presents the design considerations of the optical fiber based day lighting system, comprising of sunlight capturing unit, optical fibers and luminaires. The two articles contributed by P. Verma et. al. are on PIXE: a method for composition analysis, and Rutherford Backscattering Spectrometry (RBS). Rachana Kumar et. al. analyses the influence of some external parameters on the efficiency and power generation capacity of thermo-electric generators and hence can be made suitable for usage in day to day activities as an alternative source of green energy.

Parul Yadav has discussed the fabrication and characterization of a potentiometric based ion selective membrane for pH sensor and Neetu Agrawal et. al. analyse strained graphene structures and show a novel effect viz. valley beam splitting. Another article also contributed by P.Verma et. al. gives a review of a technique named XRF: X-ray Fluourscence which has been used to determine the type and amount of pollutants present in various environmental samples say plants, soil, water etc.

Anuj Jain et. al explain functioning of MFIs in Pre digitalization period and new challenges to be faced by this industry in Post digitalization world. The article by Arokia Ramya Terrance focuses on the operational aspects of search engine and provides details of various search engine optimization techniques and SEO tools.

The next article under theme "Sustainable environment management on the principle of 4R's: Reduce, Reuse, Recycle & Recreate" is contributed by Ritu Payal et. al. which presents analysis on estimation of Sun Protection Factor (SPF) by using UV-Visible Spectrophotometer for cosmetic formulations. K. Pandey et. al.'s article on GreENergy is a pristine idea which refers to the generation of electricity using plants. Meena Yadav et. al have discussed the possibility of Disposable sanitary pads and sustainable environment.

Abhijitha C S et. al have reviewed the current status of the Indian medicinal databases and the bioinformatics tools and the techniques that are used in various fields of herbal plants and medicines, while the paper contributed by Riya Sharma et. al. reviews the achievements and the recent advances in the application of biotechnology in medicinal plants and the use of DNA Barcode to identify different medicinal plant species.

This issue of the proceedings thus encompasses all the subthemes covered in the conference and brings the essence of the same to the reader.

The Editoral Team

The emphasis of the interactive seminar was majorly on the following sub themes:-

I. *Alternative sources of energy*
II. Digital India (a) Digital Media (b) Digital Marketing
III. Green Chemistry
IV. Sustainable environment management on the principle of 4R's: Reduce, Reuse, Recycle & Recreate
V. Medicinal Plants in India : Tapping their potential for the society

A series of interactive workshop cum hand on training session along with lectures by experts in the College premises formed an integral part of the seminar. The emphasis of lectures and hands on training were on how to equip young students of our and other colleges with information like how to go for start-ups, digitally market products, make herbal shampoos and other such products at home, make them aware about use and conservation of medicinal plants to prepare homemade medicines etc.

NATIONAL ADVSORY COMMIITTEE

1. Prof. A. K. Ghatak Formerly Professor of Physics, I. I.T. Delhi, Delhi
2. Prof. Anurag Sharma Head, Department of Physics, I .I. T., Delhi, Delhi
3. Prof. V. K. Bhasin Department of Zoology, University of Delhi, Delhi
4. Prof. A. K. Singh Department of Zoology, University of Delhi, Delhi
5. Prof. Ruplal Department of Zoology, University of Delhi, Delhi
6. Prof. Neeta Sehgal Department of Zoology, University of Delhi, Delhi
7. Prof. Dinabandhu Sahoo Department of Botany, University of Delhi, Delhi
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10. Prof. Satish Kumar Awasthi Department of Chemistry, University of Delhi, Delhi
11. Prof. Anirban Pathak Department of Physics, J. I .I. T., Noida, Delhi
12. Dr. Govind Prinicipal Scientist, N.P.L., Delhi
13. Dr. R. K. Kotnala Chief Scientist, National Physical Laboratory, Delhi
14. Mr. Saurabh Pandit Director, Digital Media, Adobe India, Delhi.

ORGANIZING COMMITTEE

Patron — Dr. (Ms) Anula Maurya, Principal

Convenor — Dr. Pushpa Bindal, Associate Professor, Department of Physics

Co-Convenors (Executive Committee Members)

Area-I : Dr. Rachna Kumar, Department of Physics

Area-II(a) : Dr. Manisha Arora Pandit, Department of Zoology

Area-II(b) : Ms. Sweety Kataria, Department of Computer Science

Areas-III, IV : Dr. Tarkeshwar, Department of Zoology; Dr. Amit Kumar, Department of Chemistry

Area-V : Dr. M. Arunjit Singh, Department of Botany

Department of Science & Technology sponsored
TWO DAY NATIONAL SEMINAR
on
"सक्षम महिला, सक्षम समाज: एकवैज्ञानिक दृष्टिकोण: A PARADIGM SHIFT TOWARDS EMPOWERMENT OF WOMEN (NSSC-2017)" 3–4 February, 2017.

Technical Schedule for DAY 1, on 3rd February 2017.	
Venue: Sangam Parisar, Kalindi College.	
Registration	8:30-9:30 hrs
INAUGURAL SESSION **Chief Guest**: Prof. Krishan Lal, Co-Chair, IAP for Science, the Inter Academy Partnership, Immediate Past President, (AASSA) Immediate Past President, INSA, Former Director, NPL. **Guest of Honour:** Prof. Ravi Chaturvedi (Famous Cricket Commentator)	9:30-10:30 hrs
High Tea	10:30-11:00 hrs
Technical Session – I **Session Chair**: Prof. Krishan Lal, Co-Chair, IAP for Science, the Inter Academy Partnership.	
Invited Speaker: Dr. R. K. Kotnala, Chief Scientist, Head, Environmental Sciences and Biomedical Metrological division, CSIR-NPL, Delhi. **Title of Talk-**"A Green Energy Device Hydroelectric cell invention for masses" **Workshop-** "Demonstration of working of hydroelectric cell"	11:00-11:40 hrs 11:40-12:10 hrs
Technical Session – II **Session Chair**: Prof. Prem Lal Uniyal, Dept. of Botany, University of Delhi.	
Invited Speaker: Dr. Sunita Garg, Emeritus Scientist, CSIR-NISCAIR. **Title of Talk** –"Conservation & preservation of medicinal plants for environment protection and entrepreneurship prospects"	12:10-12:50 hrs
Workshop- Dry and Wet Preservation techniques for Plants Mr. R.K Khanna, Senior Technician-II, CSIR-NISCAIR.	12:50-13:30 hrs
Lunch Break + Poster Session	13:30-14:30 hrs
Technical Session –III **Session Chair:** Prof. C. K. Jaggi, Dept. of Operational Research, Faculty of Mathematical Sciences, University of Delhi.	
Invited Speaker: Ms. Bansari Vyas, Vertical Head, Facebook India. **Title of Talk-** "The Digital life- A great leveller"	14:30-15:10 hrs
Invited Speaker: Mr. Prateek Mundae, Founder, BA (ICT) Byte Matrix Pvt. Ltd. **Title of Talk**- "A beginner's guide to digital marketing"	15:10-15:50 hrs
Workshop: *by* Ms. Nishtha Chauhan, Byte Matrix Pvt. Ltd.	15:50-16:20 hrs
Technical Session –IV *Oral Presentations* **Session Chair (Sangam Parisar)**: Dr. Anjana Nanchal, Department of Botany, Kalindi College. **Session Chair (Conf. Room)**: Dr. Govind, Principal Scientist, CSIR-NPL.	16:20-17:30 hrs

Technical Schedule for DAY 2, on 4th February, 2017	
Venue: Sangam Parisar, Kalindi College.	
Technical Session –V **Session Chair**: Prof. A. K. Singh, Department of Zoology, DU.	
Invited Speaker: Dr. V. C. Kalia, Scientist G, IGIB, CSIR. **Title of Talk**- "Green Technologies for Clean Fuel and Bioplastics from Biological Wastes" (Includes Workshop)	9:30-10:30 hrs
Tea	10:30-11:00 hrs
Invited Speaker: Prof. S. K. Awasthi, Department of Chemistry, DU **Title of Talk**-"Rational Approach for Drug Discovery"	11:00-11:30 hrs
Invited Speaker: Prof. R. K. Sharma, Department of Chemistry, DU **Title of Talk**-"Green Chemistry Preventing Pollution and Health Hazards" Hands on Training on "Green Chemistry"	11:30-12:00 hrs 12:00-13:00 hrs
Lunch Break + Poster Session	13:00-14:00 hrs
<u>Technical Session –VI</u> **Session Chair**:.Prof. S. K. Awasthi, Department of Chemistry, DU	
Invited Speaker:.Mr. Lalit Kuashik (Synnova Power) Hands on Training- "Entrepreneurship in Renewable Energy Resources (Solar Equipments)"	14:00-14:30 hrs
Invited Speaker: Mr. R N Sharma and Mr. Deepak Saini (Clean India Ventures) Hands on Training- "GWR (Green Waste Reprocessor) an Entrepreneurship While Serving Environment"	14:30-15:00 hrs
<u>Technical Session –VII</u> *Oral Presentations* **Session Chair:** Dr. Priti Malhotra, Department of Chemistry, Daulat Ram College	15:00-16:15 hrs
Valedictory Session **Chief Guest:** Prof. Vinay Gupta (Dean Examination, DU) **Guest of Honour:** Prof. Anil Mishra (INMAS) **Lecture by distinguished guest:** Mr. H. P. Singh.(Senior Consultant, NIESBUD)	16:15-17:15 hrs

Schedule for Oral Presentations

Day 1: 3rd February, 2017			
Technical Session IV (A)-Venue-I (Sangam Parisar)			
S No.	**Title**	**Authors**	**Oral Presentations**
1	Tinospora: An excellent medicinal plant	K.Kumari	Venue-I
2	Bryophytes as herbal medicines	S.Soham, P.L.Uniyal, K.Shantanu	Venue-I
3	Flax seeds : A penecia to PCOS	P.Joshi, S.Avasthy, S.Jha, G.Malik, K.Pandey, T.Aggarwal, J.Taneja	Venue-I
4	In silico analysis of compounds from Indian medicinal plants against Dengue virus, DENV	L.Mishra, Divya, A.Verna, Shraddha, S.Sharma, M.Divya Gnaneswari	Venue-I
5	An Era of Computer-Aided Research in Medicinal plants	Abhijitha CS, A.Singal, D.Verma	Venue-I
6	Treasure of herbal plants in the Kalindi College	Archana, B.Pathak, Shivani, D.Verma	Venue-I
7	Recent advances in the application of biotechnology in Medicinal Plants	R.Sharma, S.Parveen, D.Verma	Venue-I
Technical Session IV (B) Venue II (TRI-Block)			
1	Search engine optimization - A critical element in Digital Marketing	A.R.Terrance	Venue-II
2	Impact of demonetization on Supply Chain in India	C.K.Jaggi, R.Jain, M.Verma	Venue-II
3	Delhi Metro: A potential and promising future alternative source of renewable energy	P.Verma, T.Sharma, R.Gupta, D.Bhardwaj, Neeta, S.Patwal, Kavita,	Venue-II
4	PIXE: A novel technique for sustainable environment management	P.Verma, R.Gupta, Ch.V.Ahmad, K.Chakraborty, T.Sharma, A.Gupta, S.Gupta	Venue-II
5	Rutherford Backscattering Spectrometry: An analytical technique for near surface layer analysis	P.Verma, T.Sharma, R.Gupta, Ch.V.Ahmad, K.Chakraborty	Venue-II
6	X-Ray Fluorescence and detection of contamination in environmental samples trace and ultra-trace levels	P.Verma, R.Gupta, Ch.V.Ahmad, K.Chakraborty, T.Sharma, A.Gupta, S.Gupta	Venue-II

Day 2: 4th February, 2017			
S No.	**Title**	**Authors**	**Oral Presentations**
Technical Session VII **Venue I (Sangam Parisar)**			
1	Blossoming of magmatic nanoparticles in Catalysis	M.Yadav, R.K.Sharma	Venue-I
2	Estimation of sun protection factor (SPS) by using UV- Visual spectrophotometer For Cosmetic Formulations	R.Payal, P.Malhotra, A.Jain	Venue-I
3	Chemistry of Textiles	S.B.Mehta	Venue-I
4	Green Energy	K. Pandey, T. Aggarwal, P. Joshi, S. Avasthy, S. Jha, G. Malik, J. Taneja	Venue-I
5	Role of dietary anti-oxidant in energy economy organism.	R.Roshan, M.N.Shakarad.	Venue-I
6	Handmade Paper Making by Eco-friendly Processes: Generation of acid free, chlorine free and azo free paper	A.Gupta, A.Bhatt, B.Sirohi, S.Mishra, V.Beria, Rimjhim, O.Verma, Nishtha, J.Rani, A.Gupta, J.Arora, M.Pathak, B.Roy, A.T.Sheikh, P.Jolly	Venue-I
7	Disposable sanitary pads and sustainable environment	M.Yadav, S.Goel	Venue-I

Schedule for Poster Session

DAY 1: 3rd February, 2017			
S No.	**Title**	**Authors**	**Poster No.**
1	Ferroelectric photovoltaic effects in Barium titanate thin film	S.Sharma, M.Tomar, N.K.Puri, V.Gupta	**P1**
2	Optical Fiber Technique: An alternative for day lighting systems	T.Srivastava, P.Bindal	**P2**
3	Synthesis of Mn doped LISICON material as ion selective electrode for pH sensing	P.Yadav	**P3**
4	Study of the generation of thermo-emf as an alternative source of energy using different thermocouples under various modified parameters.	R.Kumar, S. Gupta, Aparna, Swati, Tanvi, Anshul, Komal, Kajal	**P4**
5	Valley beam splitting using strained graphene structures	N.Agrawal, S.Garg	**P5**
6	A review on pharmaceutical and industrial prospects of some selected microalgae.	S.S.Devi, A.Mayanglambam, D.Sahoo	**P6**
7	A review on work on Datura stramonium L. in respect to its application and distribution	B.Bangari, A.Dharan, A.Mayanglambam	**P7**
8	Aconitiumluridum: anticoagulant, act as poison along with heparin and aspirin	Anupam, Tarkeshwar	**P8**
9	A review on medicinal plants of Kalindi College campus	S.Grover, S.Gupta	**P9**
10	Medicinal plant (Tinosporacordifolia)	Sadaf, S.Mudgal	**P10**
11	Medicinal Plants Cultivation – Arbuscular Mycorrhizal Fungi - Strigolactones: Can there be a link?	S.Tripathi, N.Bharti	**P11**
12	Miraculous medicinal boon – Genus Costus	P.S. Shruti, E.Sharma	**P12**
13	Digital India: A Challenge for Microfinance Institutions	A. Jain, K.Kumar	**P13**

DAY 2: 4th February, 2017			
S No.	**Title**	**Authors**	**Poster No.**
1	Green formulation of cosmetics and perfumeries using ionic liquids and cellulose.	P.Garg, K.Aggarwal, S.Sharma	**P1**
2	Green Formulation of Cosmetics and Perfumeries	A.Jain, M.Drall	**P2**
3	Mesoporous material as potential adsorbent for sequestering heavy metal ion from aqueous solutions	A.Jain, P.Malhotra,Shikha, Lovleen, Srijita, Parul, Jaismeen, Mahima, Aparna, Sujata	**P3**
4	Porous silica nanoparticles from rice husk for the purification of waste water	A.Jain, P.Malhotra, R.Payal, Sujata, M.Singhal	**P4**
5	An approach to protect environment: Microbial Fuel Cell	V.Bhardwaj, P.Kaushik, A.Kumar, Tarkeshwar	**P5**
6	Assessment of Packaged Foods for Microbial Contaminants	S.Beri, K. Vandana Rani, M.A. Pandit, A.Mayanglambam, A. Bansal, D.Dhiman, G.Vats, J. Goyal, Shehzadi, Abhijita CS, D.Sandilaya, J.Kaur, K. Singh, Prachi, Jhanvi, P.Pathak, N.Saini, Y.Khosla.	**P6**
7	Microbial Fuel Cell: A greener approach to protect environment	P.Khanna, Sangeeta, Tarkeshwar, A.Kumar	**P7**
8	Preparation of Biocompatible Palladium-Noscapine Nanoparticles for cancer therapy: A Green Approach	R.Kumar, N.Agarwal, S.Arora, K.Jha	**P8**
9	Understanding the Diversity, Evolution and Antigenicity of various taxa of the order *Mononegavirales* of ssRNA negative strand viruses	J.Kaur, A.Ahuja, M.Arora, S.Kaur, S.Sharma, S.Jalutharia	**P9**

INDEX

A Green Energy Device-Hydroelectric Cell Invention for Masses from India !!!

R. K. Kotnala* and Jyoti Shah†

* Chief Scientist & Head, Environmental Sciences and Biomedical Metrology Division

†DST-Women Scientist

CSIR, New Delhi-110012, India.

There have been a lot of efforts to make use of water based pollution free electrical energy source but a little success has been achieved in this direction. Recently, graphene oxide based battery of 0.1 cm^2 area at 70 %RH (relative humidity) has been demonstrated to produce maximum 2 µW power that too in presence of electrolyte [2]. Picowatt power generation using jumping water droplet from super hydrophobic surface to hydrophilic surface is also reported [3]. Cement matrix along with water has also been explored as a battery using different combination of electrodes [4]. A very low current 0.1 mA has been obtained out of 7 x 7 x 4 cm^3 cement electrolyte mould [5].

High positive free energy of water molecule needs high temperature to dissociate it. Water dissociation has been described by reducing ferrite at high temperature around 1200^oC followed by oxidation with H_2O for hydrogen gas generation. Water molecule dissociation temperature has been reduced to 850^oC by combining photosynthesis and water electrolyser [6]. Ideally at room temperature 1.23 V potential is required to split water molecule but the conductivity of pure water is very poor 0.055µS cm^{-1} so the reaction is very slow.

Recently published article in J of Energy research explored the water molecule dissociation characteristic of lithium substituted magnesium ferrite at room temperature for electricity generation [7]. Defects and porosity created in Li-substituted magnesium ferrite has been explored for water molecule dissociation and collection of ions achieved by placing zinc and silver electrodes on it to convert into a complete cell coined as "Hydroelectric Cell" (HEC). This cell currently exhibits a current density of 5 mA/cm^2 with voltage 0.9 V and maximum power output of 160 mW. HEC is low cost green source for producing a portable electrical energy source.

The reported invented HEC dissociates water molecule at room temperature without any external energy supply is a significant advancement in the development of green energy source to open a new area research. According to their investigations monovalent lithium substitution at divalent magnesium site has preferentially occupied octahedral site has created more defects in octahedral lattice. The most defective octahedral lattice fringes (111) are exposed on the ferrite surface confirmed by high resolution transmission microscopy. Moreover presence of hydronium ion charge at room temperature due to water molecule dissociation on the surface of lithium

substituted magnesium ferrite has been confirmed directly by electrostatic force microscopy besides ionic diffusion obtained by Nyquist plot. The coordinated defects on surface and inside nanopores generated enough potential for chemidissociation of water molecule at room temperature. Dissociated hydroxyl and hydronium ions get attracted towards the zinc and silver electrodes by capillary and surface diffusion. Hydroxyl ions get reduced at zinc electrode releasing two electrons. These electrons move toward silver electrode by external circuit and oxidation of hydronium ions at silver electrode liberates hydrogen gas. Thus HEC develops 920 mV cell potential and generates short circuit current 80 mA. The electric power capacity of the HEC depends upon the electrode/ferrite contact area.

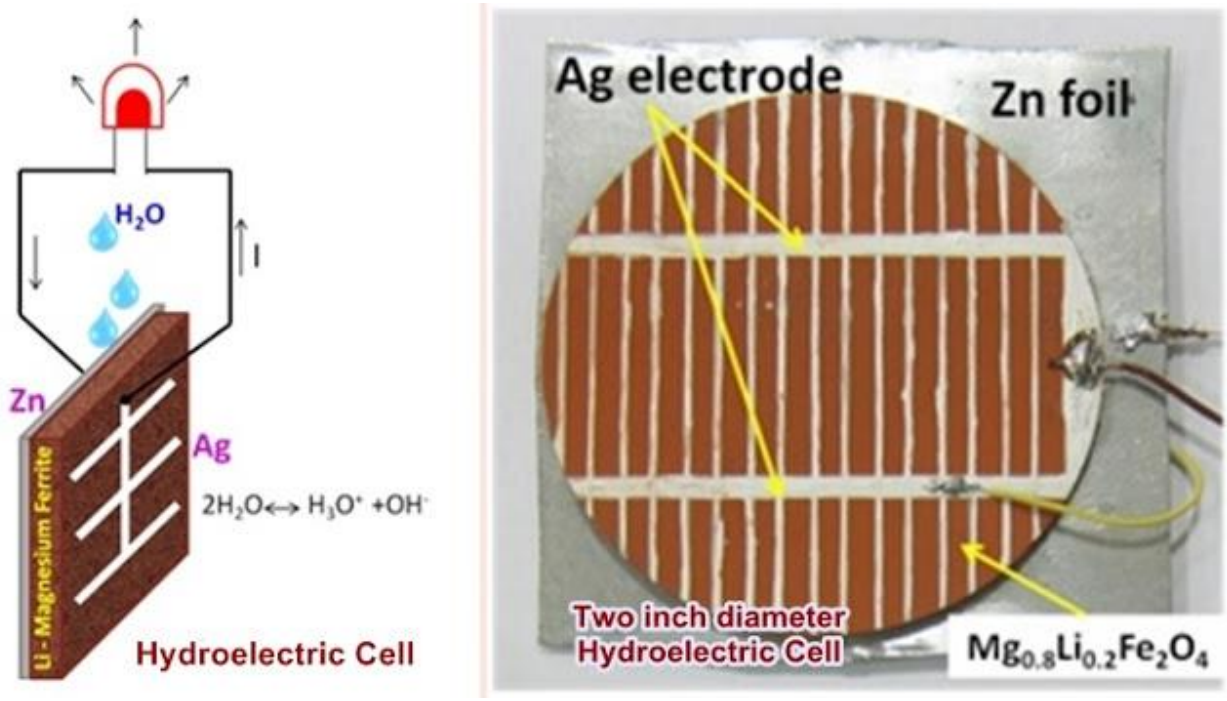

Figure 1. *Electricity conversion by adsorbing few drops of water by magnesium ferrite at room temperature. Nanoporous Li-substituted magnesium ferrite dissociates water molecules into Hydronium and hydroxide ions. Zinc and silver electrodes are attached to ferrite pellet to collect ions which ultimately generates electric current in the external circuit.*

Currently existing lithium ion batteries needs development of anode-protecting materials to maintain reaction rates. Also non-flammable electrolytes that are stable at high voltage and can tolerate temperature above 55°C. HEC working does not require any electrolyte which makes it safe. A nominal amount of water is needed for its operation thus it can also be run even in high humidity coastal regions.

Minimum weight, size and low cost are prerequisite for energy production system. Nevertheless current situation warrants innovative way of breakthrough in this direction. This has

been achieved in HEC. Hydroelectric cell has got a very high potential to establish itself a robust candidate for commercialization. However proving HEC basic working mechanism there is a big scope for its design development to yield more energy output delivery for longer times.

The energy produced by HEC can be utilized in domestic residential applications in decentralized mode at low cost because conventional usage of electrical energy is associated with huge expense of electrical transmission and distribution. Production and usage of such cells is not capital intensive unlike electrical power generation systems.

Technological improvements could make HEC as an electrical energy source imbibed with an economic reality in bigger scale. It can also supply the electrical needs of the household and in automotive engine as a clean energy source. Although a considerable amount of research is required to generate HEC cell panels like enhancement and their maintenance for large scale usage in the form of a power station. The future of power generation will certainly include HEC systems.

HEC that it shall prove superiority over solar cell & fuel cell application in future:

The potential role of hydrogen in the energy economy of the future is an optimistic view however its usage demands an elaborate set up due to its stringent safety protocols, dangerous explosive possibilities and high input cost of pure hydrogen impose a big constraints on hydrogen liberal usage as energy source for domestic applications. Most attractive option of hydrogen energy usage is fuel cell. A fuel cell directly converts chemical energy into electrical energy and its maximum theoretical efficiency is not bound by the Carnot cycle and device size. In fuel cell Electro-chemical reactions occur at catalyzed anode and cathode through a polymer electrolyte membrane (PEM) but output voltage of cell depends on operating conditions such as temperature, applied load and fuel/oxidizer flow rates. Use of Carbon paper & PEM besides high input cost of pure hydrogen gas makes fuel cell proposition very expensive for common man.

Another associated serious problem is hydrogen storage and safe delivery is a road block to mass commercialization of fuel cell for automotive and stationary applications. Hydrogen storage and delivery on a mass scale is a long term issue with certain reservations even today after 60 years of its first use. While at present nearly universally accepted, the future switching to a “hydrogen economy” will be extremely costly and will take decades to compete. Even though installing local hydrogen generation plant erection in select locations Government subsidy would be high. Although several initiatives to utilize compressed hydrogen in vehicles has been a reality at an exorbitant cost. At present a 600 km drive about 450 Kg Fuel system is required with conventional hydrides, as impractical dead weight for vehicles.

In dry cell modified form of Laclanche cell the negative electrode is made of an amalgam of zinc, mercury and cadmium to prolong the life and to produce steady state current of the cell. It

also reduces the rate at which zinc dissolves in cell liquid. Dry cell turns chemical energy into electrical energy with an efficiency of about 90%. In fact it is the most efficient way but expensive method of producing electricity and used chemicals, therefore not eco-friendly after its disposal. Ammonium chloride, MnO_2 used in dry cell are poisonous.

However proving HEC basic working mechanism there is a big scope for its design development to yield more energy output delivery for longer times. The energy produced by HEC can be utilized in domestic residential applications in decentralized mode at low cost because conventional usage of electrical energy is associated with huge expense of electrical transmission and distribution. Production and usage of such cells is not capital intensive unlike electrical power generation systems. Technological improvements could make HEC as an electrical energy source imbibed with an economic reality in bigger scale. It can also supply the electrical needs of the household and in automotive engine as a clean energy source. Although a considerable amount of research is required to generate HEC cell panels like enhancement and their maintenance for large scale usage in the form of a power station. The future of power generation will certainly include HEC systems replacing solar cell and fuel cell.

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Optical Fibre Technique: An alternative for day lighting systems

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Abstract *The illumination of building interiors by natural day light is highly effective for indoor environment and healthy in comparison to the artificial lighting systems. Moreover, day lighting systems play a significant role in reducing electrical energy consumption. Typically, the day lighting systems use windows, doors, skylights, sun dome, light pipes etc. for illumination, but these basic systems have constraints on architectural features, therefore, can not be used to illuminate the most interior areas of multistoreyed buildings/undergrounds. Moreover, additional cooling systems are also required to overcome the heating effects of these systems. Recently, optical fibers have been suggested as an alternative for day lighting systems. In this work we present the design considerations of the optical fiber based day lighting systems.*

The optical fiber technique for day lighting systems is employed to harness the sun light and transports the energy to the deepest recesses of the building. It not only provides the advantage of reduced electrical energy consumption, but also gives a healthy indoor environment by avoiding ultraviolet and infra-red radiation, thereby enhancing the quality of indoor lighting systems and making it a desirable and useful study.

Keywords: Optical Fibers, Day lighting systems, Renewable energy.

1. INTRODUCTION

The use of natural sun light in our daily life is essential and highly recommended for better health; however, nowadays work culture does not allow sufficient sun light exposure. Scientifically it has been proven that the sun light reduces the recurrence and impact of illness(Dunne, 1989, Ullah 2012). Therefore, for illumination of buildings/offices natural sun light, known as day lighting is preferred, which, not only reduces the electrical energy consumption but also creates a beautiful visual appeal. In sustainable development the emphasis is given to illuminate the building interiors using day lighting. The architectural design has a significant consideration of accessing sun light through windows and doors. Such kind of illumination is non-uniform and inconsistent, due to which some area remains dark. Therefore the progress in day lighting systems has resulted into new techniques, such as skylights, sun dome and light pipes. It is to be mentioned here that these techniques are installed on the roof top to capture the sun light. However, it is difficult to capture the sun light throughout the day. A sun tracking module should be implemented to collect the day light with maximum efficiency. Therefore, an optical fiber

based day lighting system is designed and realized, which has high efficiency as compared to other day lighting systems (Ullah et al. 2014 and Roseman et al. 2008). This technology addresses all the above mentioned issues.

In this work, we are studying the design and texture of the entire proposed optical fiber technology in day lighting systems.

2. DESIGN CONSIDERATIONS

The fiber optic day lighting system comprises of sun light capturing unit, optical fibers and luminaires. The sun light is collected using parabolic/Fresnel lenses and imaging systems and then coupled to the appropriate optical fiber bundle which guides and carries it to the interiors and is thereafter, distributed through the luminaires. The detailed design considerations are discussed below:

2.1 Sunlight Capturing Unit:

The performance of the day lighting systems highly depends on the efficiency of the sunlight capturing unit, which would optimally collect the sun light and focus to a small area. The two types of configurations which are mainly employed are parabolic reflectors and Fresnel lens as discussed below:

(a) Parabolic reflectors

A fiber-glass based parabolic reflector with large aperture size and small f/D ratio (fis focal length and D is diameter of parabolic mirror) is used to collect maximum sun light. Such configuration uses a combination of convex and concave parabolic mirrors. The sunlight is incident on the concave parabolic mirror which is focused at its radius of curvature and further, reflected back and collimated by the convex parabolic mirror(Figure 1). In order to achieve maximum reflection and collimation, following condition should be satisfied:

$$f1=f2 \tag{1}$$

where f1 and f2 are the focal lengths of the concave and convex parabolic mirrors, respectively.

The collimated light is then coupled to the optical fibers. The uniform distribution of the light is achieved if:

$$D_{concave} = D_{convex} \tag{2}$$

where, Dconcave and Dconvex are the diameters of the concave and convex parabolic mirrors respectively.

It is to be mentioned that in order to focus the sunlight optimally, the thickness variation in the parabolic reflector should not be greater than 1/20 of the incident wavelength. The visible light

has a wavelength range ~ 400- 700 nm, hence the thickness of the reflector must be correct to within about 20 nm.

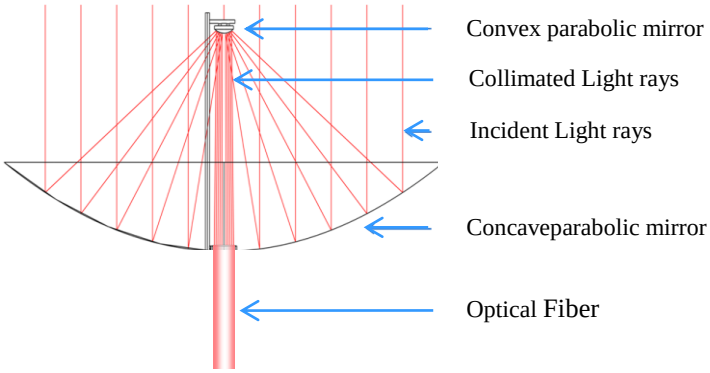

Figure 1. *Schematic of parabolic reflector design.*

(b) Fresnel Lenses

Fresnel lens is a collection of large number of normal lenses designed in a suitable mannersuch that, it cumulatively provides a short focal length as shown in Figure 2.

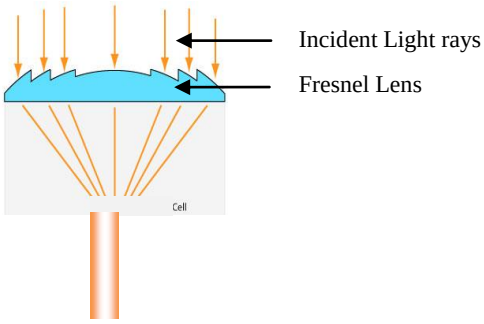

Figure 2. *Schematic of Fresnel Lens.*

The effective focal length of Fresnel Lens Feffis given by:

$$F_{eff} = r/(n-1) \quad (3)$$

where r is the radius of Fresnel lens and n is the refractive index of the material used.

The Fresnel lens apart from focusing the light to the smaller spot size, alsofilters out some of the infrared and ultraviolet light spectrum. The reason is attributed to the fact that due tochromatic aberration,different wavelengths gets focused at different distances from the lens. The fiber ends are placed in the focus for the visible wavelengths where the infrared and ultraviolet rays are less dense.

Fresnel lens collectors tend to be smaller than parabolic mirrors and can be used in smaller areas due to their relatively compact design.

As we know that the altitude as well as the azimuth of the sun changes, hence a two way stepper motor with a micro-controller is required to be installed with the mirror, so that they turn the mirror to the correct alignment, thereby achieving high performance.

2.2 Optical Fibers

The light focused with the parabolic reflector/Fresnel lens is coupled to the end of optical fiber and thereby, guided and transmitted through it.The usage of optical fibers for the transmission of sun light makes daylight available to the inaccessiblespaces, such as interior spaces of multistoreyed buildings. As discussed earlier the ultraviolet and infrared radiations, which produce heat, is not transmitted through the optical fiber cables, which reduces the need for space cooling.

Typically, silica fiber is one to the options for the light transmission due to its low loss ~ 0.2 dB/km (single mode fiber) at telecommunication wavelength 1550 nm. However, the loss is ~ 2.7 dB/kmin the visible range of spectrum, which is still small enough for long length (~ few hundreds of meters) propagation. But, such fibers are expensive and the light coupling requires high precision, due to its small core diameter. On the other hand, large core (~ few millimeters to 1 cm core diameter) plastic fibers are low cost and have flexibility and strength. These fibers exhibit high loss as compared to the silica fibers [Ghatak et al.]. Figure 3, illustrates the variation of percentage loss with respect to length of plastic fiber for the attenuation factor ~ 20 dB/km.

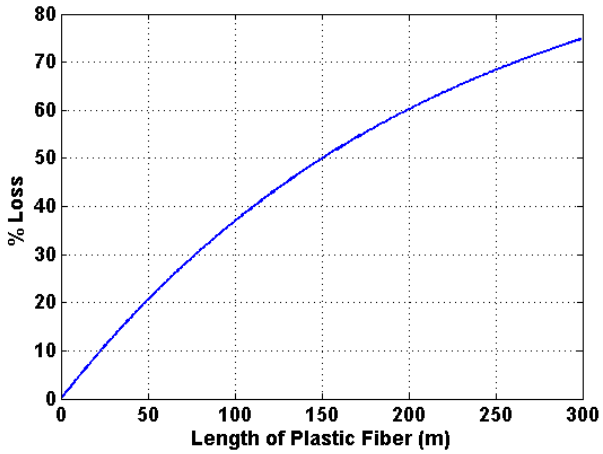

Figure 3.*Variation of percentage loss with respect to length of plastic fiber for attenuation factor 20 dB/km.*

It is observed that, at the length ~ 150 m, 50% of the coupled energy is lost, which imposes an inherent constraint on the length of the optical fiber. However, this length is sufficiently large for illuminating multi-storeyed buildings. The plastic fibers also have other advantages as compared

to the silica fiber, such as large bending radius typically, of the orders of few centimeters, which can efficiently be used for wiring of optical fibers.

It is to be mentioned, that apart from using single optical fiber it is beneficial to employ fiber bundle, because the thin fibers have lowmicrobending losses [Shenoy et al]. Moreover, at the output end, each fiber can be separated out from the fiber bundle and can be distributed at different regions of the space, thereby enhancing the efficiency of the day lighting system.

2.3 Light distributors and Luminaires

The appropriate distribution of the light at the desired location is also important for day lighting systems. There are mainly two types of techniquesemployedfor day light illumination. In order to illuminate the entire room, the diffusive lenses/prisms are used in the proper fixtures, called luminaires. On the other hand, the spotlight/concentrated lightening areachieved by End emitting/Side emittingoptical fibers or hollow light pipes.

3. CONCLUSIONS

In this work, we discussed the shortcoming of the conventional day lighting systems and presented the design considerations of the optical fiber based day lighting system, comprising of sunlight capturing unit, optical fibers and luminaires. Such a system is used as an alternate source of energy; harvesting the sun light energy and reducing the electrical energy consumption.

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PIXE: A novel technique for sustainable environment management

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Abstract: *Present paper is a review of implementation of PIXE technique to detect heavy metal concentration in environmental samples around the world in the past 30 years. PIXE, a versatile method for composition analysis, is non-destructive and has high sensitivity and multi-element detection capacity. It has been observed from the literature survey that PIXE has high sensitivity in detecting elements with atomic number in the range of 3<Z<92 in trace and ultra-trace amounts in both thick as well as thin samples. Tested samples discussed in this paper include soils, vegetables and fruits, plants, flour and bread, tree rings, snow, ground water, fly ash and coal. The samples were irradiated with 2-3 MeV proton beam and the emitted x-rays were detected and then analyzed using suitable x-ray detectors and software. From the inference of the review study it has been realized that utilization of this technique in Delhi will help to identify various pollutants and their concentrations in environmental samples of different regions at trace and ultra-trace levels with high accuracy. Sample collection and preparation has been initiated from different areas of the capital city. These samples will then be analyzed with PIXE to determine their metal contamination concentrations. The knowledge so obtained can then be used constructively to recognize high pollutant absorbing vegetation species and soil types. Various suitable methodologies can then be devised to stop further contamination followed by implementation of better scientific ways to reduce the level of pollution. This will ultimately lead to sustainable management of environment.*

Keywords: PIXE, environmental samples, Si(Li), LEGe, Ultra LEGe, x-rays.

1. INTRODUCTION

The inter-dependence of human-ecosystem drives nature and sustainability is the key to maintain this equilibrium. Unfortunately unregulated development along with excessive usage of conventional resources over the past century has inadvertently disrupted the human-ecosystem balance contributing to atmospheric contamination. The repercussions of accelerated industrial growth have been reduction in the dimension of contaminating particles. As the particle size decreases, its ability to seep through soil and vegetation increases. Consumption of food grown on

such soil by humans or animals paves way for the pollutants to enter the body and cause diseases like cancer.

Sustainability can be achieved by environment management. This includes first defining the problem clearly and then develop suitable methods to rectify or control the situation. In this case, the problem constitutes detection of heavy metal pollutants in environmental samples using basic atomic phenomenon. Presence of even small concentration of heavy metals like lead in human body can have dangerous effects on the nervous system. To counter the problem it is foremost to identify the areas most affected by heavy metal contaminants. For this we require effective techniques that can detect presence of heavy metal contaminants in environment samples like soil and vegetation in even ultra-trace amounts. This forms our solution which is Particle Induced X-ray Emission or PIXE. PIXE is a non-destructive, highly sensitive and versatile accelerator based technique to detect elemental composition of a sample which has the advantage of multi-element detection capability. The sample can be tested in a vacuum environment as well as in atmospheric pressure. The determination of trace levels of elements in biological and food matrices is accompanied by interference problems. The interfering ions have to be separated by certain procedures which are all time consuming and may result in loss of elements in the sample [1]. PIXE can accomplish the determination with minimum interference problems.

In this paper the use of PIXE technique to detect heavy metal contamination of plants, vegetables, fruits and soil samples from around the world have been discussed. The methodology used and the results obtained have been studied, analyzed and summarized here.

2. METHODOLOGY

2.1 Basic principle of working

Emission of x-rays is an inherent characteristic of all elements. When vacancies are created in the inner-shells of an atom of an element by any external method like bombarding the atom with high energy ions, electrons from higher energy levels transit down to fill those vacancies. During the transition, photons having energy equal to the energy difference between the levels from which the electron has come and the level to which the electron has jumped down to fill the vacancy, is emitted. These photons are called characteristic x-rays and are unique to every element, as shown in Figure 1. PIXE takes advantage of this uniqueness of characteristic x-rays to identify the type of element present in a sample.

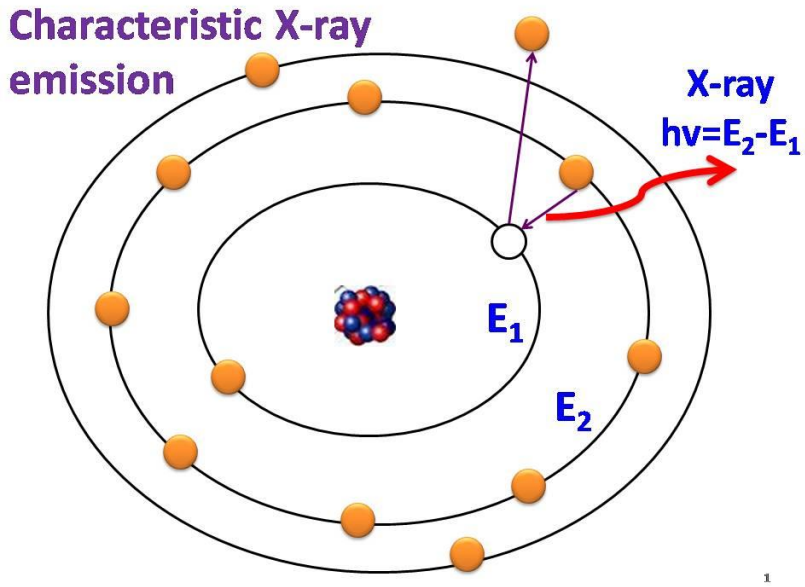

Figure 1. *Schematic representation of the emission of characteristic X-radiation by exciting a K-electron and refilling the vacancy thus created with an L-electron.*

PIXE is an accelerator based technique in which there is an ion-source which produces desirable ions like protons in case of PIXE. The ions are then accelerated by the accelerator to achieve required energy. When this ion beam of moderate energy is impinged on a target, the ions interact with the neutral target atoms resulting in emission of x-rays which are characteristic of the elements present in the target. These x-rays can then be detected using suitable x-ray detectors and the spectrum so obtained is analyzed to identify the elements present in the target sample and their concentrations. This process forms the basic principle of working of PIXE method.

Even though PIXE is a particle induced process but proton beam is preferred and sometimes helium too over other heavier particles. The reason behind this is that proton is the lightest particle and has smallest interaction as far as mass is concerned. The interaction of energetic proton (moderate energies achieved by accelerating protons with an accelerator) with other heavier elements does not alter the elemental configuration of the target whereas interaction of heavy elements like Carbon with the target sample will lead to heavy-ion atom collision processes leading to destruction or alteration in the elemental configuration of the target. As a result, PIXE is a non-destructive process which is highly desirable.

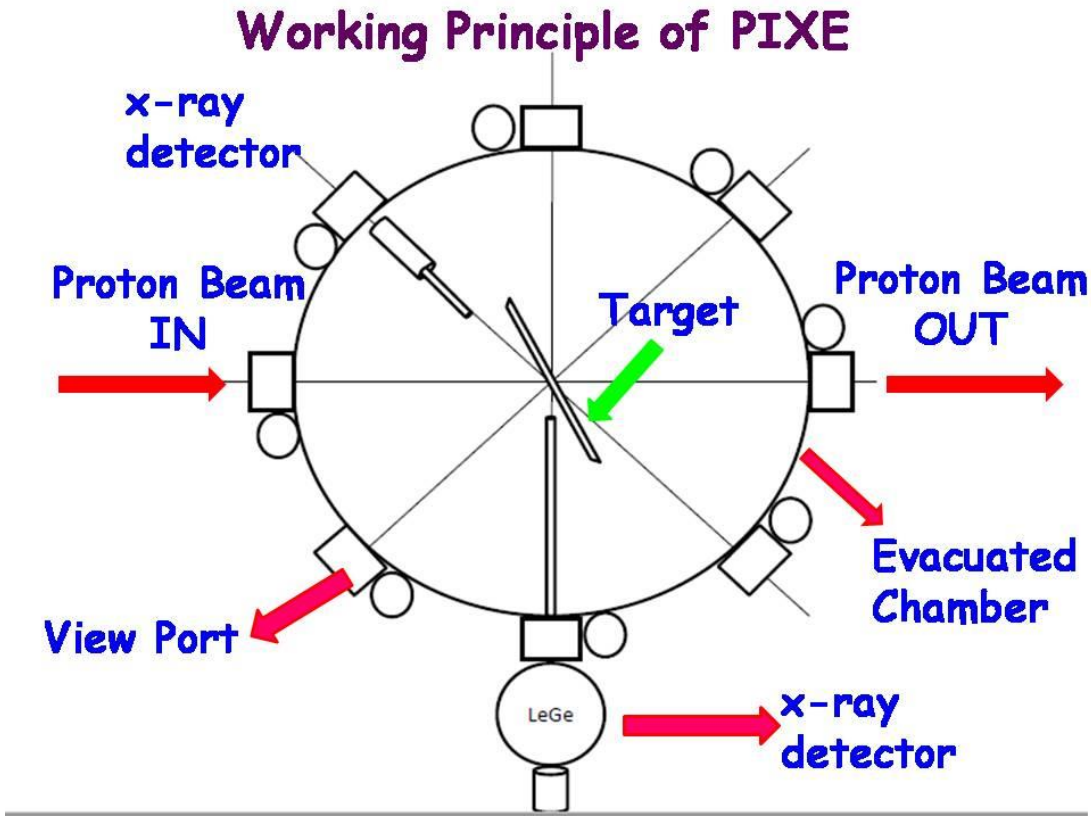

Figure 2. *Schematic representation of PIXE set-up and technique.*

2.2 *Sample collection and target preparation*

2.2.1 Environmental sample preparation. From the literature survey, as summarized in Table 1, it was observed that PIXE has been used extensively to analyze a wide variety of samples that include aerosols, soils, vegetables and fruits, plants, flour and bread, tree rings, snow, ground water, fly ash and coal. It was also observed that samples have been collected from both pollution affected and non-affected regions.

Based on the inferences drawn from literature survey, soil and plant samples have been collected from two places, Kamala Nehru Ridge and Azadpur traffic intersection in Delhi, India. The places were chosen for sample collection to draw a comparison for pollutant contamination levels between a well maintained biodiversity park i.e, Kamala Nehru Ridge and a heavily polluted area i.e, Azadpur traffic intersection. Similarly, aerosol samples have been collected from Mahipalpur and Dhaula Kuan intersection.

Aerosol samples were prepared using High Volume Sampler capable of collecting air particulate samples in PM10 (aerodynamic diameter≤ 10µm) on Glass micro fiber filters having diameter of 46.2µm and PM2.5 Sampler capable of collecting air particulate samples in PM2.5 (aerodynamic diameter ≤2.5µm) on Poly tetra fluoro ethylene (PTFE) filters having dimensions of 20.3 x 25.4 cm. The sampling time was about 4-5 hours.

For preparing plant sample targets, samples were collected and washed in tap water and rinsed thoroughly in doubled distilled water to remove surface contamination. The samples were then oven dried at 60^0C for about 24 hours and homogenized in agate mortar. The powdered samples were then mixed with high purity graphite powder in 3:2 ratio and the final mixture was compressed to form pellets of various diameters and thickness. Similarly, soil samples were collected and sieved to separate small stones & plant debris. The sieved samples were then pulverized and homogenized in agate mortar. They were then air dried and pressed to form pellets of various diameters and thickness.

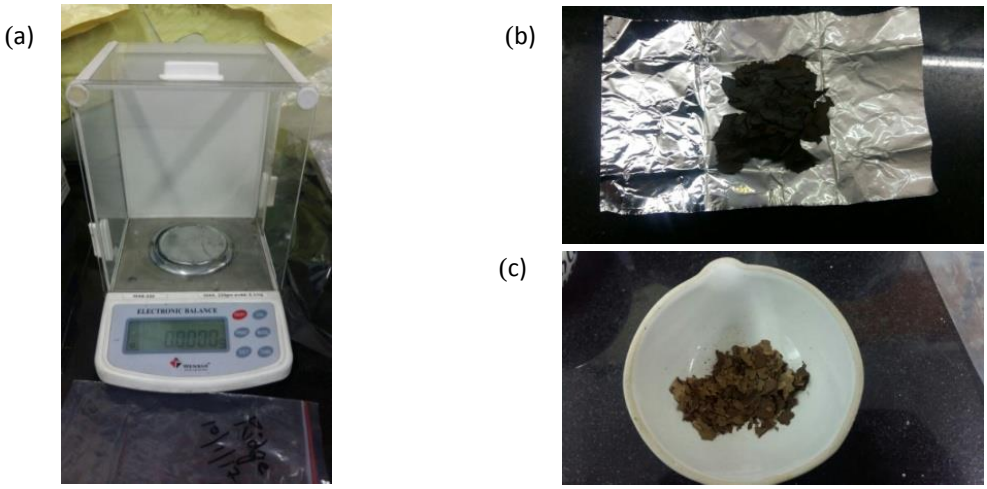

Figure 3. *(a)Electronic weighing balance for weighing plant samples. (b) Sample on an aluminium foil. (c)Oven dried sample in china dish .[Photos courtesy of Dr. Chirashree Ghosh, Env. Sc.Dept, DU].*

2.2.2 Elemental target fabrication. The technique for target preparation is chosen depending on the thickness and the properties of target material. There are different types of methods through which target can be prepared which include electron vapor deposition, resistive heating, rolling machine and pellet making press. In this section preparation of elemental target like gold, bismuth etc. has been discussed [2]. Target lab at IUAC provides us facility to prepare solid targets. The high vacuum chamber is used for fabrication of foils of materials.

Basic steps for preparation of elemental target are as follows:

- A rectangular glass slide is coated with $BaCl_2$ which acts as a releasing agent; thermal evaporation method is used for $BaCl_2$ deposition.

- The slide is kept in the chamber on a stand which is at certain height from the crucible and sample to be deposited on it is kept in the crucible. The electron vapor deposition method is used to deposit the material on the glass slide.
- Either carbon is deposited on $BaCl_2$ coated glass to provide support or the element can be directly deposited on the $BaCl_2$ coated glass.
- After deposition, the target can be then floated on water after being scratched into square shapes with the help of sharp blade. These are then lifted on target holders.

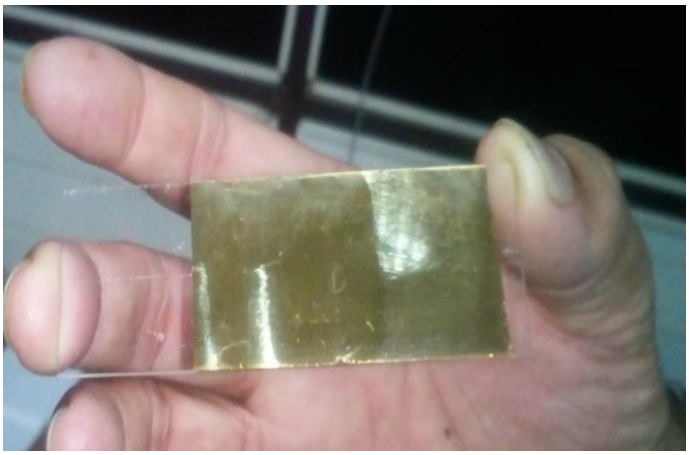

Figure 4. *Au target with carbon backing deposited on a glass slide.*

3. EXPERIMENTAL PROCEDURE, DETECTOR PECIFICATIONS AND DATA ACQUISITION TECHNIQUES

3.1 Accelerator machine details

It has been inferred from the literature survey that the experiments had been conducted using a proton beam of energy 2.0 MeV to 3.0 MeV. Protons of this energy range are non-destructive and hence keep the composition of the target intact during the course of the experiment. The overheating of the targets had been avoided by optimizing the beam energy as well as the beam current which in most cases had been kept in the range 3 nA to 250 nA depending on beam energy and target thickness. Irradiation time had not been exceeded beyond 30 minutes.

Based on the observations from literature survey, the energy of the proton beam to be used to irradiate the samples will be decided by range calculations to be done using SRIM software [3]. Similarly, beam current and irradiation time will be set in accordance with target thickness. The accelerating machines to be used for the purpose will be Folded Tandem Accelerator (FOTIA) [4] at BARC, Mumbai for proton beam and PARAS [5] accelerator facility at IUAC, New Delhi for helium beam. Further, the irradiated targets will be analyzed further for composition identification

using Rutherford Backscattering (RBS) technique at PARAS, IUAC. PIXE along with RBS will give an accurate description of the elemental composition of environmental samples.

3.2 Detector specifications and Data acquisition systems

The emitted x-rays will be detected using Si(Li), LEGe [6], or Ultra-LEGe [7] x-ray detectors all of which are solid-state detectors. Their basic working principle is same. When radiation falls on the depletion region of the detector crystal, electron-hole pairs are created which are swept to the opposite electrodes under the applied reverse bias and constitute current which appears as a signal after processing through required electronics. Before using the detectors in the experiment to identify x-rays of unknown energy, energy and efficiency calibration of the detectors will be performed using radioactive sources Am-241, Fe-55 and Co-57. The resolution of Si(Li) detectors is 30 keV and below, for LEGe detectors it is 3 keV to 500 keV and for Ultra LEGe it is 0.3 keV to 300 keV at 5.9 keV energy [8]. From the literature survey it was found that analysis of the x-ray spectrums obtained by these detectors have not shown any variation and all the above mentioned detectors have delivered successful results.

The energy and efficiency calibration data will be acquiesced using CAMAC controller and analyzed with ORIGIN, ROOT, GNUPLOT or similar softwares all of which give satisfactory results. For analyzing PIXE spectra, literature survey points out that the preferred software for spectrum analysis was GUPIX [9] though DATTPIXE, SAPIX, and LEONE have also been favored. But GUPIX is preferred over others because of its easy availability and user friendly attributes. GUPIX provides a non-linear fitting of the PIXE spectrum and provides information on the elemental concentrations of the tested sample. The concentration of a specific element in the tested sample can be found using the formula [10]:

$$C_Z = \frac{Y}{Yt\varepsilon QTH} \quad (1)$$

where CZ is the concentration of the element to be calculated, Y and Yt experimental and theoretical intensity of X-rays, Q is the measured proton beam charge, ε is the efficiency of the detector used, T is the transmission coefficient for transmission through any absorber or filter between the target and the detector and H is the hybrid parameter.

Ref. No.	**AREA OF STUDY**	**SAMPLE**	**ENERGY (MeV)**	**REFERENCES**
11		Plants	2.6	S. Szymczyk *et al.*,, NIM B 181 281-284(1981)
12		Annual tree rings, snow, groundwater, river sediments, fly	3.5	G.S. Hall *et al.*, NIM B 3 431-435(1984)

		ash & coal		
13	Africa	Aerosols	2.4	W.Maenhaut *et al.*, NIM B 22,254-258 (1987)
14	Japan	Aerosols	3.0	M.Kasahara *et al.*, NIM B 75, 240-244 (1993)
15	Mexico city	Aerosols	4.5	Javier Miranda *et al.*, Atm. Env. 28, 2299-2300 (1994)
16	Nigeria	Medicinal plants	3.5	S. O. Olabanji *et al.*, Bio. Trace Element Res. 1-12 (1995)
17	Greenhouse	Plants	2.0	Thorsten Schneider *et al.*, NIM B 158, 329-334 (1999)
18	Kyoto & Seoul	Aerosols	2.0	Chang-JinMa *et al.*, Atm. Env. 35,747-752 (2001)
19	USA	Soils	2.0	Hakan Wallander *et al.*, FEMS Microbiology Ecology 39, 147-156 (2002)
20	Lebanon	Soils	1.0	B. Nsouli *et al.*, NIM B 219-220, 181-186 (2004)
21	Hidalgo	Soils	3.0	C. Soils *et al.*, NIM B 241, 351-355 (2005)
22	Visakhapatnam	Plants	3.0	G. J. Naga Raju *et al.*, Applied Radiation and Isotopes 64, 893–900 (2006)
23		Soil & vegetables	2.0	K. Dias da Cunha *et al.*, NIM B 243, 179–186 (2006)
24	Manipur	Plants	2.4	K. Nomita Devi *et al.*, NIM B 266, 1605-1610 (2008)
25		Sand & Soil	2.5	A. Markwitz *et al.*, NIM B 266 4010–4019 (2008)
26		Plants	3.0	Antoaneta Ene *et al.*, Environmental & Earth Phys. 806-814 (2009)
27	Europe	Soils	2.5	Geoffrey W. Grime *et al.*, X-ray Spectrom 40, 210-214 (2011)
28		Tomato, cabbage, pepper, and parsnip	3.0	Ana Pantelica *et al.*, Romanian Reports in Physics 63 997–1008 (2011)

29	Andhra Pradesh	Plants	3.0	S. Abdul Sattar *et al.*, X-ray Spectroscopy 41, 111-116 (2012)
30	Andhra Pradesh	Plants	3.0	S. Abdul Sattar *et al.*, J. Radioanal Nucl. Chem 294, 337–341 (2012)
31		Plants	3.0	Benedetta Cestone *et al.*, Sci of Total Env. 427–428, 339–346 (2012)
32	Nigeria	Soils	2.5	E. P. Inyang *et al.*, Soil & Tillage Research 124, 178–182 (2012)
33	Nigeria	Soils	2.5	Inyang Ephrains P *et al.*, Springer Plus 2, 208 (2013)
34	Greenhouse	Plants	3.0	Lyudmila Lyubenova *et al.*, Journal of Hazardous Materials 248– 249, 371–378 (2013)
35	Tehran	Aerosols	2.0	N. Esmaili *et al.*, Environ Monit Assess 186, 7512 (2014)
36	Nigeria	Aerosols	2.80	G. C. Ezech *et al.*, NIM B 334, 28-33 (2014)
37	Israel	Aerosols	2.4	Willy Maenhaut *et al.*, NIM B 3318, 119-124 (2014)
38		Flour bread samples	1.220 2.220	Felix S. Olise *et al.*, NIM B 318 207–210 (2014)
39		Plants and soil	3.0	K. Ishii *et al.*, NIM B 332 46–49 (2014)
40		Plants	1.8	S.O. Olabanji *et al.*, NIM B 318 187–190 (2014)
41	Jamaica	Aerosols	2.3	Johan Boman *et al.*, NIM B 363, 131-134 (2015)
42	South Africa	Plants	3.0	S.Groeber *et al.*, Biologia Plantarum 59 (4), 560-569 (2015)
43	Spain	Plants	2.8	Paula Madejon *et al.*, Environ Monit Assess 187, 663 (2015)
44	Brazil	Soils	2.5	Melissa Rosa de Souza *et al.*, Chemosphere 139, 512–

				517 (2015)
45	Bangladesh	Vegetables	2.2	S. Akter *et al.,* Bang .J. Phys.18 73-79 (2015)
46		Dumpsite soils and vegetables	2.5	Olabanji I. O. *et al.,* J. Env. Chem. Ecotox. 7, 1-10 (2015)
47		Fluted pumpkin leaves	2.5	Akpan Ita Okon *et al.,* Eur. Sc. J. 11 373-383 (2015)
48		Aralia armata Seem, Arundodonax Linn, Calotropisgigantea Linn, Cassiaalata Linn, Desmodiumgangaticu m DC	2.5	R.K. Bhanisana Devi *et al.,* NIM B 343, 163–166(2015)
49		Soil & Vegetables	2.5	M. R. Rahman *et al.,* Int. J. Env. Sc. Dev. 7, 16-21 (2016)
50		Rice shoot	2.0	S. Bado *et al.,,* NIM B 371 407–412 (2016)

4. RESULTS AND DISCUSSIONS

Some authors studied the contamination in atmospheric aerosols using PIXE technique seasonally; some studied day and night and at different sites i.e., commercial, industrial and gave their inferences. Maenhaut & Akilimali *et al.,* (1987) [13] compared the contamination in aerosols of two locations, i.e., Kinhasa and Butare. The elements Br and Pb were found to be highly enriched at both locations and their concentrations were also similar. They also studied the samples day and night and found that K concentration is high in night samples than day samples. Kasahara *et al.,* (1993) [14] investigated the preferable measurement conditions for PIXE analysis of atmospheric aerosols and found that analysis by lower beam energy using a thinner absorber was suitable for lighter elements and analysis by higher beam energy using thicker absorber was suitable for heavier elements. Miranda *et al.,* (1994) [15] analyzed atmospheric aerosols samples and found that the analysis gave information on elements which are heavier than Ne. 17 elements were found by PIXE in fine mass while 20 were detected in coarse fraction. Ma C.J. *et al.,* (2001) [18] studied the characterization of atmospheric aerosols in winters and found that carbonaceous materials and ammonium salts such as NH_4 NO_3 and $(NH_4)_2SO_4$ are the major components in fine fraction. Esmaili *et al.,* (2014) [35] did elemental analysis of aerosols in 4 seasons in Tehran and found that total mass concentration increases from spring to winter. Hence Tehran is highly polluted in winter and the dominant elements of air pollution are Ca, Fe and Si. Ezech *et al.,* (2014) studied elemental composition of $PM_{10\text{-}2.5}$ and PM_{10} aerosols during rainy season and determined elemental concentrations of about 24 elements in coarse and fine fractions of

suspended particulate matter. Maenhaut *et al.,* (2014) [37] studied fine aerosols seasonally for ten years and found that concentration of S varies seasonally the most and determined that its concentration was 1.6 times higher in summer than in other three seasons. Boman & M. Gaita *et al.,* (2015) [41] studied the elemental composition of $PM_{2.5}$ at an industrial site. Concentrations of Si, S, Cl, K, Ca, Ti, V, Cr, Fe, Ni, Cu, Zn, Br and Pb were determined and hence concluded that air quality is bad in the studied area.

Schneider *et al.,* (1999) [17] studied the accumulation of Cd uptake in roots and shoots of plant Brassica juncea L. and its resulting effects on elemental distributions of Cd treated plants using PIXE analysis. They observed major alterations in Cd stressed plants than controlled plants. S content was high in root hair zone (RHZ) of Cd stressed roots than of the controlled root. Raju *et al.,* (2006) [22] analyzed the presence of trace elements in anti-diabetic medicinal plants and found 13 elements in which Cl, K and Ca concentrations were major and Fe concentration was the highest in all plants. The study justified the usage of these medicinal plants for the treatment of Diabetic Mellitus as these plants provide appreciable amount of required elements like K, Ca, Cr, Mn, Cu and Zn other than diet to the DM patients. Nomita Devi *et al.,* (2008) [24] employed PIXE and PIGE techniques to determined trace elements in some medicinal plants and found concentration of medium Z elements like K, Ca, Mn, Zn, Fe, Sr, Rb, Cu by PIXE analysis and light elements using PIGE analysis. The concentration of elements varied in studied plants but found that concentration of Mn and Zn were high in certain samples. Authors analyzed some anti-cancer medicinal plants, some anti-diabetic medicinal plants, some anti-epileptic medicinal plants in order to find out trace elements in these plants and to justify whether these plants are relevant in the development of various drugs. Sattar *et al.,* (2012) [30] analyzed 12 anti cancer medicinal plants and 10 anti-epileptic medicinal plants and determined trace elements Mn, Zn, Se, Ca and V. This study gave justification for the usage of these plants in the preparation of anti-cancer and anti-epileptic drugs as no toxic heavy elements like As, Pb, Hg were detected. Cestone *et al.,* (2012) [31] studied the spatial distribution of copper in roots and leaves of B.Carinata plants that were exposed to CuEDDS and found that the free Cu ions are more toxic to plants than the CuEDDS complexes. Lyubenova *et al.,* (2013) [34] studied the plant Typhalatifolia and found that it can tolerate accumulation of toxic heavy elements in its tissues from soil and complete its life cycle. Groeber *et al.,* (2015) [42] studied the Ni & Ca distribution in seeds and seedlings of hyper accumulating plants like Berkheyacoddii during germination. This study determined that Ni and Ca accumulated in the seeds of B.coddii but did not contribute in the seedling development until first leaves were established. Madejon *et al.,* (2015) [43] studied the effects of soil contamination in seed germination and seedling efficacy of plant Populus alba. The study found that P.alba can

accumulate toxic elements like Cd and did not affect seed germination and seedling efficacy from contaminated sites.

PIXE has been used successfully to detect middle and higher atomic number elements from Na to radioactive species like U. For lower atomic number elements Particle Induced Gamma Emission (PIGE) has been employed. A detailed study of the results shown by researchers over the past 30 years has identified the PIXE analysis technique as a robust and versatile method of pollutant detection in environmental samples. Comparison with electron based x-ray analytical techniques such as energy dispersive spectroscopy (EDS) shows that PIXE offers better peak to noise ratios and consequently much higher trace element sensitivities. Absolute trace sensitivity to a given trace element is dependent upon a number of factors, such as matrix composition, detector efficiency and peak overlap. However, tests performed on the Harvard system have produced parts per million (ppm) level measurements for certain elements. [http://www.mrsec.harvard.edu/cams/PIXE.html].

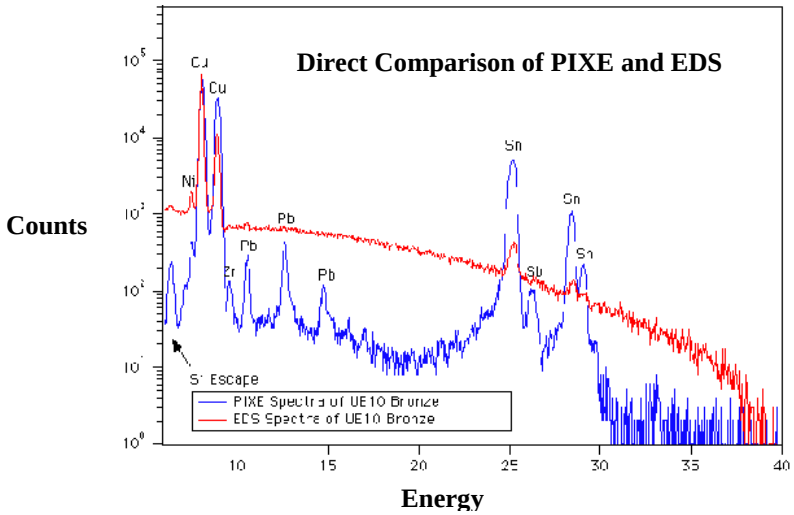

Figure 5. *Figure demonstrating high sensitivity and multi-element detection capability of PIXE. [Image courtesy of http://www.mrsec.harvard.edu/cams/PIXE.html*].

From Figure 5 it is clearly evident that sensitivity of PIXE is far higher than that of EDS method. Detection sensitivity of PIXE also surpasses that of chemical and other absorption techniques.

5. CONCLUSIONS

From the study it was clearly seen that PIXE can turn out to be a powerful tool in detection of pollutant contamination in environmental samples. This technique is simple and requires basic knowledge of atomic, detector and accelerator physics. In Delhi, this technique can be successfully implemented with a table top accelerator present in Inter-University Accelerator centre (IUAC), New Delhi, FOTIA at TIFR etc. The different levels of pollution can be recognized and methods can be adopted to prevent further contamination, find out and conserve those vegetation species which inhibit the accumulation of metal pollutants like lead, mercury etc. Apart from these, areas

with soil types which absorb metal pollutants easily can be isolated which will help to improvise preventive steps to stop further spreading of pollutants. All these steps will ultimately lead to sustainable management of environment.

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Rutherford Backscattering Spectrometry: An analytical technique for near surface layer analysis

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Abstract: *Rutherford Backscattering Spectrometry (RBS) is a widely-used ion beam based analytical technique for the near surface layer analysis of materials. The technique is in use since 1911 when Lord Ernest Rutherford first used the backscattering of alpha particles from a gold foil to determine the fine structure of the atom, resulting in the discovery of the atomic nucleus. RBS provides us information about thickness, composition and concentration depth profile of target. From the back scattered angle we can find kinematic factor (mass determination), scattering cross-section (qualitative analysis of atomic composition) and energy loss (perception of depth). These concepts allow RBS analysis to give quantitate distribution of target with different masses.RBS is used to detect the amount and type of impurity present in any target sample to be used in any experiment of nuclear physics, atomic physics, material science or ion implantation study. The detection of these impurities before performance of any experiment is essential as the impurities present in target sample may hamper the results of the experiments.*

RBS application is not only limited to atomic, nuclear and material science experiments but it is widely used in analysis of environmental samples like aerosols, soil, plant and vegetation. Using this technique, one can easily find the amount and type of toxic elements present in environment samples. In this paper 640 µg/cm^2 self-supporting Au and 250 µg/cm^2 Zr with carbon backing were analysed using RBS technique. Results will be discussed.

Keywords: Rutherford backscattering spectrometry, Kinematics factor, depth profiling, scattering cross-section, environmental samples.

1. INTRODUCTION

Rutherford back-scattering spectrometry is most frequently used technique for qualitative and quantitative analysis of elemental composition, concentration depth profiling and thickness of solid samples near the surface region. The technique is in use since nineteen-sixties and has evolved into a major material characterization technique. RBS gives the quantitative analysis without the requirement of reference sample. Moreover, RBS is a non-destructive technique which gives a good depth regulation of the order of 10^{-9} m.

2. PRINCIPLES

The principle of RBS is quite simple: an ion beam of energy around 1.5 MeV of helium ion is bombarded on to a solid target. The beam enters the sample, scatters on atomic nuclei and travel back out and detected by a solid-state detector. The qualitative description of the target is given by the kinematics factor k and the quantitative analysis is given by scattering cross-section Ω. The perception of depth or depth profile can also be found through RBS buy measuring the energy loss of projectile ions through the target. [1]

2.1 Qualitative analysis (Determination of K factor)

Rutherford back-scattering can be considered as an elastic collision between fast moving projectile and the target. If a particle of mass M_1 is scattered in electrical field of nuclear of mass M_2 at angle θ, its energy is K-part of initial energy E_0. Applying the principle of conservation of energy and momentum, one can obtain equation for kinematic factor K.

$$\mathbf{E_1 = KE_0} \qquad \mathbf{(1)}$$

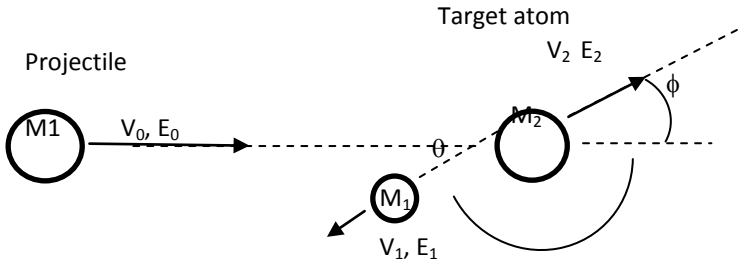

Figure 1. *Schematic diagram for Rutherford back-scattering.*

$$\frac{E_1}{E_0} = K = \left[\frac{\left(\frac{M_1}{M_2}cos\theta + (1-(\frac{M_1}{M_2})^2 sin^2\theta)^{\frac{1}{2}}\right)}{1+\left(\frac{M_1}{M_2}\right)}\right]^2 \qquad \mathbf{(2)}$$

Where, K is kinematics factor, E_1 is the final energy, θ is scattering angle, M_1 is mass of projectile and M_2 is mass of target. The energy ratio E_1/E_2, called kinematic factor, gives that energy after scattering depends only on three factors i.e. M_1, mass of projectile, M_2, mass of the target atom and the scattering angle θ. Hence if M_1, E_0 and θ are known, mass of target may be determined and the element present in the target may be identified.

2.2 Quantitative analysis (Scattering cross-section)

It is probability of elastic collision between the projectile and target atoms. The probability of collision between incident particles and target particles is given by

$$\mathbf{d\sigma/d\Omega \; \alpha \; Z_1^2 \; Z_2^2/E^2} \qquad (3)$$

will provide information about composition analysis of target material. This analysis can be done by calculating the yield which is area under the curve. It is also given by numbers of backscattered ions detected by particle detector of solid angle dΩ at an angle θ.

$$\mathbf{Y = \sigma(\theta) \times \Omega \times Q \times Ns} \quad (4)$$

where, Y is Yield (area under peak) σ(θ) scattering cross section, Q is incident charge and Ns is number of target atoms in atoms/sq.cm. [2]

2.3 Energy loss (Depth profiling)

As highly energetic ions penetrate through matter, they lose energy by various collision processes. When such an ion is back-scattered, its final energy is then determined by the elastic nuclear collisions at a certain depth of the sample and the additional inelastic energy loss mainly due to electrons on its way in and out of target. The deeper the probe particles are back-scattered inside the sample, the more is their total energy loss [2].

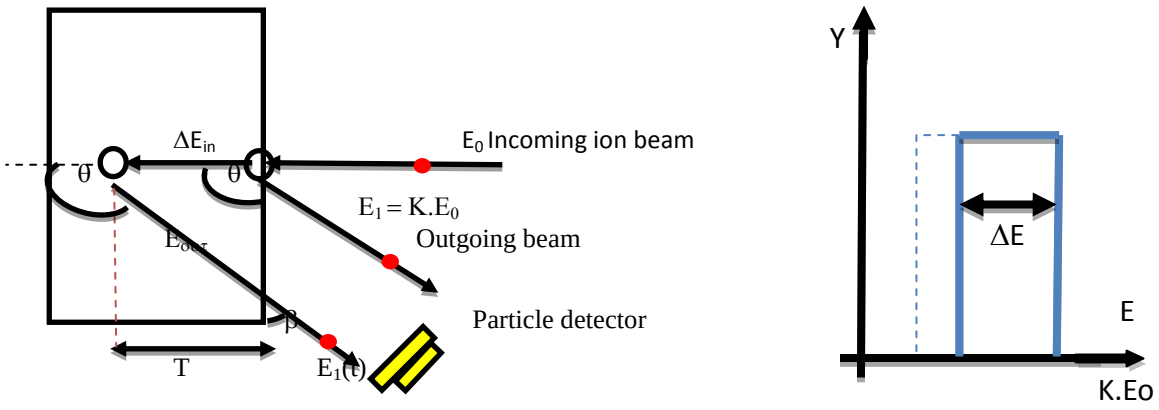

Figure 2. *Mechanism showing energy loss in target.*

The relation between ΔE and areal concentration is given by:

$$\Delta E = Ns.\varepsilon \quad (5)$$

ε stopping cross section factor = $KE_{in} + (E_{out})/(\cos\theta)$

Ns= N.t, by knowing density, thickness of film can be found

Where, t is thickness

$$t = Ns/N \quad (6)$$

Further details description can be found in previous paper P. Verma et al. [3]

3. INSTRUMENTATION

To perform RBS analysis mainly the following instrumentation is necessary. An ion source that produces the suitable ions; an accelerating tube that accelerates the ion to suitable energy; a beam line that directs the beam onto the sample; a scattering chamber in which target is mounted and then finally a detector with suitable electronics that observers the energy distribution of the back-scattered ions. [4]

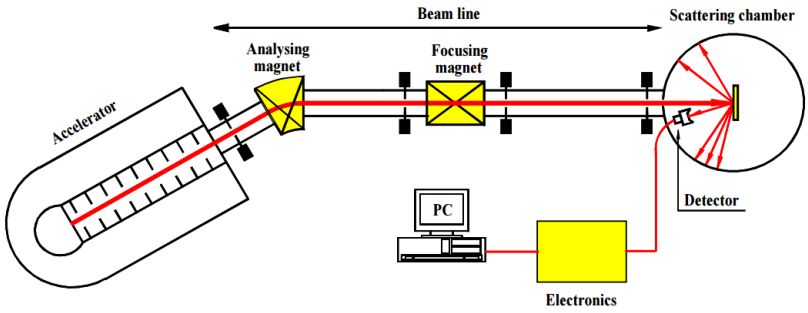

Figure 3. *Schematic overview of the RBS set-up. Energetic ions are generated by the accelerator and directed to the sample by the beam line. The scattered ions are detected by the detector, which signal is evaluated by the electronics and the PC.*

3.1 Experimental Details

RBS measurements for gold and zirconium thin films were performed using 1.7MV 5SDH Pelletron accelerator at IUAC. The sample was mounted on a sample holder in general theta geometry inside the chamber and the chamber was maintained at vacuum of the order of 10^{-6}. The target was bombarded with $4He^{+}$ having energy of 2MeV and the backscattered He^{+} ions were detected using silicon surface barrier detector having resolution of 15KeV.The detector was kept at an angle of 166^{0} from the incident beam. The data was recorded and simulations were done using XRUMP code of RBS. Further details of data simulations code can be found in the reference [5] and the references mentioned there.

3.2 PARAS, RBS facility at IUAC

Pelletron Accelerator RBS-AMS System (PARAS) facility has been installed at IUAC which consists of a Rutherford Backscattering Spectrometry (RBS) facility with 1.7 Million Volt Pelletron accelerator [3] [6]. The facility is equipped with:

- Alphatross ion source for producing negatively charged He and H ions.
- 1.7MV 5SDH-2 Pelletron accelerator

- A four-axis goniometer (model name RBS-400)

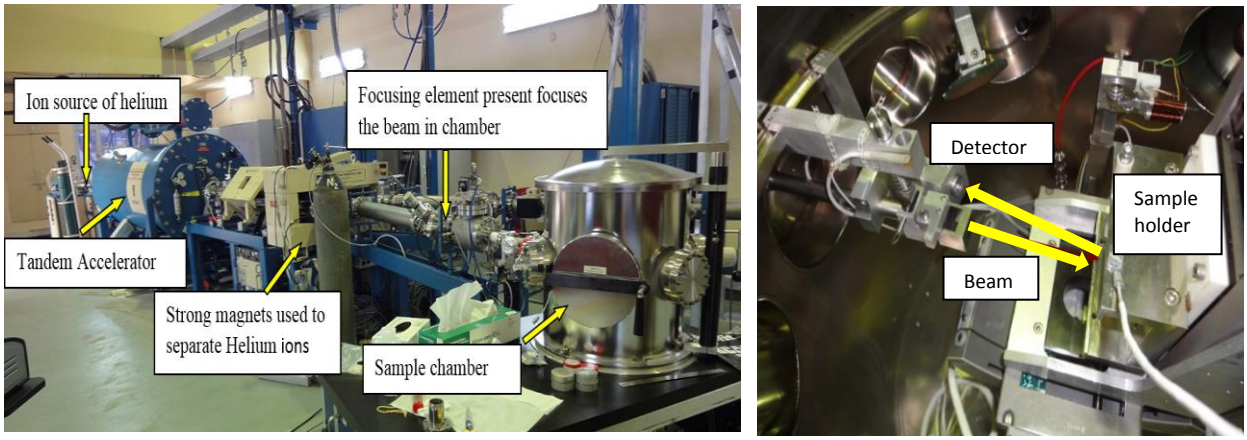

Figure 4. *PARAS, RBS facility at IUAC, New Delhi.*

3.3 Data acquisition and analysis

Signal from the detector is processed and fed to the computer. Typically yield vs. channel number plot is obtained; the channel number is then converted into energy with the help of energy calibration. Simulation programs like XRUMP, SIMNRA etc. are used in which experimental parameters like incident energy, detector solid angle, resolution fed and parameters like thickness and target composition are varied for simulation. A good fit of simulated and experimental spectrum will provide necessary information [5].

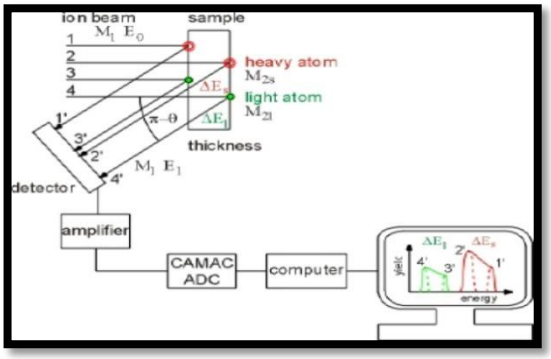

Figure 5. *Electronic components and data acquisition system [Image courtesy : www.iuac.res.in/accel/paras/].*

4. EXPERIMENTAL DATA

RBS spectrum for 640μg/cm^2 (6.4 X 10^{-3} Kg/m^2) self-supporting gold and 250 μg/cm^2 (2.5 X 10^{-3} Kg/m^2) Zirconium with carbon backing are shown below. From the spectrum, we can infer that the gold foil has no impurity whereas the zirconium foil contains carbon, oxygen and barium.

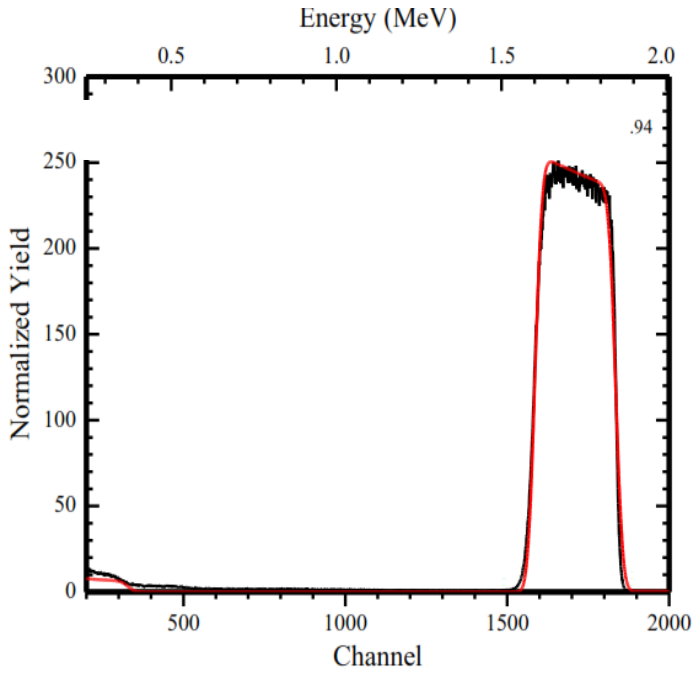

Figure 6. *Calculated RBS spectrum for gold. Computer simulations using XRUMP code.*

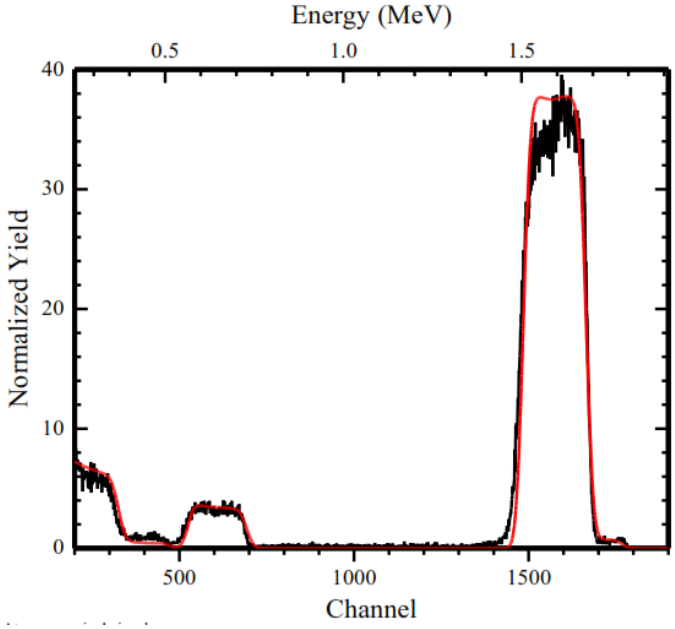

Figure 7. *Calculated RBS spectrum of zirconium. Computer simulation using XRUMP code. Carbon, oxygen and barium are found as impurities.*

5. RESULT

- Thickness of gold film from RBS was found to be 1.3X 10^{18} atoms/cm^2 which was comparable to the thickness of gold 1.9 X 10^{18} atoms/cm^2 (640μg/cm^2 or 6.4 X 10^{-3} Kg/m^2) noted using quartz crystal while target preparation.

- Thickness of zirconium film from RBS was found to be 4.8 X 10^{17} atoms/cm^2 which was comparable to the thickness of gold 1.6 X 10^{17} atoms/cm^2 (250μg/cm^2or 2.5X 10^{-3} Kg/m^2) noted using quartz crystal while target preparation.

6. CONCLUSIONS

Rutherford Backscattering Spectrometry (RBS) is one of the best analysis techniques as it is nondestructive, has good depth resolution and is very sensitive for heavy elements of the order of ppm and it provides quantitative analysis without the need for reference samples. From RBS, we can find the kinematic factor which is characteristic property as it depends on the mass of element. This kinematic factor provides us information about the elements present in the target. Moreover, RBS gives more accurate measurement for thickness of target as compared to quartz crystal.

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Study of the generation of thermo-emf as an alternative source of energy using different thermocouples under various modified parameters

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Abstract: *In the current scenario, World is facing major difficulties regarding energy management and the fast dwindling sources of energy not being sufficient in comparison to the energy consumption. Moreover, there is an ever increasing concern regarding environmental issues like Global Warming. Thermoelectric modules play an important role by the conversion of waste heat into electricity. The thermoelectric devices are pollution free, generate power in single step and hence can be regarded as a step towards green energy generation.*

Two dissimilar metals joined at the ends to form junctions maintained at different temperatures form a thermocouple. The thermocouples are widely used in science and industry as temperature sensors. Thermoelectric principles on which the study is carried out are Seebeck Effect, Peltier Effect, Thomson Effect. The classical thermocouples Fe-Constantan, Constantan-Nichrome, Cu-Fe, Cu-Nichrome, Fe-Nichrome are generally studied in labs for the generation of thermo-emf. Under normal conditions maximum thermo-emf generated is of the order of a few milli-volts at temperature difference of ~3200C.

Present investigations target to generate and measure thermo-emfusing thermocouples first under normal conditions and then compare with modified condition i.e. application of electric field

The thermo emfvs temperature curves were generated for two thermocouples under normal mode. The effect of application of electric field was then studied at high temperature ~ 3200 C at which thermo-emf nearly peaks for the tested thermocouples before getting temperature of inversion. The results show a positive enhanced effect of electric field on thermo-emf generated.

The effect can be utilized for generation of enhanced thermo-emf that can be used for potential applications as an alternative source of energy.

Keywords: Thermocouple, Thermo-emf, Seebeck effect, electric field.

1. INTRODUCTION

It is a well-established fact that conventional energy sources of the world are limited. The perspective of enhanced usage in various fields of science and technology as well as changing lifestyles, world is facing a serious threat towards their disappearance in near future. This bleak scenario is augmented with another dimension of extensive pollution that is generated by use of these energy sources. Researchers all over the world are working towards alternative energy

sources which can also be pollution free for sustainable development. One of the current areas of research is the use of thermoelectric generators as alternative source of renewable energy.

Thermoelectric generators work on principle of Seebeck effect; that is when a temperature gradient is maintained at the junction of two dissimilar metals (thermocouple), thermoelectric-emf is generated (Figure 1). As a result of temperature gradient, charge carriers move from a material of higher electron density to a material of lower electron density.

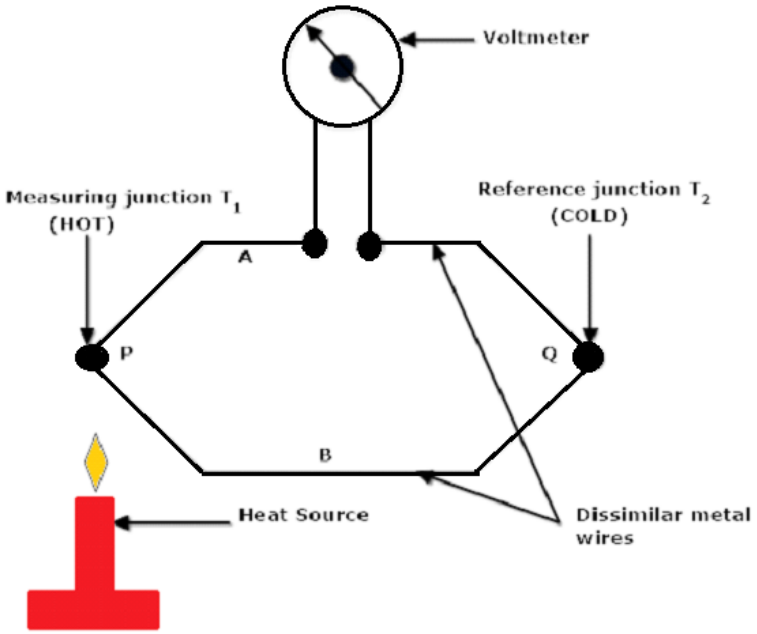


Figure 1. *Schematic diagram of a thermocouple*

The thermoelectric effect can be used to generate electricity, measure temperature or change the temperature of objects. Because the direction of heating and cooling is determined by the polarity of the applied voltage, thermoelectric devices can also be used as temperature controllers.Numerous such devices can be connected in series to increase the output voltage or in parallel to increase the maximum deliverable current. Large arrays of Seebeck-effect devices can provide useful, small-scale electrical power if a large temperature difference is maintained across the junctions.

Considerable amount of research work has been reported on using waste heat developed in power stations, industries etc. to convert in electrical energy by thermoelectric generators. [1,2,3,4]. Cars and automobiles can also use automotive thermoelectric generators (ATGs) to use the heat developed in their exhausts in generating electrical energy, hence improving their fuel efficiency [5]. Different types of thermoelectric generators are available: conventional (based on exhaust heat) and nonconventional (based on solar heat). The power generation from combined system of solar dish and thermoelectric modules is also reported [6].

Thermoelectric power generation system is still in development process. Researchers are using various experimental techniques to improve their efficiency [1,7]. There are many parameters which may affect the efficiency of such thermoelectric systems like temperature, type of material, heat sink etc.. Scientists are using different types of materials, semiconducting liquid anisotropic media [8,9,10,11] to get an enhanced effect on power generated.

The current work aims at study of generation of thermoelectric-emf under normal conditions and an attempt towards its enhancement with modified parameters so that it can be used as an alternative source of energy which is pollution free, easy to generate and cost effective. These advantages trigger the continued research in thermoelectric power generation to improve their efficiency(12).

2. EXPERIMENTAL DETAILS

The experimental setup was arranged as per theFigure 2. Thehot junction was achieved using sand bath and the cold junction by crushed ice.Experiments were performed in the laboratory with two types of thermo-couples –Copper-Constantan and Iron- Constantan. The balance point was obtained and the corresponding length of the potentiometer wire was noted. Thermo-electric emf was calculated for the temperature range 150^0C to 320^0C. Graphs of thermo-emfversus temperature difference were plotted for Copper-Constantan and Iron- constantanthermocouples in NormalMode(Without the application of any external parameter).

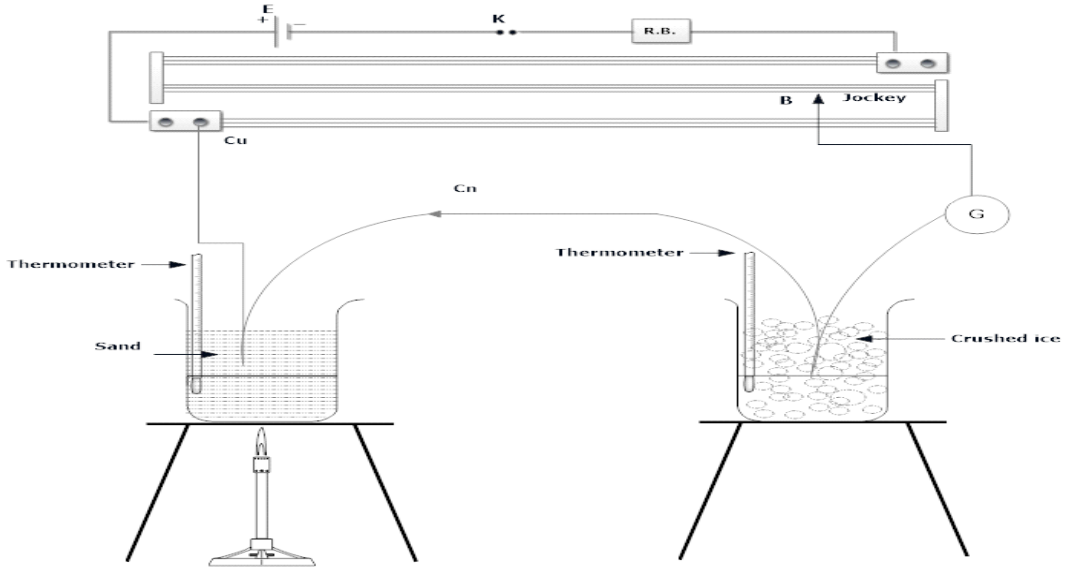


Figure 2. *Experimental Setup for measuring Thermo-emf (Normal Mode)*

Thermocouples were then placed under the influence of Electric Field per the setup given in Figure 3.

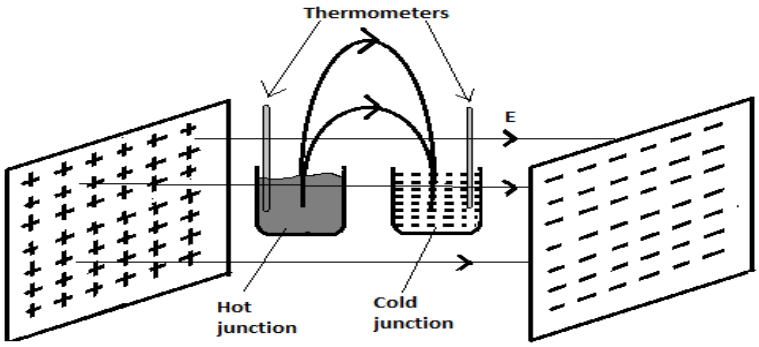


Figure 3. *Experimental Setup for studying the effect of Application of Electric Field and the effect on thermo-emf was recorded at 320^{0}C for various values of electric field.Graphs of electric field vs thermo emf were plotted for Copper-Constantan and Iron- constantan thermocouples to study the effect of Application of electric Field.*

3. RESULTS AND DISCUSSION

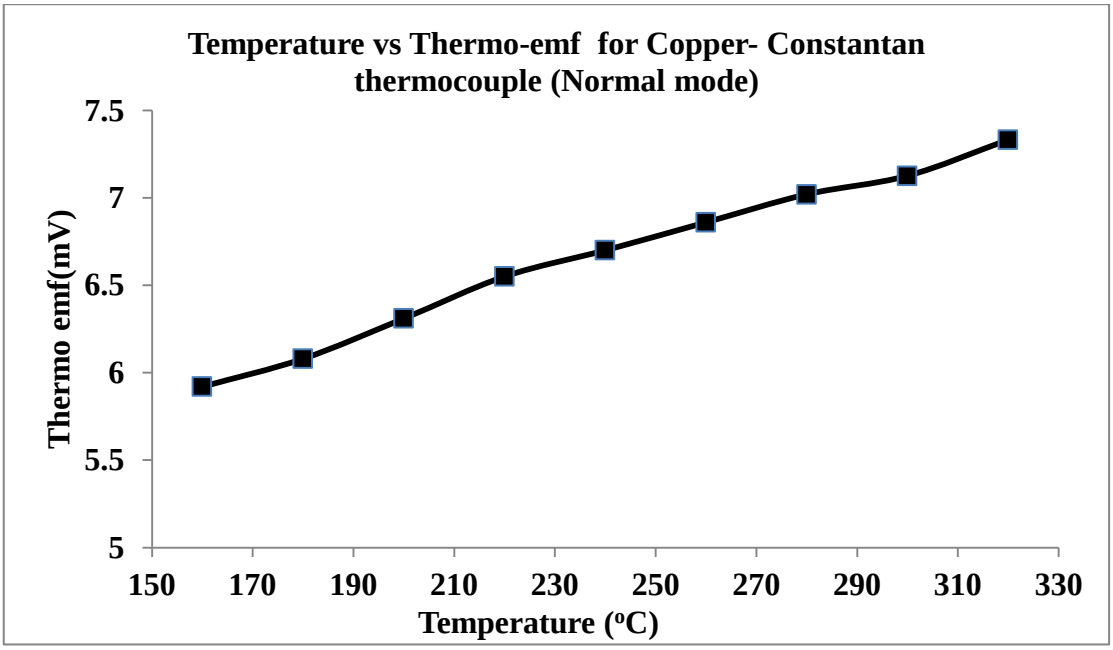
The variation of thermo-emf with temperature was recorded for Copper Constantan thermocouple and Iron Constantan thermocouple and the corresponding graphs were studied (Graph 1, Graph2) in Normal Mode.Potential drop per cm of the wire:

$$= \quad \boldsymbol{E * r/(R + r)L}$$

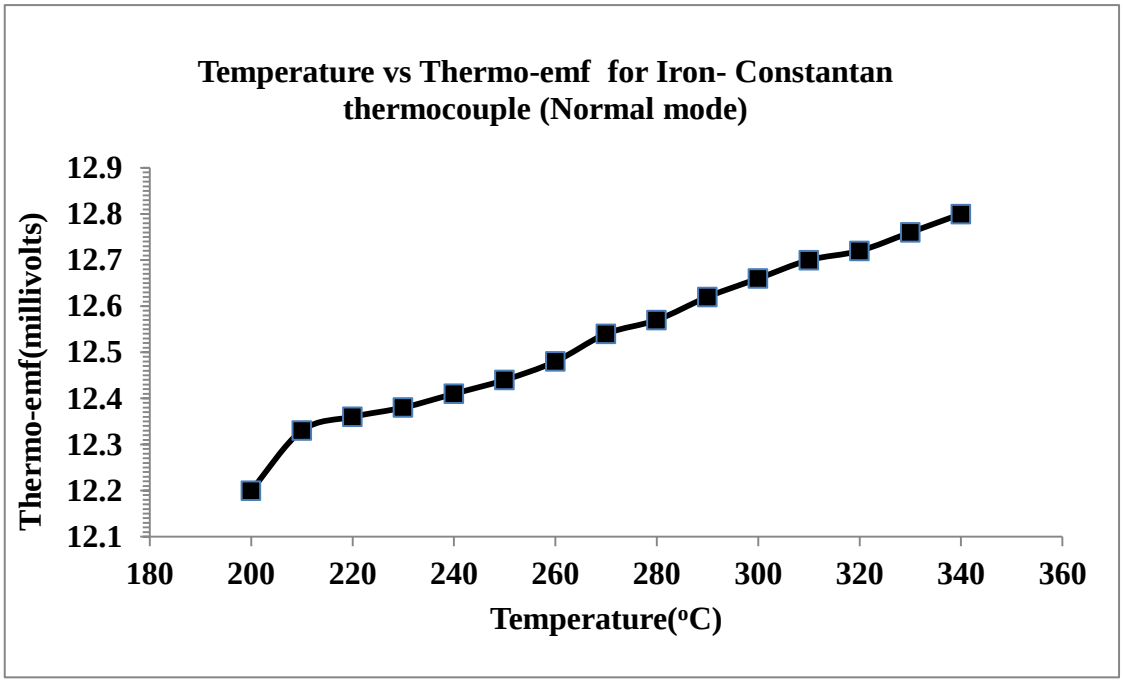
Thermo-emf= Potential drop per cm of the wire*length of potentiometer wire at balance

$$= \boldsymbol{E * r * l/(R + r)L}$$

where r, Resistance of the potentiometer wire, E , Emf of the battery, L, Length of the Potentiometer wire, R , Resistance in the circuit ,l, length of potentiometer wire at balance



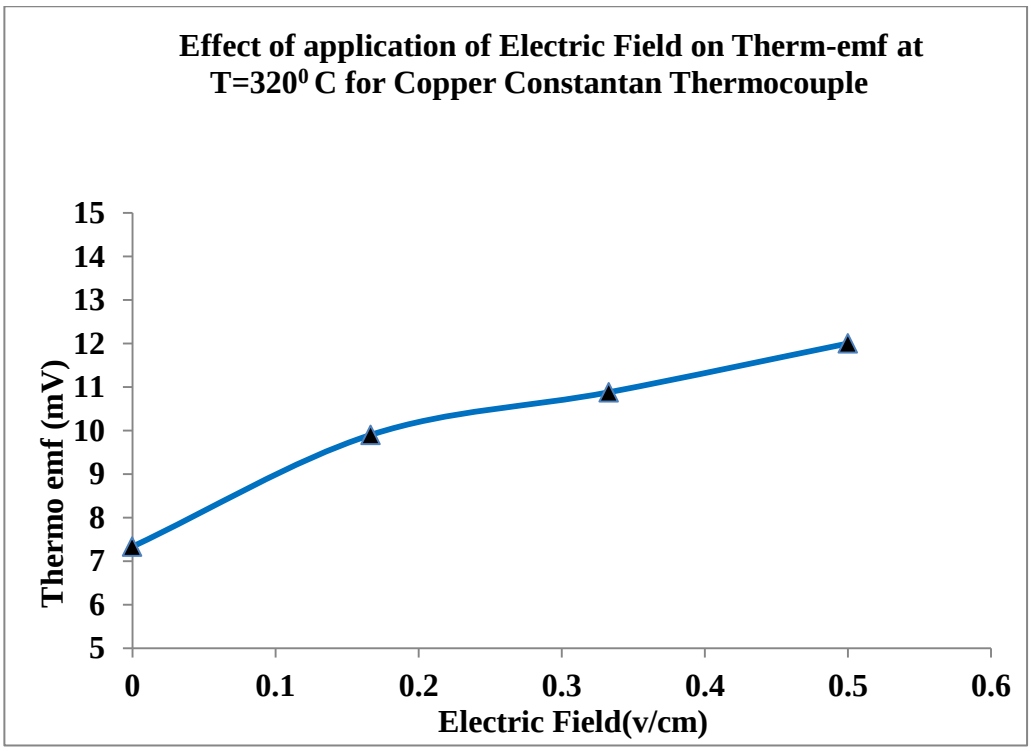
Graph 1. *Temperature versus Thermo-emf.*



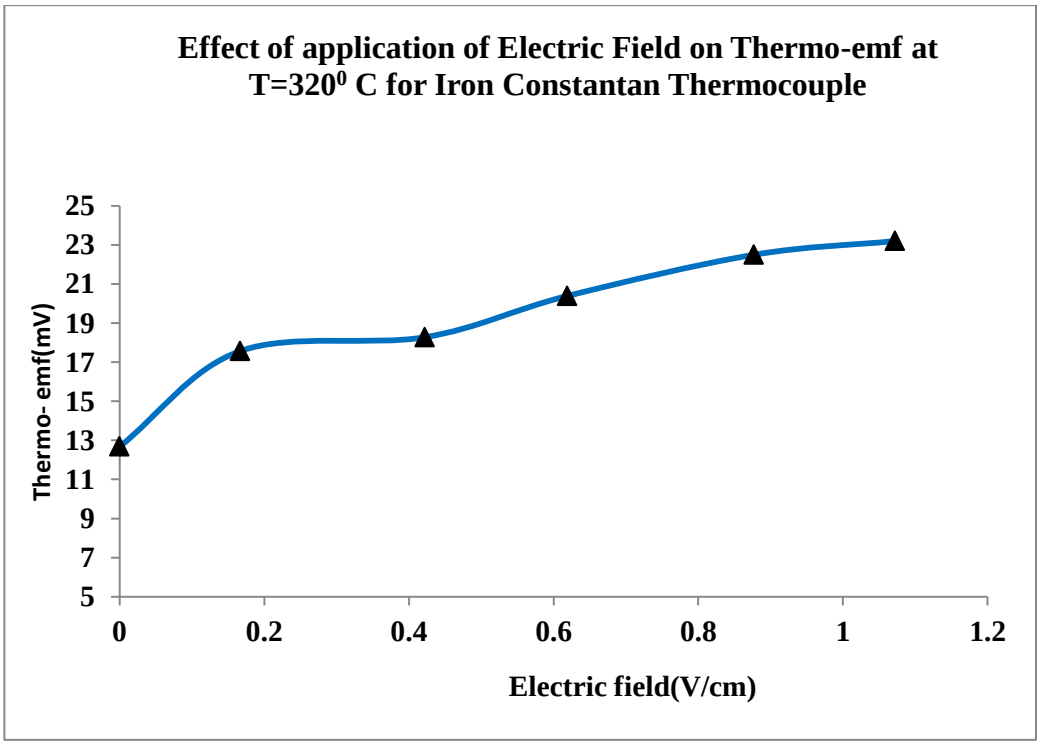
Graph 2. *Temperature versus Thermo-emf.*

It is seen that value of thermo-emf generated for Iron- Constantan thermocouple was greater than value of thermo-emf obtained for Copper Constantan thermocouple which is as expected from Seebeck Series that metals more farther apart in Seebeck Series will show greater generation of thermo-emf.For Normal mode:The value of thermo-emf obtained for Copper Constantan thermocouple at 320^{O}c = 7.332 mV and the value of thermo-emf obtained for Iron-Constantan thermocouple at 320^{O}c = 12.72 mV.

Thermo-emf was measured for Copper Constantan thermocouple and for Iron- Constantan thermocouple at 320^{O}c under the influence of Electric Field. It is seen that application of Electric Field is showing an enhancement in thermo- emf. A graph of thermo-emfvs Electric Field was plotted for Copper Constantan thermocouple (Graph 3) and for Iron- Constantan thermocouple (Graph 4). It is observed that with increase in electric field thermo-emf increases at a given temperature for both thermocouples.



Graph 3. *Thermo-emf versus Applied Electric Field.*



Graph 4. *Thermo-emf versus Applied Electric Field.*

4. CONCLUSIONS

The current study supports the fact that applied strength of electric field affects the electrical conductivity of both the charge carriers (electrons and holes) and hence enhances the thermal power generation and thermo-emf of the material [12].

The above results open a new dimension of research that by the influence of some external parameters, the efficiency and power generation capacity of thermo-electric generators can be improved and hence can be made suitable for usage in day to day activities as an alternative source of green energy, also giving their contribution in controlling pollution to an extent. Thermo-emf power generation is still in a nascent stage but any research related to it remains relevant as it addresses one of the biggest challenges before the mankind today, energy management in synergy with environmental protection.

Acknowledgement

The authors would like to thank Dr. AnulaMaurya, Principal, Kalindi College for providing the necessary support and infrastructure for carrying out this research work.

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Synthesis of Mn doped LISICON material as ion selective electrode for pH sensing

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Abstract: *LISICON is a solid state ionic material which shows high ionic conductivity. LISICON (LiZr2P3O12) and Mn doped LISICON (Li0.5MnTi1.5P3O12) materials are synthesized using solid state reaction method. LISICON based low cost; highly sensitive sensor probe has been fabricated and characterized. The sensor utilizes the electrochemical cell method for pH sensing. The results indicate nearly linear variation of emf for 0 to 7 pH solutions. A chemical stability of this ceramic at high temperature (up to 1000 0C) makes this ceramic useful in industrial pH sensors.*

Keywords: LISICON, pH sensing, Ion selective electrode, Solid state reaction method, X-ray diffraction microscopy.

1. INTRODUCTION

In recent years, researchers are employing LISICON ($Na_{1+x}Zr_2Si_xP_{3-x}O_{12}$) material (acronym for Li Superionic conductors) for various applications such as gas sensing, Li^+ based batteries, ion selective electrodes etc. because of its high ionic conductivity as compared to other solid electrolyte materials such as sodium beta alumina, cubic stabilized zirconium [1-6].

The measurement and monitoring of pH is required in chemical, biomedical and environmental sciences for applications such as titration, blood sample, quality of water obtained from different kinds of sources.

Presently, more than 95% of pH sensors are based on spectroscopic, optical and electrochemical methods. First two methods are expensive and in electrochemical methods, generally glass membrane are used which cannot be used in food processing. The search of new materials as pH sensors is of great interest in industrial domains like food industry because of the weakness of the glass membrane electrodes that prohibits their use, as sensor, in food industries. Different oxides have been studied for metal oxide-pH sensors like, molybdenum oxide, ruthenium oxide, and iridium oxide. The detailed study of metal oxides as pH sensors have been done by Glab et al. and Fog and Buck [7-13]. These studies are based on redox reactions that are dependent on the redox potential of the solutions.

In this chapter we report the synthesis of two structures LISICON ($LiZr_2P_3O_{12}$) and Mn doped LISICON ($Li_{0.5}MnTi_{1.5}P_3O_{12}$) and fabrication of a low cost LISICON based solid electrolyte sensors for detection of pH of solutions

2. EXPERIMENTAL

2.1 Synthesis of LISICON and Mn doped LISICON structures

The standard LISICON and Mn modified LISICON bulk samples have been prepared by conventional solid state reaction method [169]. The known weights of following compounds LiOH, SiO_2, $(NH_4)H_2PO_4$ and $ZrOCl_2$ were mixed together according to their molar ratios to get LISICON with x=0 and LiOH, TiO_2, $(NH_4)H_2PO_4$ and MnO_2 were taken for Mn doped LISICON ($Li_{0.5}MnTi_{1.5}P_3O_{12}$). Firstly, known amounts of $(NH_4)H_2PO_4$ and LiOH were mixed in water separately. Both of the aqueous solutions were rigorously stirred for an hour and then intermixed. Secondly, known amounts of $ZrOCl_2$ (in case of Mn doped LISICON, MnO_2 and TiO_2 were taken), LiOH, MnO_2 and TiO_2 were also mixed separately in water and then stirred and intermixed as above. Above obtained solution was ball milled to obtain a powder with uniform particle size distribution and the final solution was dried for 2 hours at 150 ^oC. After drying LISICON powder was found which was again sintered at 1000 ^oC for 3 hours.

2.2 Fabrication of LISICON sensor probe

We have designed two different probes to detect pH of solutions. In designing probe, LISICON (LiZr2P3O12) and Mn doped LISICON (Li0.5MnTi1.5P3O12) pellets were used as a membrane. Both probes were fabricated (as shown in figure 1), by attaching different pellets at the end of hollow glass tube with inorganic adhesive (diameter = 0.9 cm) and a polished silver wire of diameter 1.5 mm fixed with silver conducting glue at its top. The surface area in contact with the liquid electrolyte was 2.54 cm2. The external reference electrode for both probes was an Ag/AgCl wire. The electrochemical cell can be described by the following sequence:

Ag / Ag / Ag+ // LISICON // solution under test / Ag

3. RESULTS AND DISCUSSIONS

3.1 Structural studies of LISICON and Mn doped LISICON

Figure 2 shows the XRD pattern of LISICON nanograin powders, prepared by solid-state reaction method and sintered at 1000 oC. Peaks are well matched to the LISICON phase,

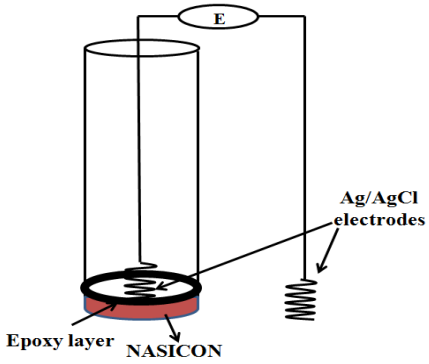

Figure 1. *Schemetic diagram of designed probe.*

reported in JCPDS file. Figure 3 shows the XRD patterns of Mn doped LISICON phase prepared by solid-state reaction method sintered at 1000 oC. The structural modifications observed on partial replacement of Ti atoms by Mn, are shown by XRD spectra and reported in Table 1.

Table 1 shows the values for lattice parameters for LISICON, and Mn doped LISICON. All these values have been calculated from XRD data by UNITCELL refinement program software. From the table it can be seen that as Zr is replaced by Ti and Mn, which have smaller ionic radii compared to Zr, unit volume is reduced from 1.2876 nm3 to 1.1851 nm3 which is because of smaller ionic radii of Ti and Mn as compared to Zr.

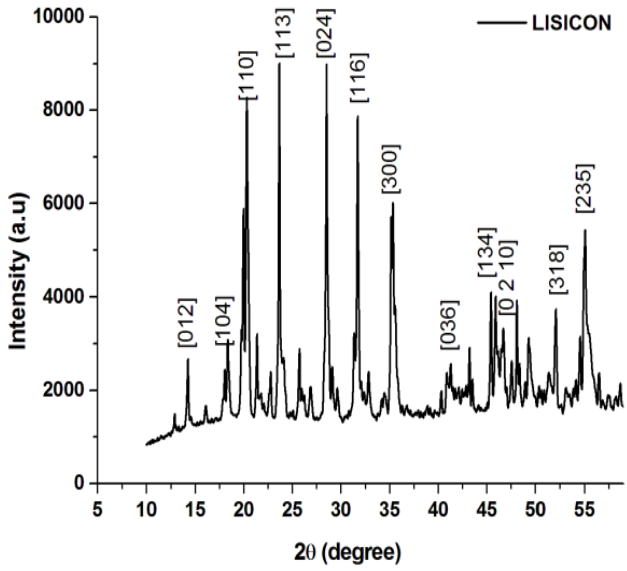

Figure 2. *XRD pattern of LISCON sintered at 1000 ^{o}C.*

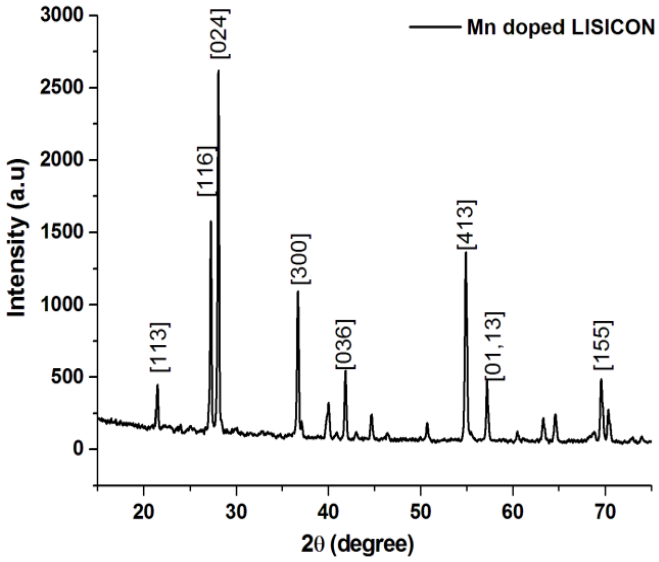

Figure 3. *XRD pattern of Mn doped LISICON sintered at 1000 ^{o}C.*

Table 1. *Lattice parameter values of NASICON, LISICON and Mn doped LISICON*

Composition	*a(nm)*	*b (nm)*	*c (nm)*	*Unit volume (nm)^3*	*Structure*
$Na_3Zr_2Si_2PO_{12}$	0.9074	0.9074	2.2279	1.5887	Rhombohedral
$LiZr_2P_3O_{12}$	0.78928	0.66089	2.5429	1.2876	Monoclinic
$Li_{0.5}MnTi_{1.5}P_3O_{12}$	0.71183	0.71236	2.4033	1.1851	Monoclinic

3.2 *Sensing Mechanism of LISICON based pH sensor*

The solutions under test were buffer solutions for pH from 1 to 14. Nitric acid and lithium hydroxide solutions were used for low and high pH values. The pH of the solution was adjusted with nitric acid. To study the response characteristics of the sensor, emf values were recorded for different pH solutions. Figure 4 shows the graph between emf and pH values for NASICON, LISICON and Mn doped LISICON sensing probes with varying pH. In figure, symbols are the experimental data points. From the figure it can be seen that as pH value of the solutions increases, the emf values decreases upto 7 pH values and above this value, it again starts increasing till 14 for NASICON. It has happened because, in the range of 8 to 14 pH values, lithium ions may start interfering and increase the emf accordingly.

To overcome this problem, new materials LISICON and Mn doped LISICON were synthesized. In LISICON material, Li was substituted in place of Na in NASICON and this

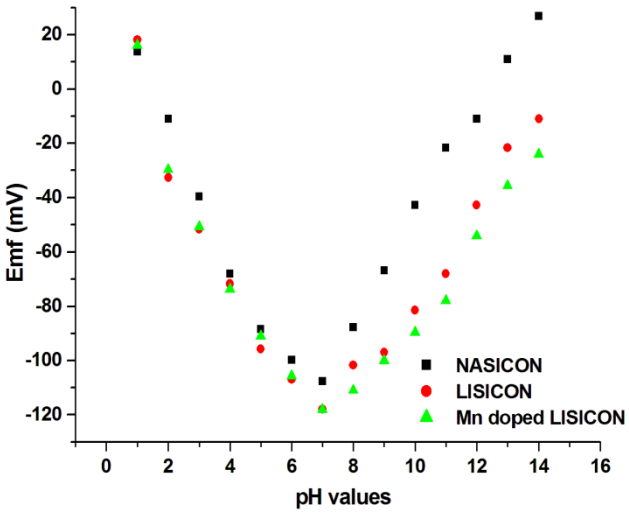

Figure 4. *Variation of emf with different pH values for the NASICON, LISICON and Mn doped LISICON probe.*

LISICON material was further modified by substituting Mn and Ti in place of zirconium to reduce the bottleneck size of material so that the penetration of sodium ions can be minimised. From figure 4, it is clear that in the range 1 to 7 pH values, all the graphs show nearly same slope as that of NASICON but in the pH range of 8 to 14, the emf again starts increasing as NASICON membrane due to lithium ion penetration. The slopes for different samples in pH range 8 to 14 are different. The corresponding values of slope for NASICON, LISICON, Mn doped LISICON sample membranes are 19.43, 18.82, 16.10 mV/pH respectively. From Table 1, the lattice volume for above three sample membranes are 1.5887, 1.2876 and 1.1851 nm^3 and from these results we can conclude that as lattice volume of NASICON material is reduced by structural modifications, the lithium ion passage can be controlled. So, the contribution to emf due to sodium ions in the pH range 8 to 14 can be reduced. All the three membranes are suitable for pH sensing in the range 0 to 7 only.

4. CONCLUSION

The fabrication and characterization of a potentiometric based ion selective membrane for pH sensor has been carried out. The sensor operates in only 0 to 7 pH range. The sensor has advantages of low cost, miniaturization, reusability, high sensitivity and high stability at high temperature.

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Valley beam splitting using strained Graphene Structures

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Abstract: : *Recently, graphene has been attracting much interest due to its unique electronic properties arising from its singular energy spectrum, where in the vicinity of the points labelled as K and K' in reciprocal space, the charge carriers behave as massless quasiparticles and exhibit an almost linear dispersion. Also, being an atomically thin sheet of carbon atoms, graphene can be thought of as a flexible and stretchable membrane, so the prospects of strain engineering to control the electronic properties of graphene has opened up new opportunities and directions for graphene research. Strain essentially can be considered as a perturbation to the in-plane hopping amplitude, which induces a gauge potential in the effective Hamiltonian which has opposite signs in the two valleys thereby preserving the time reversal symmetry. Thus, the strain can induce a valley-dependent magnetic field. Here this should be mentioned that the valleys in graphene refer to the Dirac cones situated at the six corners of the hexagonal Brillouin zone of which there are two in-equivalent types labelled K and K' The valley degree of freedom represents a spin-like quantity, and the study of manipulating and making use of valleys in technology is termed as valleytronics. We investigate the effect of vector potentials on a region of uniform uniaxial strain and find that an efficient valley beam splitting can be achieved within experimentally accessible structural parameters.*

Keywords: Graphene, Strain, Valleytronics.

1. Introduction

Various optics like behaviour of ballistic electrons in the two-dimensional electron gas have been shown to exist due to the quantum-mechanical wave nature of electrons. This is because analogies between the phenomenon occurring in two different physical systems provide a way to have a physical insight and a better understanding of both the systems.[1]-[2]. During the past few years, grapheme, two-dimensional carbon crystal has attracted much attention [3][4]. Graphene's electronic properties are drastically different from those, say, of conventional semiconductors. Charge carriers in single-layer graphene behave like relativistic, chiral massless particles with a speed equal to the Fermi velocity and possess a gapless, linear spectrum close to the K and K′ points.

Also, as already mentioned above, graphene being an atomically thin sheet of carbon atoms, can be thought of as a flexible and stretchable membrane. Hence paves for strain engineering to effect and manipulate various electronic properties. In this paper, we investigate the effect of vector potentials on a region of uniform uniaxial strain and find that an efficient valley beam splitting can be achieved.

2. Formalism

Practically strain can be introduced in graphene sheets via deposition onto stretchable substrates and by suspending the sheets across trenches defined by nanolithography [5-8]. Mathematically, the effect of strain can essentially be considered as a perturbation to the in-plane hopping amplitude, which induces a gauge potential in the effective Hamiltonian. In the deformed graphene all bonds are, in general, nonequivalent and the three nearest-neighbors hopping parameters t_i 's (say) can be all different. If one repeats the derivation of the Dirac Hamiltonian with non-equal hopping parameters one finds that for the electron states in the vicinity of the K and K' point, the effective Hamiltonian reads [8]:

$$H_K = v_F \vec{\sigma} \cdot \left(\vec{p} - v_F^{-1} \vec{A}^S(\vec{r}) \right)$$
$$H_{K'} = v_F \vec{\sigma} \cdot \left(\vec{p} + v_F^{-1} \vec{A}^S(\vec{r}) \right)$$

where $\vec{A}^S(\vec{r})$ has the form

$$\vec{A}^S(\vec{r}) = \delta t_1(\vec{r}) - \frac{1}{2} \left(\delta t_2(\vec{r} + (\delta t_3(\vec{r})) \right)$$
$$\vec{A}^S(\vec{r}) = \frac{\sqrt{3}}{2} \left(\delta t_2(\vec{r}) - \delta t_3(\vec{r}) \right)$$

Here δt_i are the local perturbations (due to strain) to the three nearest neighbor hopping intergrals. These valley dependent gauge fields (can be seen by gauge fields with opposite signs in [6]-[8] arising from strain can be used to promote valley splitter.

3. Modelling: Uniaxial strain

For definiteness, we consider the change in the hopping integral only along x-direction, so that

$$A^S(\vec{r}) = A^S(x)\hat{y}.$$

Thus the low energy Hamiltonian (inter-valley scattering has been neglected), reads:

$$H_\zeta = \hbar v_F \begin{pmatrix} U_0 & \hat{k}_x - i\left(\hat{k}_y + \frac{\zeta A^S}{\hbar v_F}\right) \\ \hat{k}_x + i\left(\hat{k}_y + \frac{\zeta A^S}{\hbar v_F}\right) & U_0 \end{pmatrix}$$

Let we begin with a situation when electrons from free graphene region are incident on a strained graphene region of width '2d'. Then inside the strained region the electrons see a momentum dependent barrier of height

$$\left(\hat{k}_y + \frac{\zeta A^s}{\hbar v_F}\right)^2$$

With the momentum conservation along y direction, the corresponding Snell's for this system are obtained as:

$$\sin|\theta| = \sin|\phi| + sgn(\phi)\frac{\zeta A^s}{\hbar v_F}$$

For the positive incidence angle ϕ (say), the motion of charge carriers in K valley beam and K' valley beam is obtained as:

$$\sin\theta_K = \sin\phi + \frac{A^s}{\hbar v_F}$$
$$\sin\theta_{K'} = \sin\phi - \frac{A^s}{\hbar v_F}$$

The angle of refraction is clearly different for the K valley beam and for K' valley beam, and the vector potential arising due to strain can be tailored to a value that

θ_K and $\theta_{K'}$ have opposite signs.

4. Conclusion

Thus clearly we see that the final emergent beam angle is different for the K and K' valley electrons, thereby leading to beam splitting. The amount of angular splitting depends clearly on the vector potential which in turn depends on strain produced in the graphene.

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X-Ray Fluorescence and detection of contamination in environmental samples trace and ultra-trace levels

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Abstract*: Development of science and technology in twentieth century with its rigorous understanding and major achievements in every walk of life has left us spellbound. We have surrounded ourselves with gadgets and machines to make our lives effortless. Although during this journey from stone age to iron age we have put ourselves and our environment in huge risk. It is hence need of the hour to measure and account for the damage caused by us to the environment. In this paper, we give a brief review of a technique named XRF which has been used to determine the type and amount of pollutants present in various environmental samples say plants, soil, water etc. In this technique x-ray photons are used which are synonyms to signatures for all elements. The energy of x-rays emitted by different elements is unique to them. When a collimated beam of these x-rays is incident on the target under investigation the photons are absorbed and an electron is ejected from the atom present in that target. This ejected electron carries away all the energy of the absorbed photon except the energy required to break free the bound electron of the atom. The vacant space of the ejected electron is then filled by another electron in higher energy level of that atom thus leading to emission of x-rays. These emitted x-rays are then analyzed using x-ray detectors for example Si-Li detector to determine the type of impurity present in the sample. According to literature survey it has been observed that x-ray radioactive sources such as 55Fe or synchrotron radiation have been used to investigate targets of 18<Z<92 using L and M sub shell x-ray emission to detect trace and ultra-trace elements like chromium, arsenic, selenium, silver, mercury, lead etc. in all types of environmental samples. XRF technique is a nondestructive technique and the equipment's required are portable hence it is extensively used by environmentalists as well as physicists to determine impurities in a sample. Environmental samples are being prepared for investigations with this technique.*

Keywords: XRF, Si-Li detector, x-rays, ultra-trace elements.

1. INTRODUCTION

Growing industrialization has created disturbances in the constituents of environment resulting in environmental pollution. Experimental observations have revealed the role of several elements in our daily life. Particular amount of concentration is important while deficiency or excess is bad

for any biological system. Due to anthropogenic activities, high levels of these elements adversely affect the biotic and abiotic components of the ecosystem. It is now time to preserve the environment in such a way that human life is not affected and should not be exposed to any other additional threat. In densely populated cities like Delhi wastes from the industrial activity has become source of toxic elements and affect the ecosystem by changing the concentration of elements dramatically. Various techniques are used to determine the concentration and distribution of elements in environmental samples like soil, plants, aerosols and water etc. like electrochemical techniques and atomic spectrometric techniques.X-ray fluorescence is an atomic spectroscopic technique and is advantageous over other techniques because of the multi-element detection capacity, flexibility and portability. It is an excellent tool to study the distribution of trace elements and determine reasons for their concentration changes in the environment.

2. BASIC PRINCIPLE OF XRF

2.1 Production of X-rays

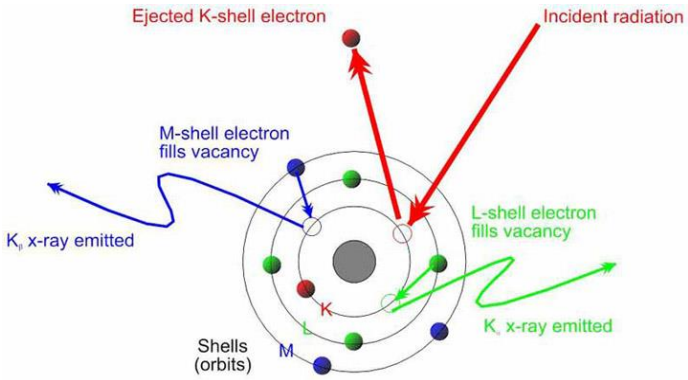

Figure 1. *Production of X-Rays courtesy of*

http://alloytester.com/atester80/uploads/images/characteristic-X-ray-production.jpg

X-rays are electromagnetic radiations which lie in the wavelength range of 10^{-10}-10^{-9} meters.Characteristic x-rays are produced when an element is bombarded with ionizing radiation. This ionizing radiation strikes a bound electron present in an inner shell of the atom. This electron is then ejected from the atom. After the electron has been ejected, the atom is left with a vacant energy level, also known as a core hole. Outer-shell electrons then fall into the inner shell, emitting quantized photons with an energy equivalent to the energy difference between the higher and lower energy states. Each element has a unique set of energy levels, and thus the transition from higher to lower energy levels produces X-rays with energies that are characteristic to each element.

2.2 Fluorescence

Fluorescence is the emission of light by a substance that has absorbed light or other electromagnetic radiation. In most cases, the emitted light has a longer wavelength, and therefore lower energy, than the absorbed radiation. However, when the absorbed electromagnetic radiation is intense, it is possible for one electron to absorb two photons; this two-photon absorption can lead to emission of radiation having a shorter wavelength than the absorbed radiation. The emitted radiation may also be of the same wavelength as the absorbed radiation, termed resonance fluorescence. In x-ray fluorescence the ionizing radiation bombarded on samples are x-rays generated using x-ray tubes or radioactive sources like ^{55}Fe.These x-rays then create vacancies in the sample atoms by ejecting inner shell electrons. These vacancies when get filled by electrons present in higher levels of the atom x-rays are emitted. The intensity of x-rays emitted from a sample are fingerprints of atoms present in the sample. The intensities of observed lines for a given atom vary as the amount of that atom present in the sample varies.

3. LITERATURE SURVEY

Table1.*Literature survey of XRF technique used to determine impurities present in various environmental samples*

Ref.. No.	AUTHOR	YEAR	STUDY AREA	SAMPLE	TECHNICAL INFORMATION about samples	MAJOR FINDINGS
[1]	H.K. Bandhu	1996	Chandigarh, India	Aerosols	Aerosol samples were collected on 47 mm diameter, 0.8 p-m pore size, cellulose nitrate filter papers	Concentration levels ofvarious elements and gave insight into the possible sources, namely, natural source, i.e. soil dust, refuse burning field, automotive exhaust and smelter activity taking place in and around the city of Chandigarh.
[2]	H.K. Bandhu	1998	Chandigarh, India	Aerosols	Aerosol samples were collected on 47 mm diameter, 0.8 mm pore size, cellulose nitrate filter papers. The air through the filter paper was sucked at a flow rate of 12 LPM.	The mean concentration levels of different elements indicate presence of Pb and Br, which is usually related to vehicular emission. The Br/Pb concentration ratio was found to be between 0.02±0.15 whereas, for pure vehicular emission this ratio is 0.38. This indicates, vehicular traffic is not the main contributing source of leadpollutioninChandigarh.
[3]	H.K. Bandhu	2000	Chandigarh, India	Aerosols	Aerosol samples were collected on 47 mm diameter, 0.8 p-m pore size, cellulose nitrate filter papers	Sixteen elements, namely, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Br, Rb, Sr, and Pb were quantized in most of the aerosol samples.
[4]	I.Queralt	2005	Spain	Plants	Prepared a powder pellet by mixing 2g	9 macroelements, 5 microelements & 3 non-essential

					of plant powder with 0.2g of pure wax (40mm dia)	elements in five medicinal plants were determined.
[5]	Antoaneta Ene	2009	Romania	Soil	Soil samples were dried, homogenized & sieved at 250µm particle sizes.	Concentration of heavy elements decrease with distance from metallurgical works.
[6]	M. Alrakabi	2012	Chandigarh, India	water	The water samples were filtered using normal filter paper and dried in disposable glass containers in an electric oven. More than 500 ml of each of the water samples was used to obtain at least 200 mg of the residue.	Concentrations of the Br, Sr and U elements are found to be high in ground water samples and also exhibit general correlation with the total salt content.
[7]	G. Singh	2013	Chandigarh, India	water	Reply to query related to ‘‘Study of uranium contamination of ground water in Punjab state in India using X-rayfluorescence technique’’	Potential long term effects of uranium contamination of ground water due to irrigation-supported agriculture have also been observed.
[8]	Maria Cruz Minguillon	2014	Barcelona	Aerosols	PM samples were collected using Harvard impactor at flow rate- 102/min on Teflon filters (2µm pore size)	Most of elements were measured in higher concentration during warm period
[9]	Mariana Achad	2014	Argentina	Aerosols	PTFE filters (47 mm thick) were used. Flow rate – 10L/min	Fine particulate matter in atmosphere is responsible for adverse health effects on humans
[10]	Kanan Deep	2014	Punjab, India	Water	The different water samples in equal amounts in thin polythene bags were, in turn, mounted on sample holders and irradiated with photons from low power X-ray tube with operating voltage 6kV/0.2mA	Hardness of water is attributed to presence of calcium in water in the range of 0.1-100 ppm

[11]	Alexander McCumber	2017	USA	Soil	Samples were dried for 2 hrs in an oven between 120 & 150 deg C and passed through 10 mesh sieve& then 60 mesh sieve.	The measured lead values ranged from 10 to 170 ppm.

3.1 Inference from literature survey

- XRF finds wide ranging applications in detecting pollutants in various environmental samples which include aerosols, plants, soil and water.
- The advantage of multi element detection capacity of XRF technique is evident from [3] where sixteen elements were detected in aerosol samples.
- XRF is an efficient technique to detect elements at ultra trace levels which is evident from the fact that calcium was found in the range of 0.1-100 ppm in water samples as reported by Deep et al[10] and lead was detected in range of 10-170 ppm in soil samples as reported by McCumber et al[11].

4. EXPERIMENTAL SET UP

X-Ray fluorescence spectroscopy can be performed by two instrumentation techniques namely Wavelength Dispersive X-Ray fluorescence (WDXRF) and Energy Dispersive X-Ray fluorescence (EDXRF) where in wavelength dispersive x-ray fluorescence we measure x-ray intensity as a function of wavelength while in energy dispersive x-ray fluorescence we measure x-ray intensity as a function of energy.

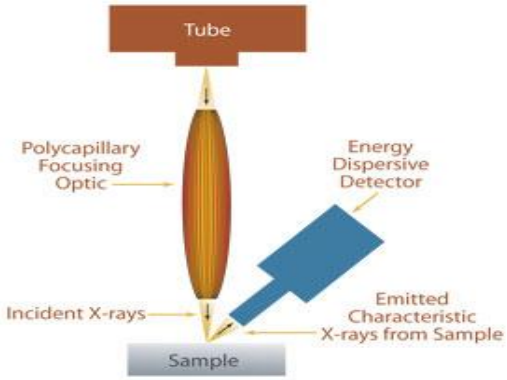

Figure 2. *Set up of an XRF Spectrometer courtesy of https://xos.com/technologies/xrf/micro-x-ray-fluorescence//*

Figure2 shows a typical XRF set up which comprises of an x-ray source, the sample to be investigated and an energy dispersive x-ray detector for example low energy germanium detector.

Resolution of the spectral lines emitted by the various elements determines the selective elements present in the sample and is possible by some form of energy categorizing or wavelength dispersing device. This process is different for both Wavelength Dispersive X-Ray fluorescence technique and Energy Dispersive X-Ray fluorescence technique. For Wavelength Dispersive X-Ray fluorescence technique Bragg's law is used to analyze crystal whereas for Energy Dispersive X-Ray fluorescence technique we use the detectors like gas filled proportional detectors, scintillation detectors, or the solid-state semiconductors detectors. Instrumentation required for energy dispersive XRF is discussed in detail in the following sections.

4.1 X-ray sources

Thefirst and foremost part of experimental setups consist of X-ray source of natural radioisotope such as ^{55}Fe, ^{57}Co, ^{109}Cd, ^{241}Am, and ^{244}Cm or a low dissipative x-ray tube excitation source. But recently, x-ray tubes have become more popular due to some disadvantages of using radioisotopes like continuous emitting of radiations, fall in intensity as the source decay gradually and also the wavelengths and intensities of the emitted x-rays are not adjustable.

The x-ray tubes work on the principle of excitation of anode material by impinging it with fast moving electrons ejected by cathode. Different materials like Cd, Cu, Mo, Rh, Ag, W, Pt, or Au are used as anode depending upon the applications.

4.2 Sample Preparation

- Plant samples are first dried and then powdered. This powder is then mixed with pure wax in the ratio of 10:1. This mixture is then converted into a pellet.
- Water samples collected from various water bodies are first filtered using normal filter paper. This water is then dried up using ovens and the residue hence collected is converted into a pellet.
- Soil samples are first oven dried and then sieved in multiple steps to achieve particle size in range of 10^{-6} m. These particles are then converted into pellets similar to plant samples.
- Aerosol samples are generally collected on 47 mm diameter, 0.8 mm pore size, cellulose nitrate filter papers. The air through the filter paper are sucked at a flow rate of 12 LPM.

Plant, soil and aerosol samples are being prepared for performing XRF in upcoming months at Inter University Accelerator Center, New Delhi. The sample preparation techniques are discussed briefly in the paper referred at [12] presented by the author in the same conference proceedings.

4.3 Energy dispersive detectors

4.3.1 Proportional Counters

Proportional Counters are gas detectors which work in the proportional region which means detector output is proportional to the incident radiation. The gas of the chamber is an inert gas .When ionizing radiationcollides with a molecule of the inert gas an electron ion pair is produced. As the ionizing radiation travels through the chamber it leaves a trail of electron ion pairs along its trajectory. The chamber geometry and the applied voltage to the detector are such that in most of the chamber the electric field strength is low and the chamber acts as an ion chamber. However, the field is strong enough to prevent re-combination of the ion pairs and causes positive ions to drift towards the cathode and electrons towards the anode. The field strength becomes large enough to produce Townsend avalanches near the anode wire. These electrons collected at the anode are then converted into an electrical pulse by using appropriate electronics.

4.3.2 Scintillators

The active medium present in scintillators is various types of crystals for example ionic crystal of sodium iodide activated with thallium, organic crystal like anthracene etc. When ionizing radiation passes through these crystals the electron in the valance band gets excited to the conduction band thus creating a hole in the valence band. When this excited electron returns to the valence band photons are emitted in form of fluorescence radiation. These photons are then converted to photoelectrons using a photocathode and then amplified using a photomultiplier tube. These photoelectrons are then converted into an electrical pulse.

4.3.3 Semiconductor detectors

Semiconductor detectors find first preference as x-ray detectors due to high resolution as compared to other detectors. Various semiconductor detectors are available for x-ray detection which include Lithium drifted Silicon detector (SiLi), Low energy germanium detector (LeGe), High purity germanium detector (HPGe) etc. They are chosen according to the energy range of x-rays to be detected. All of them work on principle of generation of electron-hole pairs when radiation falls in the active area (depletion region) of the detector. Electron-hole pairs created are swept to the opposite electrodes under the applied reverse bias and constitute current which appears as a signal after processing through required electronics.

Before using any detector in the experiment it is thoroughly tested for its efficiency. The detector is also calibrated using standard x-ray sources like ^{55}Fe, ^{57}Co, ^{241}Am etc. before using

them to detect energy of unknown x-rays. Energy calibration and efficiency measurement of LeGe detector has been done at IUAC, New Delhi and is discussed in detail in [13].

5. DATA ANALYSIS

5.1 Calculation of concentration of an element in a sample

The concentration of various elements in a given sample is determined using Eqn(1):

$$C=\frac{Y}{I\sigma\beta\varepsilon} \quad (1)$$

Where C is the concentration of the element in the sample, Y is the yield of characteristic x-ray peak of that element, I is the initial intensity of x-rays incident on the sample, $\boldsymbol{\sigma}$ is the fluorescence cross-section for that x-ray peak, β is the correction factor included due to absorbance of x-rays, ε is the efficiency of x-ray detector for that peak.

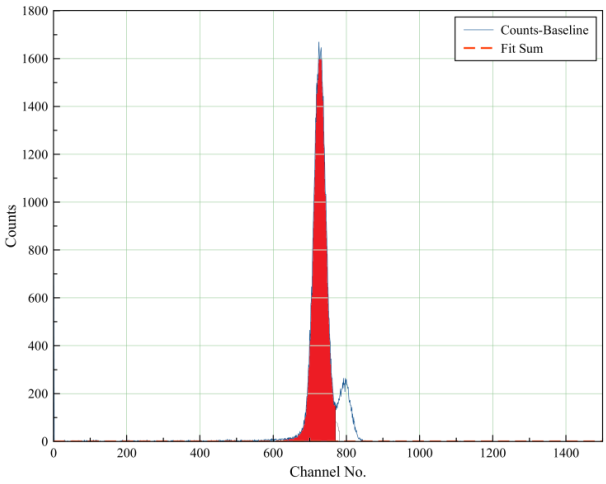

Figure 3. *X-ray spectrum obtained using ^{55}Fe radioactive source on an LEGe detector.*

The red colored area in Figure3 gives the yield of K_αx-ray emitted by ^{55}Fe radioactive source. The x-ray spectrums can be analyzed by using various computer software like Origin, Magic plot, root etc. Similar characteristic x-ray peaks are observed for the impurity elements present in the sample.

6. DISCUSSIONS

It is inferred from literature survey that XRF technique can be employed for almost all environmental samples like soil, water, plants, aerosol etc. Sixteen samples were simultaneously detected by Bandhu et al [3] in a aerosol sample using XRF. This shows the multi element detection capacity of XRF.The sensitivity of the setup is evident from the fact that people have found heavy elements like ^{208}Pb in soil samples in ppm range of 10-170[10]. XRF is useful for

detecting elements present even in ultra-traceamounts.. Its sensitivity along with the portability of the instrument makes XRF a popular choice for detection of impurities in various samples among environmentalists as well as physicists. Plant, soil and aerosol samples are being prepared to determine the type and amount of contamination in them using XRF.

Although measuring only the damage caused to the environment will do our environment no good. It is high time that we as responsible citizens take account of each of our activities and look for alternative ways in order to proceed towards sustainable management of our environment and its resources.

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Digital India: A Challenge for Microfinance Institutions

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Abstract: *The concept of microfinance is not new in India. Microfinance began its journey by providing credit to the poor. Since 1992 NABARD had been taking initiatives to develop this sector through SHGs, NGOs, corporative societies, RRBs etc. However this sector could only be unorganized. Besides this in private sector, microfinance institutions played a vital role in providing micro credit to micro poor in rural as well as in urban areas. Various models were used by MFIs to disburse loans and collect repayments from their customers. All these models were functioning more or less on cash basis. Introduction of demonetization and digital India campaign put a check on the functioning of MFIs. Disbursement of loans in cash and collections of repayments has badly hit in this sector. Indian economy is taking a turn around. In the view of this changing environment of economy, it has become necessary for MFIs to adopt the route of digitization and to use new models for their business. In this article, the author has tried to explain functioning of MFIs in Pre digitalization period and new Challenges to be faced by this industry in Post digitalization world.*

Keywords: MFIs, Microfinance, Demonetisation, Digitalisation.

1. INTRODUCTION

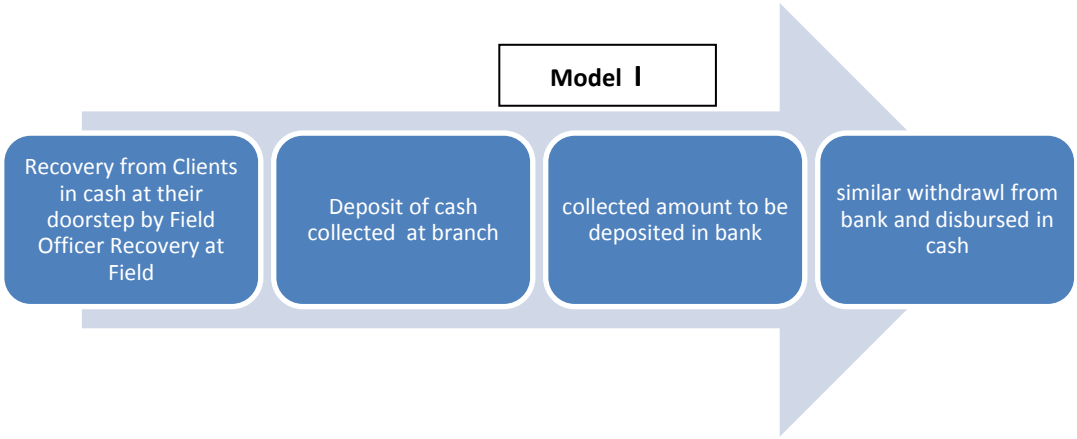
The concept of microfinance is not new in India. Since 1992 NABARD had been taking initiatives to develop this sector through SHGs, NGOs, corporative societies, RRBs etc. however this sector could only be unorganized. MFIs found good opportunity in this sector with an object of profit making. It was a known fact that india was having its largest population in rural areas. According to a survey report about 58% population of india depends on agricultural sector for its livelihood and 28% population is living below poverty line. This population in rural area required micro credit for different purposes such as small business purpose, agricultural purpose and personal purpose. Formal banking system was not interested in providing this type of loan as recovery of such loans become difficult. MFIs recognized this need of rural sector. They started to provide micro credit on cash basis in rural areas by creating groups. Responsibility of recovery of loans was on that group. Since the cost of providing loan was high, MFIs charged high rate of interest from the borrowers. In some cases this rate of interest was as high as 48% p.a. This type of earning attracted other MFIs in this area. Such MFIs were funded from banks at lower rate of interest and provided micro credit in rural areas at high rate. To capture more customers MFIs provided discount offers. Soon they had lakhs of clients. But multiple borrowing by a single client

from different MFIs changed the game upto 2010. Most of borrowers were not in the position to refund the loan amount. Over indebtedness in AP can be gauged from the fact that, in comparison to national average of Rs. 7,700, in Andhra Pradesh, the average debt outstanding per household was Rs. 65,000 *(CGAP, 2010)*. Inability of borrowers to repay such huge amount resulted in stress on the part of borrowers and use of coercive methods on the part of MFIs to recover the loan payments, which ultimately resulted in suicides of the borrowers. One of the major factor behind these crisis was non digitization. After 2010, some big MFIs named as SKS MICROFINANCE LTD.(now, BHARAT FINANCIAL INCLUSION) , SATIN CREDITCARE, UJJIWAN and EQUITAS tried to apply digitization in this industry but at low speed. However, According to a report by Sa-Dhan, an industry association of community development-focused finance institutions, MFIs' total loan portfolio has grown by a staggering 46.89%, to Rs 48,882 crore in 2015. The sector has also seen the average loan per borrower go up to Rs 13,162 from the previous year's Rs 10,079.

2. MODELS USED BY MFIs DURING PRE-DIGITITASION PERIOD

2.1 Model I

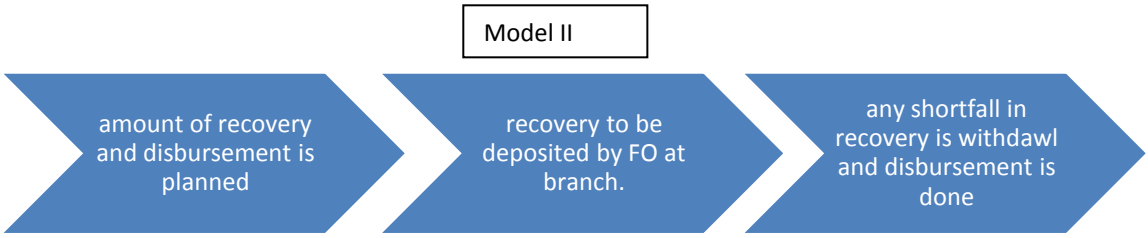
This model was purely based on cash system. Field officers made recovery of loan in morning at door steps. Such recovery was brought to branch office and then it was deposited in branch of such bank where MFI maintains account. A similar amount was withdrawn from bank from a separate account. This amount was used for disbursement of loan. Remaining cash was held with branch overnight.



Model II

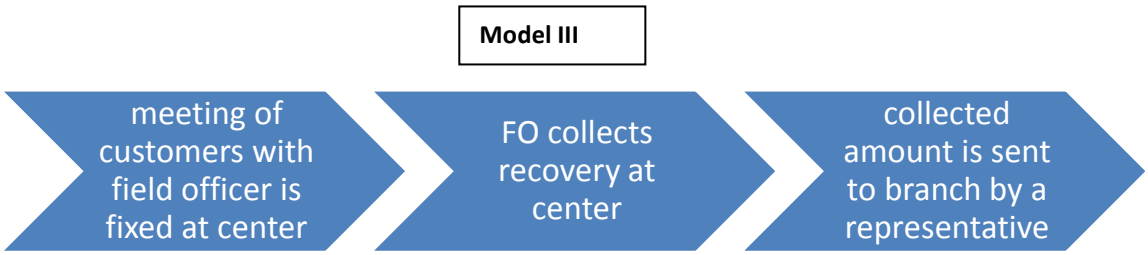
This model was also based on cash system. Generally the Branch Manager had an idea about the amount of to be collected and the amount to be disbursed in a single day. Field Officer brought the recovery by 12 noon In case the recovery was more than the planned disbursements, the difference was deposited in the bank and in case the disbursements were more than the recovery, the amount

was withdrawn from the bank. In the evening the disbursements took place and if all the clients came, no amount was left as balance or a minimal amount remained as balance.



Model III

In this model, the Field Officer visited the Center as per the recovery schedule, conducted the meeting and ensured that the collection was complete as per the schedule. He/she would inform about the recovery/non recovery as the case may be to the BM. The collected cash was then deposited at the Branch Office by one of the representatives of the Center either on the same day or latest by next day morning. The responsibility of depositing cash at the Branch Office was shared by members on rotation basis. The uniqueness was that the Field Officer did not handle cash while in field which reduced the cash risk for the staff.



3. **PROBLEMS FACED BY MFIs DUE TO NON DIGITISATION**

3.1 **CASH RISK**: As mentioned in the above models, handling of cash is one of the crucial step involved in recovery and disbursement of loan. In the whole process cash is collected by field officer and carried to branch. There involves a huge risk of theft, misuse or manipulation. The MFIs (and their customers) are thus exposed to cash risk (storage and transit) and incur cost to manage cash and related risks.

3.2 **LACK OF MULTIPLE PRODUCTS**: In the absence of digitization, diversification was not possible under traditional MFIs functioning. Earlier MFIs had been providing a single credit product to their customers. However many research studies have supported other financial

products including, variety of credit products, saving and other deposit products, insurance, pension etc for clients. In 2010 Andhra Crisis also raised the need of such diversification

3.3 **HIGH COST**: handling of high cash with risk, recovery of loan, deposit and withdrawl of cash involve time lag. It also involves huge man hours. All these activities raise operational cost to a certain extent.

3.4 **TIME CONSUMPTION**: it takes about 15-20 days in sanctioning of loan by MFIs to a customer as it involves checking history of customer, form filling by customer, documentation of customer etc. many a times customer fills forms with errors. Documents deposited by customer may be insufficient. All these activities are time consuming which makes the operational cycle lengthy.

3.5 **LACK OF PROPER RECORDS**: multiple loans by one customer from different MFIs can be possible if MFIs don't have his records. In the pre digitization period Andhra Crisis is the live example of this problem when due to improper records many borrowers took multiple loans and committed suicide.

3.6 **LIMITED GROWTH**: Business operations could be spread only up to a limited area due to lack of digitization.

3.7 **DEMONETIZATION**: certain government decisions such as demonetization of high value currency can put a check on operation of MFIs if they don't accept digitization. This also happened with Indian MFIs. In India traditionally about 85% of loan disbursements by MFIs and 95% of recovery of loan is done in cash. If we accept this fact then it is clear that this factor can become a great headache for MFIs as these types of factors put a check on functioning of MFIs by reducing disbursements and increasing NPAs.

3. POST DISITISATION PERIOD: DIGITAL TOOLS FOR MFIs

Digital India campaign can be proved as life saver for MFIs. Various digital tools can be used by MFIs to fight with above mentioned challenges and problems. Some of these tools are as under:

- **Mobile Device**: In India use of mobile networks is increasing on a rapid fire basis. According to available data India's mobile banking subscriber base crossed one billion landmarks in January 2016. MFIs can use different mobile devices such as android operated cell phones, I pad, tablets etc. to make their functioning digital. At the initial stage field officer can approach to their prospected borrower with digital devices. A data base of such borrower can be made ready without any error.

  Documents of such prospected customer can be scanned in such mobile device. This can help MFIs to create a large data base even in remote areas. The prospected customer can

find it easy to apply for a loan without paper work. By doing this location of a prospected customer can easily be traced.

- **Micro ATMs**: Handling of cash by field officer creates cash risk in transit for MFIs. Also, it is not possible for each commercial bank to open ATM or branch in each village. To solve this problem, biometric micro ATMs integrated with biometric modality for authentication are contributing towards development of micro finance. This system was introduced in 2012 by Unique Identification Authority of India (UIDAI). This biometric micro ATM device "Aadhaar Enabled Payment System" (AEPS) helps the customers of MFIs to withdraw money near their doors through core banking system. Micro ATM is connected to banks across country. Biometric identity authentication is must before performing transactions like withdrawing or putting money into their bank accounts.
- **Personal Digital Assistant (PDAs)**: Time gap between application of loan and sanctioning of loan is very crucial for each MFIs. It decides operating cycle of MFIs. Scrutinization of customer's loan application and documents is a prerequisite for sanctioning loan. Different software can be developed for this purpose. sc PDA as used by SKS microfinance for their operations is a portable computer like platform running software programs to standardize lending methodologies and assist in collection of information. Software leads to time reduction by conducting loan Scrutinization and disbursement of funds.
- **Management Information System (MIS)**: multiple loans by same customer from different MFIs causes great loss for this industry and situations like Andhra Crises arises in the economy. To avoid this situation, effective information system can only be provided through digital world Automation due to development of computers and software applications like MIS has transformed the way MFIs operate. Information is made readily accessible by MIS. It facilitates loan officers track clients' repayment schedules and balances and monitors progress toward attainment of operational objective. An evaluation framework provides a way of assessing the fit of a software solution for your organization. It is impossible to come up with an evaluation framework which will suit every MFI but there are a number of factors, which each MFI must consider before applying any system. These factors may include cost of software, easiness in handling, security issues, reporting system of MFI etc ;
- **Social Media**: Facebook, Youtube, Twitter and likedin have become major players on social media. All these provide platform where MFI can create a link with their present and future customers. Discussions can be done with the prospected customers.MFIs can

increase their customer base by offering different discounts and products on Facebook page.

- **CREDINFO SYSTEM**: This system offers an online assessment function that allows the handling of the assessment process according to the group lending procedure. In this case the members of the applicant's group also participate in the assessment process online. An important aspect is that the loan committee of the MFI starts its assessment only after the group has assessed the loan application and given a positive backing to it. However, the online solution will not eliminate the actual meetings of the group members prior to assessing the loan online.
- **Internal network – Intranet :** The internal network is a work in progress item, that will run from the end of the year. It is designed as a tool to exchange information between headquarters and branches, offering basic e-learning and an information platform for staff and volunteers to share documents, news and an internal newsletter.
- **POS terminal:** this type of terminal can also be used by MFIs for transferring money.
- **Mobile WALLET:** In India many Apps like Paytm, Mobikwik, Freecharge, Bhim are in operation which are providing secure cash transferring facilities to customers. MFIs can use these as their digital tool.

5. DIGITAL CHALLENGES BEFORE MFIS

- **Partnership with financial service providers**: To survive in this digital world MFIs have to create digital environment internally as well as externally. For this purpose, an agreement with digital financial service provider is necessary. Choice of a suitable digital financial service provider is a challenge for MFI.
- **Training of workers**: Digitization can be successful only if all the workers of MFIs have proper knowledge of digital tools. Each worker of MFI at each stage must be capable in handling mobile devices such as tablets, mobile applications, software, internet usage, scanners, laptops etc. to provide proper training to each staff member according to their needs is a great challenge before MFIs .
- **Infrastructure development** : Setting of computer system, development of software, purchase of tablets, creation of mobile application, purchase of internet connection are the big challenges for MFIs. In rural areas of india where MFIs mainly perform their functions are far behind in infrastructure facilities such as internet connection, MFIs will have to work harder.

- **Cost of software and budget:** Cost of digitization may be high and beyond budget of MFIs. Anyhow there is capping of interest that can be charged by MFIs from its customers. Therefore MFIs have no scope of shifting the burden of digitization cost on customers.
- **Adoption by customers:** It is not easy to convince the customers to accept the change in old ways of functioning. In india people like cash transactions especially in rural areas. It is a big challenge for MFIs to convince the rural customers for becoming the part of digital world .
- **Awareness in customers :** MFIs customers in rural sector are not well educated. Some of them use mobile phones but of old technology. In simple words these customers are not aware of digital world. It is main challenge for MFIs to aware their customers about digitization and to provide them proper training and education related to use of digital divices.

6. CONCLUSION

During pre digitization period MFIs suffered with many losses. They knew the limitations of their operating models. They had to bear a significant risk. Risk of loss of cash in transit, multiple loans by same customer, non recovery of loans, delay in sanctioning of loans, lack of proper records of customers, lack of timely communication with customers were certain problems of MFIs. The only way that could solve such problems was digitization. Development of technology opened the ways for MFIs to find the solutions of their root problems. By using digital tools as mentioned above MFIs can track the records of their customers, loan sanctioning period can be reduced from 25 days to 10 days, risk of handling cash can be at bottom line, timely communication can be done and real time analysis is possible. However, it involves huge cost in developing digital infrastructure but long term benefits are greater than such costs.

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Search Engine Optimization – A critical element in Digital Marketing

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Abstract: *In the current digital world, businesses can flourish manifold by capitalising on Digital Marketing. In order to increase economic growth and tap the Digital potential, the Government of India has initiated Digital India mission. A mere creation of good website for digital marketing would not increase the number of webpage hits or website traffic. In order to increase the number of eyeballs, the website needs to be ranked at the top of the Search Engine Result Pages (SERPS). Generally, the search engines uses the key element of digital marketing techniques namely Search Engine Optimization (SEO) in order to list out the relevant websites in the SERPS. The entrepreneurs or website owner should be aware of SEO techniques such as inclusion of relevant keywords and relevant hyperlinks which would substantially improve the page ranking of the website. The website owner should also need to know how to measure the metrics of the website from the search engine point of view using existing SEO tools. This paper focuses on the operational aspects of search engine and provides details of various search engine optimization techniques and SEO tools. The paper also provides the impact of Page Rank algorithm and the critical factors that affects the visibility of the website.*

Keywords: Search Engine Optimization, Search Engine Result Pages, SEO tools, Page Rank, Digital Marketing.

1. INTRODUCTION

Most of the internet users often try to find their required information based on the result from the search engine rather than the entering directly the specific webpage. As the quantity of information on the internet is increasing day by day so there are many challenges for website owner or entrepreneur to provide proper and relevant information to the internet user through search engine. Apart from the development of the content-rich typical website, the website owner should also aware of the prevalent Search Engine Optimization (SEO) techniques that helps their website to be available in the beginning of the Search engine result pages (SERPS). In order to understand the SEO techniques properly, the paper focuses on the operation aspects of search engine, various SEO techniques and tools and its impact on PageRank of the webpage.

2. OPERATIONAL ASPECTS OF SEARCH ENGINE

The working of the search engine involves four major activities namely Crawling, Indexing, Calculating Relevancy and Retrieving Result pages (Samrat, 2011).

a. Web Crawling:

The web crawler is a program that browses the world wide web and stores the indexed words in the database. The result web pages for the given query obtained from different search engines namely Google, Yahoo, Bing differ as the crawler or spider software of search engine follows different ways to search for the given query words in the internet and maintains different frequency to crawl the webpages available in the internet. The crawler basically looks for text and hyperlinks to move from one web page to another webpage. The crawler does not understands the images, videos, client side scripts and password protected files or directories in the webpage. The website developer should make sure that the relevant content is also given in the alternate text for the images and videos so that the alternate text is consider for crawling.

b. Build Indexing:

The next activity is to index the spidered texts and spidered links from the crawling activity and to store in the giant database. It is basically maps the indexed content of the particular webpage to the relevant keywords in the index database so that the webpage will be eligible for the relevancy calculation. The website developer should make sure that the relevant content is indexed by checking the cache content of the website in the search engine.

c. Calculate Relevancy:

The search query from the user should be compared with the built-in indexes in the giant database based on the relevancy computation between the query words and index word or phrase. The PageRank algorithm of the search engine is responsible for the conversion of web links from the index database to the PageRank value. For example, the Google's Page Ranking algorithm calculates the PageRank value of our web page depending upon the link structure of the web page (Sharma et al, 2010). The Page Rank algorithm is based on the concept that if a page contains important links towards it then the links of this page towards the other page are also to be considered as important pages. Each back link is like a vote (Sharma, 2016). These votes are used to rank the webpage. Most of the search engines calculate the relevancy of web links based on the appropriate keywords and appropriate links retrieved from the database and gives out the ordered list of the pages based on the value of PageRank respectively.

d. Result Retrieving:

The order of the webpages in the SERPS should be displayed to the user as per the ascending order of the Page Rank value. The search list of the webpage plays a crucial role in the internet user's decision making process as the user intends to choose the first few websites recommended by the search engine. The information that is retrieved from the search engine to the public have a social impact as they will affect how a person thinks and acts.

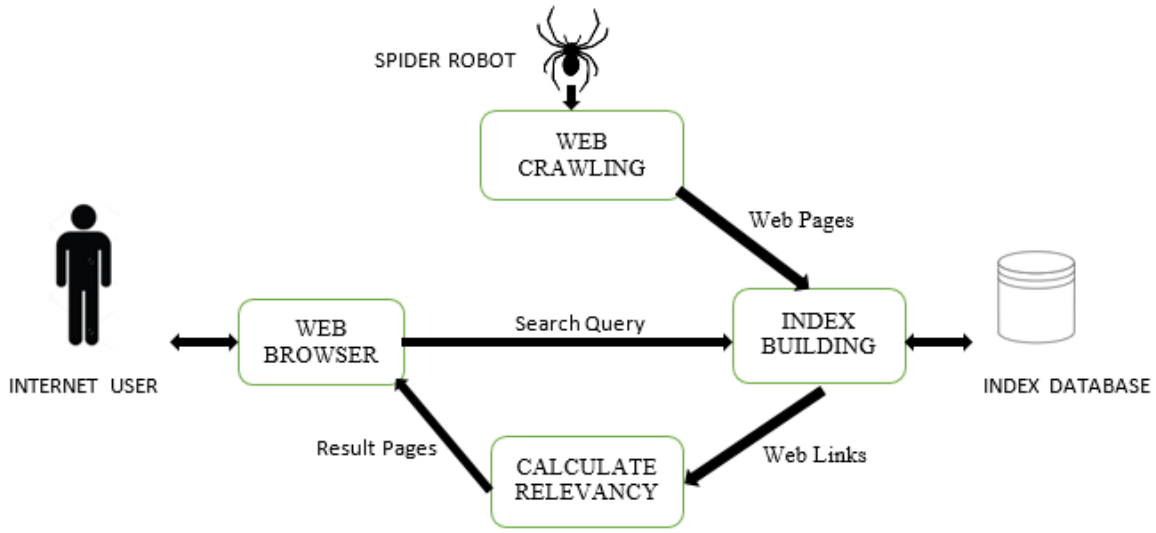

Figure 1. *The Working of Web Search Engine.*

3. TECHNIQUES OF SEARCH ENGINE OPTIMIZATION

Search Engine Optimization is a methodology of strategies, techniques and tactics used to increase the visibility of the website by obtaining a top-ranking placement in the search results page of a search engine (SERPS). Thus, SEO techniques of the website helps the search engine to place it in right position and plays a vital role in promoting the Digital Marketing of the website. The SEO is divided into two categories namely On Page SEO and Off Page SEO. The On Page optimization are the optimization techniques used in the coding part of the Webpage whereas the Off Page optimization are the optimization techniques used in the promotional methods of the Website to the outside world (Patil et al, 2015). The paper focuses on the major factors that contributes On Page SEO techniques of various search engines namely Keywords, Hyperlinks and Metadata.

a. Keyword:

Keywords are the important words available in the website and help to build the index database of various search engines (Gupta et al, 2016). Keyword Density is the percentage of times a keyword present on a webpage compared to the total number of words on the page. Keyword density plays an important role in building up the index of the specified keywords. If the search engines finds that a particular keyword is unnecessarily used for multiple times, then the web page is penalized

which is known as Keyword Stuffing. The keywords should be added by the website developer at the right place of the coding and details are given below:

- *Keywords in the Title tag of the page*: inclusion of keyword in HTML is as follows: <title> {Keywords}</title>
- *Keywords in the Header tag of the page*: inclusion of keyword in HTML is as follows: <h1> {Keywords}</h1>
- *Keywords in URLs*: inclusion of keyword in the path of the web resource
- *Keywords in Filenames*: inclusion of keyword in the name of the web resource

b. Hyperlinks or URLs:

The hyperlink is used to link one webpage to another webpage. The more number of absolute links or relative links in the web page within the website and inbound & outbound links to other website helps the search engine to give higher PageRank value to the website.

i. Internal Links

The internal structure of links between the relevant web pages plays an important role in the SEO technique. The link can be included in the HTML web page through <a>,<area> and <link> tag. The search engine provides higher priority to the legitimate hyperlinks which have the combination of appropriate keywords in the subdomain and registered Top Level domain (TLD) from country specific TLD such as .in for India, .uk for United Kingdom or generic TLD such as .edu for education, .gov for government in the root domain. In order to maintain the aesthetic aspects of all the webpages in the website, web developer needs to make sure that the links of all the menu & sub-menu items should be given properly and the link to go back to the home page should be available in all the web pages within the website.

ii. Redirection

Redirections are the ways to redirect the internet user and the search engine from the original requested link to the different link based on the HTTP status code. If the requested web page is not able to access the web server, the internet user used to get the response as standard HTTP status code 404 - Not Found.

Permanent redirection: If the requested web page is moved from one URL to another URL permanently, the internet user used to get the response webpage as standard HTTP status code 301 and load the webpage from another URL.

Temporary redirection: If the requested web page is moved from one URL to another URL temporarily, the internet user used to get the response webpage as HTTP 1.0 status code 302 or HTTP 1.1 status code 307 and load the webpage from another URL. As a part of SEO recommendation, it's better to use 301- permanent redirection as much as possible because 302 which stands for temporary redirect in HTTP 1.0 version and found in HTTP 1.1 version.

Meta Refresh: If the loading of the web page takes more time, the website developer gives the simple link to load the webpage with same content but less graphics. Even though it increases the number of links in the website, SEO does not recommend the meta refresh due to its poor usability.

c. Metadata:gives data about the data available in the web page to the search engine.

i. Meta Keyword

The meta keyword feature helps the search engine to know the list of keywords in the web page and the inclusion of many keywords in the HTML is as follows: <meta name="Keywords" content="{keyword1,keyword2,keyword3}">.

ii. Meta Description

The meta description feature helps the search engine to know the description of the web page and the inclusion of keyword description in HTML is as follows: <meta name="Description" content="{descriptions}">.

iii. Meta Robot

The meta robot feature helps the crawler software to give more weightage or importance to the relevant pages rather than giving same weightage to all the pages of the website. The inclusion or exclusion of the webpage crawling and indexing by the spider robot software in the HTML is as follows: <meta name="Robot" content="follow,index"> is used for relevant page to be crawled/indexed and <meta name="Robot" content="Nofollow, Noindex"> is used for the irrelevant page not to be crawled/indexed.

4. SEO TOOLS

a. Spider Simulator tool

The Spider Simulator SEO tool is used to find out the list of things crawled by the spider in the search engine namely spidered texts, spidered links, meta keywords and meta descriptions for the given URL.

Figure 2. *Search Engine Spider Simulator.*

b. Sheer SEO tool

i. Track the Page Rank

The PageRank value or the position in the search result of the Kalindi college website for the keyword “Golden Jubilee” in the Google search engine recorded by Sheer SEO tool on January 25, 2017 was 13 which is shown in the left side of the Figure 3. It implies that theKalindi College website is placed in the top-ranked page result for the search string “Golden Jubilee” in the Google search engine which is evident from the fact thatKalindi College was available in the firstresult page as shown in the right side of the Figure 3.

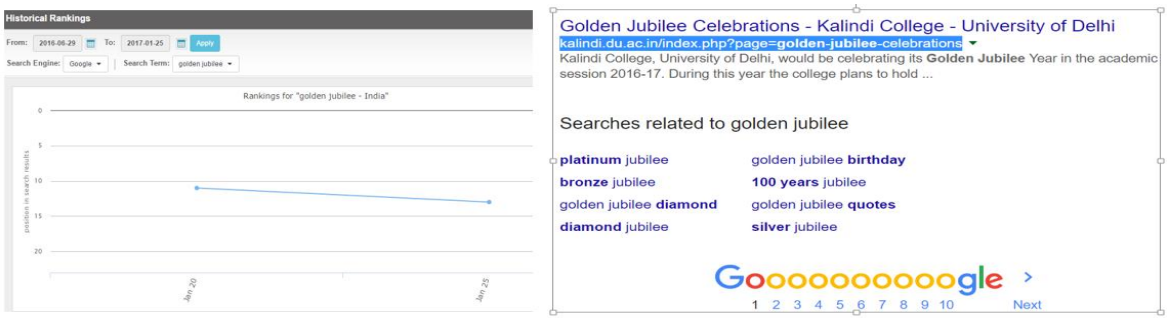

Figure 3. *SheerSEO PageRank report & Google Search Engine Result Page.*

ii. Keyword Density

The Keyword density and keyword weight of the single, double and triple keywords which is one of the major factor that impacts On-Page SEO techniques.

iii. Indexed Pages

If the number of indexed pages increases, it means the visibility of web site is increased whereas the decrease in the number of indexed pages means the visibility of web site is decreased.

5. CONCLUSIONS

The website owner should ensure that the highly relevant content-rich website is placed in the top ranked result page of the search engine using SEO techniques. The operational aspects of the search engine help to illustrate its impact in the three major contributors of SEO techniques namely Keywords, Hyperlinks and Metadata. The Crawled texts & links, Indexed pages, PageRank values, Keyword density of the web page can be monitored using SEO tools and provide the SEO report on daily or weekly or monthly basis which helps to improve the overall visibility of the website.

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Estimation of Sun Protection Factor (SPF) by using UV-Visible Spectrophotometer for cosmetic formulations

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Abstract: *The skin damage is one of the major concerns,due to changes in the globalclimate, temperatures andexposure to sunlight (Ultraviolet radiation).Ultraviolet radiation is responsible for sunburn and suntan,aging, skin cancer, photosensitivity, phototoxicity, actinicelastosis,adverse effects on the immune system,etc.Therefore,cosmetic formulatedsunscreens are used to block UV radiations that are assigned SPF, ratings that are indicative of level of protection from UVradiation and permit the treatedskin to stay longer inthe sun than under normal conditions.*

We have studied and quantify the SPFin numerous sunscreen lotions labeled with different SPF usingUV-Visspectrophotometric behavior.The different sunscreen solutions were prepared and their efficacies were calculated by recording their absorbance values in the range 290-320 nm using minimal erythemal dose (MED)formula:

$$\mathrm{SPF} = \mathrm{CF} \times \sum_{290}^{320} \mathrm{EE}\,(\lambda) \times I(\lambda) \times \mathrm{Abs}(\lambda)$$

Where, CF = correction factor, EE (λ) = erythmogenic effect of radiation with wavelength λ, Abs (λ) = spectrophotometric absorbance values at wavelength λ. The values of EE (λ) x I are constants were taken from literature values given by Sayre et.al.

Theobtained results were in good agreement with acceptable limits of determination of SPF values using UV-Vis spectrophotometricmethod.The proposed method is simple and quick for the in-vitro determination of SPFvalues of sunscreens solutions.

Keywords: SPF, Sunscreen, cosmetic formulation,spectrophotometric behavior, Ultraviolet radiation, efficacy.

1. INTRODUCTION

Skin cancer is the most common cancer.Every year, ~ 2 million people are diagnosed with skin cancer and about 9,000 dies from malignant melanoma.Most skin cancer occur on the areas that are most frequently exposed to the sun, such as the face, neck, head and the back of the hands. Although, the human skin is protected against solar radiations*via* the formation of melanin and it also prevent the mutagenesis of cellular DNA by blocking absorption of UV radiation.Ultraviolet radiation is a major carcinogen which causes 90% of all skin cancer. These radiation causes

immediate and persistent skin darkening stimulates the melanocytes which augments the cancer (Olefka, 2012).

People generally use clothing,umbrellas and hats to avoid the solar radiation's adverseeffects. Nevertheless, the use of chemicals for sun protectionwas formerlyacknowledged in the 20th century (Diffey, 1991). Therefore, protective chemicals, or sun blocks (Sunscreens) are the chemicals that shield or block UV radiations and show a variety of harmfulimmunosuppressive effects of sunlight. Owing to these facts, sunscreens substances are nowincorporated into everyday products such as moisturizers,creams, lotions, shampoos, mousses, and other hair andskin preparations.The use of skin care products especially sunscreens may be an effectiveapproach for reducing UV-B generated ROS (Reactive oxygen species) mediated photo aging immune suppression (Shaat, 1987).

1.1. Types of UV radiations

The UV radiations are characterized on the basis of intensity and on the basis of damage caused to the skin (Table 1).

Table 1. Types of UV radiations

Type	Range (nm)	Damage
UVC	100 – 290	These are absorbed by the ozone and donot affect the skin.
UVB	290 – 320	These radiations affect the outer layer of the skin and are the primary cause of sunburn and are. most intense during the summer monthsin the day time
UVA	320 – 400	These radiations penetrate deeper into the skin and the intensity is more persistent than UVB radiations without variations throughout the entire day and year.

In this paper we have collected different branded sunscreens from cosmetic and medical stores and their SPF was determined using ultraviolet spectroscopy assay (Kedor-Hackmann, 2004). We have also synthesized sunscreens by making use of natural ingredients using two different methods. Their efficacy was compared with the synthetic sunscreens.

2. DAMAGING EFFECTS OF UV RADIATION'S ON SKIN

The human skin consists of three layers: the epidermis, the dermis and the subcutis. These have the intrinsic properties to protect itself from the sun. Thus, the skin is the body's first line of

defense for external exposure with melanin as the skin natural sunscreen. But acute and chronic exposure to non-physiological doses of ultraviolet radiation leads to many skin defects, like sunburns. There are certain other chronicle effects such as:

1. **Collagen Breakdown:** UV radiation increases breakdown and causes abnormal elastin accumulation which creates solar scars on the skin and also develop wrinkles.
2. **Free Radicals generation:** UV radiations exposure can also cause certain chemical reactions in the skin and creates free radicals, which activates some allergic reactions, damages cell functionsin addition to the alterations in genetic material.
3. **Weak Immune System:** Certain chemicals are released during reactions which suppresses the immune system.
4. **Skin Cancer:** Skin cancer develops because of abnormal growth of our basal, squamous or melanocyte cells.These cells are characterized as:

Basal celland **Squamous cell** skin cancers are often called non-melanoma skin cancers. These types of skin cancers are indicated by a pale wax-like pearly bump or nodule, or a red scaly patch (Fig. 1 a& b). Generally, they arenotlethal because they do not spread to other kinds of tissue in the body. Most of the times, these are treated by dermatologist if detected at an early stage.

***Melanoma*cell** skin cancer is the worst kind of skin cancer as it is life-threatening. Melanoma appears on the skin but spreadsquickly to other places of body, such as lungs, liver or bones. It may start out as a mole-like growth that increases in size and changes color (Fig. 1c). The moles are not symmetrical, the borders are blurred or uneven, the color is not uniform and size is also bigger. If discovered at an early stage, melanoma can be treated before it spreads.

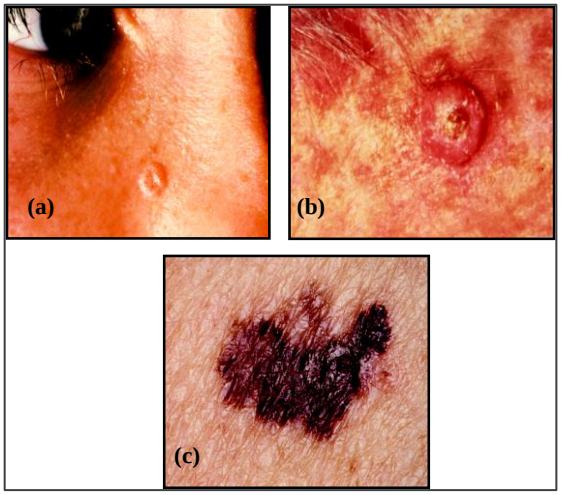

Figure 1. *Non-Melanoma cells:a) Basal call b)Squamous cell, c) Melanoma cell.*

2.1. Skin cancer outbreak

All types of cancers develop due to the abnormal growth of cells. Similarly, skin cancer progresses as a result of unusual growing of the basal, squamous or melanocyte cells. There is indeed a certain mechanism which advances the reactions inskin. First of all, on exposure UVA and UVB rays hit the epidermis which causes the DNA of skin cells to break down.The breakdown reasons the cells to grow out of control and form a mass of cancer cells.The immune system tries to repair the damage but furtherirradiation to the sun hindersthe repair. These damaged cells can mutate into skin cancer within a time span of ~5 years (Fig. 2).

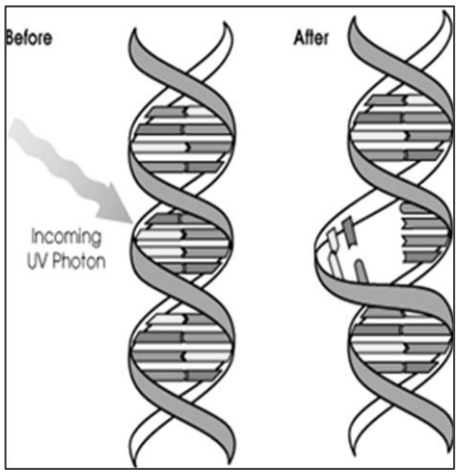

Figure 2. *Effect of UV radiations on skin DNA.*

3. PREVENTION FROM SUN DAMAGE: SUNSCREENS

Sunscreens are cosmetic formulationswhich are used to block UV radiations from continuous exposure. These are assigned with SPF, ratings which indicates the level of protection from UV radiation and permit the treated skin to stay longer in the sun than under normal conditions. Depending on the mode of action, sunscreens can be classified into:
1) Physical sunscreens (those reflect the sunlight): These are also commonly referred as "non-mineral" or "traditional" active ingredients designed to absorb and dissipate UVA/UVB rays. The chemicals work like a sponge on the skin to absorb UV for a set amount of time. They need some time to bond with skin and are hard to rub off. The best-known UV filters in physical sunscreens are TiO_2 and ZnO particles. The known mechanism of physical sun blocking is through light reflection and scattering.

2) Chemical sunscreens (those absorb the UV light): These are tiny metals that work like aluminum foil to reflects UV away from the skin. They donot need time to bond with skin and are easier to rub off. Chemical Sunscreens are usually aromatic compounds conjugated with double C=C bonds, having the electronic excitation energy in the UV range.Some of the examples are *p*-aminobenzoates, cinnamates, salicylates, benzophenones, camphor derivatives, *etc*.(Ferrero, 2002; Arjona, 2015). Each of the active ingredients provides an SPF factor related to its concentration in

the sunscreen.Increasing the concentration of the ingredient should also increase the SPF rating of thesunscreen.

4. DETERMINATION OF SPF

4.1. Synthesis of natural ingredient based Sunscreen

Solvents and Chemicals: Absolute alcohol 99.9% (Analytical grade), Shea Butter, bee wax, raspberry seed oil, coconut oil, zinc oxide, tea-tree oil, almond oil,*etc*. purchased fromSpectrochempvt. Ltd. and medical stores.

Synthesis: The sunscreen lotions were synthesized by implying modifications in the methods described elsewhere in literature (Kedor-Hackmann, 2004; Golmahammadzadeh, 2011).

Procedure 1: Beeswax, shea butter and coconut oil were melted together with 10 drops of tea tree oil. The contents were removed from heat and stirred in zinc oxide. Stirredthe mixture for 5 - 10 minutes for coolingand refrigerated until use.

Procedure 2: In this method raspberry seed oil was used as natural ingredient.

4.2. Materials and Methods

Materials: Different branded Sunscreen lotions were procured form chemist and medical stores as well as synthesized in the laboratory.

Procedure: An accuratelyweighed 1gm of sample was taken in a 100 ml volumetric flask and 50 ml of ethanol was added. The solution wasultrasonicated for 15 minutes and made up to the mark with ethanol (solution-A). The solution was filtered through whatman filter paper, rejecting the first 10 ml. From the above solution 5ml aliquot was transferred to 25 ml volumetric flask and diluted to volume with ethanol (Solution-B). Then a 2.5 ml of Solution-B was transferred into a 25 ml of volumetric flask and make up the volume with ethanol (Solution-C).The tests were performed in triplicate for each sample and SPF were calculated using absorbance values by the application of MED eq.(tables 2&3) (Sayre 1979; Mansur, 1986). MED is defined as thelowest time interval or dosage of UV light irradiationsufficient to produce a minimal, perceptible erythema onunprotected skin.

Table 2. Erythmogenic effectspectrum (EE) and solar intensity spectrum (I) values.

Wavelength (nm)	EE (λ) x I
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0837

320	0.0180

Table 3 Comparison of given and calculated SPF values of different brands sunscreens.

Sunscreen	**SPF** $_{\textbf{given}}$	**SPF** $_{\textbf{calculated}}$
Lakme	30	24.42
Lotus	50	39.97
Lo'real	30	24.89
Biotque	30	27.97
Patanjali	30	28.54
Himalya	30	28.69
Self-made (procedure 1)	-	29.63
Self-made (procedure 1)	-	28.64

5 Results and Discussions

The different sunscreens were screened for in-vitro estimation of their SPF values. For this, experimental UV spectra were recorded from 290 nm to 320 nm every 5 nm for each sample in ethanol.The obtained results were in good agreement with acceptable limits of SPF values. It was also observed that sunscreens made from natural ingredients gave more promising results (table 3). The most important ingredient in homemade sunscreen is oxide, which comes in the form of either zinc oxide or titanium dioxide. We choose Shea butter for the preparation of sunscreens as it is believed to have a natural SPF of 4- 6. Shea butter is a great moisturizer, and makes skin smoothandit also thickens the sunscreen.

It was also concluded that natural ingredients boost the efficacy of sunscreens. Therefore, it's best to use homemade sunscreen and consume themwithin six months of making it. Red raspberry seed oil is a popular choice amongst sunscreen makers, as it has an SPF of 25 to 50. Other common choices include popular base oils such as olive oil, coconut oil, castor oil, almond oil as well as popular essential oils *e.g*. peppermint**,** tulsi, and lavender having their SPF values in the range 5-10.

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6. Conclusions

The Erythmogenic effect and solar intensity are suitable parameters, which quantified the UV blocking effect. The procedure can be employed to compare fresh and aged products. The aging effect is more important in the UVA region. Therefore, the use of freshly prepared sunscreens rather than reuse of aged stock are recommended.The developed UV spectrophotometric method is simple, rapid, employs low cost. The results were in good agreement with acceptable limits of in

vitro determination of SPF values. Hence, it may be concluded that Uv-Vis spectrophotometric method is precise, accurate and less time consuming and can be adopted for the estimation of efficacy of sunscreen in cosmetic formulation. The analytical method can be taken up for further research for other analytical marker compounds as this traditional formulation comprises of other sunscreen substances.

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Green Energy

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Abstract: *According to World Bank data, the electricity consumption per capita of India in the year 2000 was 390.96kWh which boosted to 641.27kWh in the year 2010. This trend of increasing electricity consumption is observed in different countries all around the globe. To combat this growing demand new ideas are being proposed which not only provide an alternative to the former methods of production but also promise to provide clean energy. One such concept is that of Green energy, more accurately, GreENergy. This is a pristine idea which refers to the generation of electricity using plants. It can prove to be cheap yet an efficient source of electricity. This aspect of plants is being scrutinized by explorers. This has furnished a new dimension to the primitive notion of renewable energy. The quest that stands before us is to make GreENergy a more reliable and effective source. The following paper accentuates the profuse facets of GreENergy, more specifically, the ability of plants to produce electricity using its metabolic processes and physical movements. Experiments that were performed to illustrate plants as generators of electricity are mentioned in the paper.*

Keywords: GreENergy

1. Introduction

Trees are the supporting unit of life. They have provided the nature with everything it needs to be complete. They have served the human race and animal kingdom by offering food, shelter, wood, medicines and numerous other utilities. Trees have been a silent helpers in the process of genesis itself. This paper is explains a more or less contemporary perception about trees. It deals with trees being used as a source of electricity.

As we humans evolved, our needs have also became more advanced. We live in world which thrives on energy.With rise in population the demand of energy is also increasing. In such a situation to meet the energy demands resources such as coal and petroleum are not enough. With time they will get depleted. Keeping all these issues in mind we need an efficient method to fulfill our energy requirements. We need to take a sustainable path which can benefit not only humans but the entire living world. The question that arise here is that can trees; being the primary source of energy, be used to generate electricity?

For this purpose scientists all over the globe have been scrutinizing over this aspect of trees. If they can serve as energy source then it will give a new dimension to the concept of renewable energy. This clean source is a form green energy, or as we call it, GreENergy.

The main topics that are covered in the following paper includes different green energy sources, the experiments carried out by different organizations and at the end we conclude by defining a new term that is introduced in the paper namely, GreENergy.

2. Concept of GreENergy-

Electricity generation from dead and decay of trees and other organic matter is not a new practice. We are aware of electricity production from biogas power plants on large scale and electricity production from potato (invented by Israeli scientists) or lemon for experimental purposes. These are old ideas allied to greENergy. Since then a lot of exploration has been made and a revolution has started, although it has failed to gain popularity in India.

2.1. *Plantain Pith Battery*

One of our neighboring country has taken a step forward to be part of this revolution. Dr. K.D. Jayasuriya, a physicist, along with a group of scientists in Kelaniya University, Sri Lanka succeeded to derive greENergy from plantain tree, a faunal species found in many areas in Sri Lanka. The tree as such has no commercial utility but the fruit of this tree has been used to produce energy. The core of the fruit was extracted, boiled and chopped. An apparatus was set up using one zinc and one copper electrode and the chopped Fruit (source of phosphoric acid) was used as electrolyte. In this way a battery was created which had the potential of lighting a big LED (Light emitting diode). These trees are abundant in villages where either electricity is not available or is deficient. Scientists are working on how to use this idea to dazzle up the whole village. They believe that one day a single plantain tree would light a bulb for one year. The question that may arise here is how is this different from potato powder battery? Plantain tree battery runs for a longer duration as compared to potato battery making it more efficient than potato powder battery. Its longer shelf life accounts for its reliability as well. Another question that needs to be answered is that can biotechnology be used to increase the efficiency or production derived from plants? If it is true we can acquire more from less amount of plantain. Research needs to be done in this area.

2.2. *Electricity from a living tree*

There is another groundbreaking discovery by a M.I.T. based electrical component manufacturer company, Magcap in the field of greENergy. They performed an experiment by connecting some wires to the trunk of a tree and a conductor to the ground. They observed very minute source of electricity. For the first time in history, electricity was derived from a living tree! Inspired by these observations University of Washington succeeded in preparing an electric circuit

from power generated by tree trunk. The electric currents produced although, were of low intensity but the power stored by the trees in a battery could be used as a fire alarm in forests by signals produced by trees itself! They have explained the phenomenon of electricity production as the pH difference between the soil and tree. They have also observed that larger is the pH difference, greater is the energy production. This is a phenomenal discovery. They are trying to increase this faint power to get a better output. If this objective is achieved then these treesmight someday be able to replace fossil fuels. These discoveries have and will change our perspective about trees.

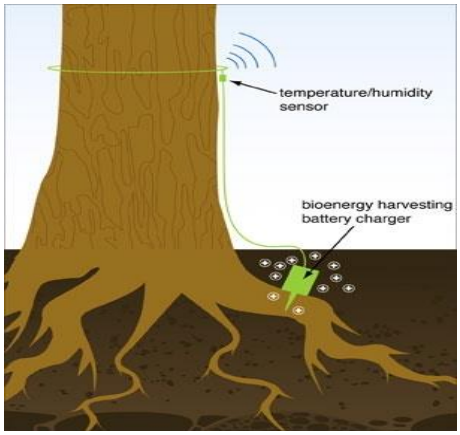

Figure 1. *Schematic diagram showing circuit being used to charge a battery of a sensor using tree [http://news.mit.edu/sites/mit.edu.newsoffice/files/styles/news_article_image_top_slideshow/public/images/2008/20090831111337593 2.jpg?itok=CCaMmDfc]*

2.3. *Bioenergy Harvester*

Another new concept called **bioenergy harvester** is being worked upon by scientists. It has the capability of converting living plant metabolic energy to electrical energy. This idea of obtaining energy can serve as sources of power for sensors, nanotechnology and also for monitoring many climatic and wildlife related matters where usage of battery is more costly and a cumbersome process. These self-sustaining batteries would revolutionize the concept of greENergy.

We imagine our future to be powered by trees. With this goal, an article was published by Scott McGarry and Chris Knight from commonwealth scientific and industrial research organisation (CSIRO) which describes various methods of producing energy by using movement of trees as source. It includes methods like energy harvesting by the horizontal acceleration of tree, its lean angle and the force or displacement of the tree. There are various techniques employed for this purpose such as –

2.3.1 *Movement energy harvesting employing an inertial mass*: In this method a pendulum is suspended connected by a transducer (It is a device used to transform one form of energy to another. This energy can be electrical, mechanical, electromagnetic, chemical, acoustic, thermal or in any other form.) Pendulum can be suspended to move in horizontal plane (tied by a string) or in vertical plane (tied by a spring). When the tree sways, pendulum also moves along with it, which is suspended via transducer. It converts the mechanical energy of the tree movement to electrical energy.

This techniques can be used in forests to provide energy to remote sensors. Presently the sensors work on photovoltaic batteries, but there are many problems such as improper penetration of sunlight due to the canopies of forest. On the other hand the technique explained above, is independent of sunlight. Apart from that there are claims that power up to 1kW can be generated from a 20m tall tree.

To prove this new idea, McGarry and Knight performed an experiment. They chosea Eucalyptus treeand did the experiment. As a result they were able to generate only 50 mill watts which they harnessed for wireless communication. The reason for such small amount of power generation is that tree dissipates a large amount of wind energy and at present we do not have sources to capture all the movements, especially energy dissipated by leaves.

Scientist Howard Rees and Michael Faigen believe that one day the "world will be powered by swaying trees". Theoretically tying trees together with ropes, pulleys and pull-retract generators (PGR's) can fetch up to 1kW of power per tree and those utilizing thousands of trees can get hundreds of kW's or even megawatts.

{The concept of movement or kinetics as a source of energy has already been used in some wristwatches which uses movement of magnet in the electromagnetic generator and the phenomena related to Faraday's law. Similarly energy from movement of tree can be captured to synthesize electricity.}

2.4. *Piezo tree concept*

Scientists are not only trying to furnish energy from trees but also build up synthetic tree-like machinery for generation of energy. One such attempt is the introduction of piezo tree concept. Synthetic leaves are connected to a piezo electric stem. These leaves and stems are made up of a synthetic flexible piezoelectric material called polyvinylidene fluoride (PVDF). For its practical and commercial application scientists are planning to build a plant like system with thousands of such piezo- leaves. The leaves are triangular and are attached to a main stem by a stalk. The stalk

and the triangular leaf are joined by a hinge (Figure1.). Elaborate experimentations are being done to increase the potential of piezo leaves. This method is cost- effective as well.

This is an artificial system that mimics a tree with fluttering leaves. The energy of oscillating piezo leaves produce electricity. This is a new concept and represents renewable energy. If an artificial system derived from nature is believed to remold renewable energy then why nature can't be used in its raw form to produce energy?

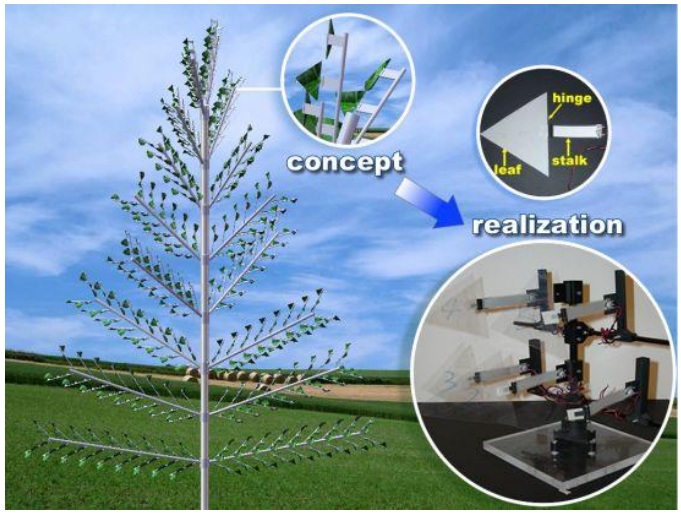

Figure 2. *A schematic picture of the Piezo tree concept [https://cdn.greenoptimistic.com/wp-content/uploads/2009/12/piezo-tree_1_pmPls_69.jpg]*

2.5. *Bioethanol Algal biofuel*

Algae is used in numerous ways. It is a primary producer and it is asserted that they will become nutritional food source in near future. Apart from this algae can produce energy as well. Bioethanol is a biofuel which is manufactured by biomass of algae along with other products. This can prove to be an effective method of energy in future.

Algae are diverse group of single – celled organisms that have the potential to offer a variety of solutions as they can be grown easily without affecting the environment. Algae efficiently use CO2, and are responsible for more than 40% of the global carbon fixation, with majority of this productivity is coming from marine microalgae. Nowadays humans are totally dependent on fuels. Due to this we have to deal with two problems: global warming and energy crisis. Not only these problems, we also have to face problems like high energy cost and decrease in reserves of fossil fuels. To overcome these problems biofuels have come as a rescue.

Algal fuels are not something new. This idea was not new but now it is considered important due to increase in demand of fuels and more importantly due to increased global warming. They are similar to fossil fuel as they releases CO2 when burnt but unlike fossil fuels,

algal fuels and biofuels only releases CO2 which is recently been removed from the atmosphere via photosynthesis as the algae or plant grew. Algal fuels have many characteristics which attract people to study them and use them as biofuel. Such characteristics are that they can be grown with minimal impact on fresh water resources, can be produced using saline and waste water, and are biodegradable and relatively harmless to the environment if spilled. Algae can produce 40 times more oil for biodiesel production compared to other plant resources. All algae have the capacity to produce energy – rich oils, and a number of micro algal species have been found to naturally accumulate high oil levels in total dry mass. The US Department of energy estimates that if algal fuel replaced all the petroleum fuel in the US, it would require 15,000 square miles, which is only 0.42% of the US map, or about half of the land of Marine.

Algae have high biomass productivity. They are rich source of lipids and carbohydrates. Algal fuel is clean, economical and sustainable source of energy. But algal fuels must overcome a number of hurdles before it can compete in the fuel market and be broadly deployed. These challenges includes strain identification and improvement, both in terms of oil productivity and crop protection, nutrient and resource allocation and use, and the production of co-products to improve the economics of the entire system.

3. The new idea- Future perspective

In the following paper we have discussed about various new discoveries in the field of renewable energy. The main aim of the paper is to introduce a new concept, that is; GreENergy. It is an endeavour to bring all the ecofriendly energy sources, which can be produced by chlorophyll bearing organisms, under one roof. This includes plantain pith batteries, bioenergy harvester, piezo tree concept, bioethanol biofuel and other such systems. Some of them are explained while some are yet to be explored.

Figure 3. *Logo depicting Green plants and yellow energy from sunlight. GreENergy is a new term which constitute of two components plants and electricity. (Self-designed)*

The main reason why plants can be and should be used for this purpose is that they themselves are self-sufficient. They can grow on their own if provided with optimum conditions. Although some care is requisite for maintenance of such systems but it is worth all the care. If one

day these plants serve as manufacturers of electricity then we will have huge farms which will comprise of forests.

Secondly, trees would serve dual purpose. Not only will they function as lungs of all life in biosphere but also help to accomplish energy goals. At present the entire world is facing certain climatic and environmental issues namely; global warming, pollution, rise in oceanic water level, extinction of species due to habitat loss and so on. In such a situation if trees provide electricity then it would work as an incentive towards afforestation. Along with it trees would counter all the environmental issues that are a concern for all the nations. This is also going to improve the health of the global population. The ecosystem would return to balance.

Thirdly, this form of energy is going to be accessible to all, since there is vegetation in all parts of the world where humans live. Where there is green there is going to be energy. The cost-effectiveness is a question that can resolved only with a plan or framework once we get a system which can be installed to get electricity. Also it should be brought to notice that there are many types of setups. Some are simple like plantain pith battery while some use complex circuits for capturing movements. Thus cost will be based on the type of setup being used and its complexity.

The vision illustrated above might seem like a fiction, but we do not know what our future would be. The pace at which work is being on the subject is good enough to make this vision a reality.

It should be mentioned that the goal behind writing of this manuscript is to sensitize people towards the need of recognizing the importance of sustainable energy source. If trees can act as such a source then it would give a new direction to the field of greENergy. If the world shifts its reliability for power from huge power plants to forests then what all benefits would it give? We have a glimpse of the possible outcomes. GreENergy as a field is a novel concept and it provides vast opportunities. It needs to be explored in depth.

4. **Conclusion**

Research and discoveries are being done in the field of greENergy. The technologies that are discussed above are still in their initial stages. A lot of development is required to make these techniques applicable for practical and commercial purpose. When this happens not only will our energy demands be sufficed but also our surroundings will become pollution free and healthy. Many benefits are mentioned in the future perspective. Environment related problems such as global warming, water level rise, ozone depletion etc. will be checked by planting trees. Electricity will become accessible to all. Everyone's requirements will be met. Forests will become a necessity. Thus wildlife will flourish and nature's balance will once again reside.

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Disposable sanitary pads and sustainable environment

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Abstract: *Sanitary Pads are absorbent disposable single use products designed to receive, absorb, and retain menstrual fluid. Most of the rural women and some urban women use cloth also as absorbent because it is cheaper. However, in our study, conducted in Delhi-NCR, we found that the use of cloth during menses has lowered a lot (2%, n=974) and the women have switched to the use of sanitary pads (90%, n=974). Though, this practice elevates the reproductive health & hygiene of women, it also raises a major problem to the environment after it has been disposed. Frequently, it is openly dumped in landfills, as it is collected with domestic waste. The rag pickers come in contact with them & contract diseases as soiled pads harbor several bacteria and viruses. There are no stringent guidelines/laws for its disposal in India and it is neither bracketed as biomedical waste, nor categorized as plastic waste. As a result, they continue to choke our landfills. One conventional sanitary pad contains the equivalent of about four plastic bags. Conventional pads may also contain furans, pesticides like pyrethrum, procymidone, mecarbam and fensulfothionsynthetic fibers and petrochemical additives. Most sanitary pads are bleached with chlorine compounds that contain traces of the dioxin. The US Environmental Protection agency (EPA) has named dioxin to be the most potent carcinogen which does not degenerate even after decades in the soil. Hence, there should be arrangements for safe disposal of commercial sanitary pads or other alternatives for menstrual hygiene, to maintain sustainable environment.*

Keywords: Sanitary pads, menstruation, hygiene, sustainable environment.

1. INTRODUCTION

The maintenance of menstrual hygiene in women is an important requirement for maintaining a healthy reproductive life. The use of sanitary napkin to manage menstrual flow is a convenient way. The sanitary pads are made up of several ingredients like absorbents, bleached cellulose wood pulp, plastics and silicon**(Figure 1)**. Many of these are non-biodegradable and are thus a threat to the environment as their concentration increases with each passing day [**pritishaborthakur.com**].

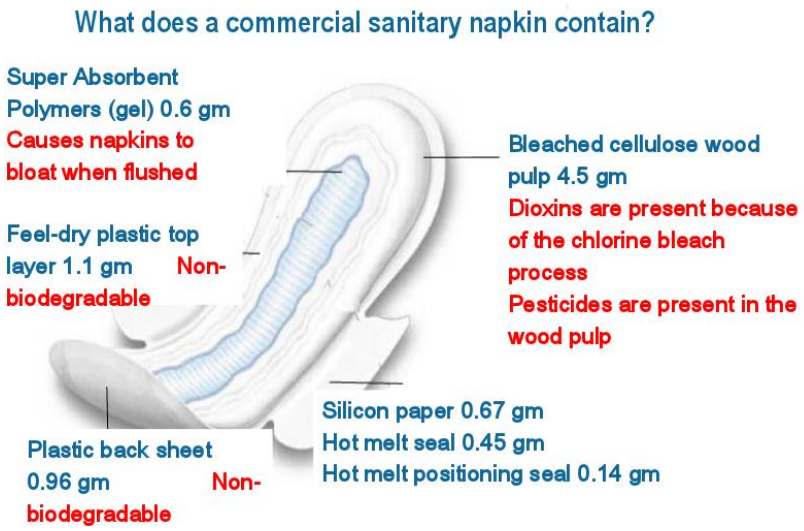

Figure 1. *Materials used in making a commercial sanitary napkin [Image source: thekachraproject.in].*

The AC Nielsen' study on 'Sanitary Protection: A woman's health right' (2011) has reported that around 42.6 million women (~12%) in India use sanitary pads**(Garg *et al.*, 2012)**and they throw 21.3 billion sanitary pads into landfill in their lives **(The Hindu report, 2013)**. Such a high number of pads accounts for approximately 9,000 mega tonnes of waste which can cover a landfill spreading over 24 hectares. Since, this waste is non-biodegradable, it poses a serious problem for the environment and increases its load, rendering the land useless for any productive work and spreading various diseases.

2. METHODOLOGY

The young women of Delhi-NCR, aged 18-24 years, were asked to fill a questionnaire based on random sampling method. The data was collected and analyzed.The respondents were asked to fill a declaration for their participation in the study and the participation was purely voluntary.

3. RESULTS

The following result was obtained after analyzing the collected data:

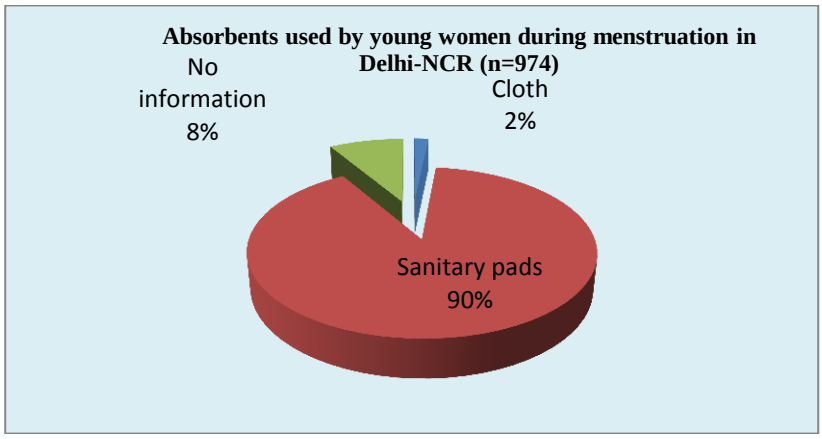

Figure 2. *Absorbents used by young women during menstruationin Delhi-NCR.*

4. DISCUSSION

Our data showed that 90% of the respondents used sanitary pads as the absorbent during their menstrual cycle while only 2% used cloth**(Figure 2)**. The data indicates that women here are more aware of their menstrual hygiene and understand the need to do so. However, using the commercial sanitary pads has its own disadvantages. Not only can the long term use of sanitary pads be harmful for the woman's health, but large scale disposal of such commercial sanitary pads has severe effects on the environment too.

4.1. DISADVANTAGES OF USING SANITARY PADS

Since the material used for making commercial sanitary pads consists of several types of chemicals, these chemicals may be dangerous for the health of women in the long run. There are several reasons for being cautious when using sanitary pads. Some of the major concerns **(anigan.com)**are as follows:

1. Sanitary pads can cause cancer:

The sanitary pads are used regularly every month. They contain several chemical contaminants which can cause cancer. Pads are made of plastic material and chemicals like BPA and BPS which can hamper embryonic development**(articles.mercola.com)**. The fiber in the absorbent pads can cause cervical cancer as they are made of cellulose gel. The dioxin in the pads can cause ovarian cancer.

2. Sanitary padscontain pesticides and herbicides:

Pads also contain some cotton as absorbent. The cotton crops are sprayed with pesticides, which may contain **furan** and some of these pesticides stay until harvested. These pesticides may remain in our body and may cause thyroid malfunction, infertility and other health problems.

Sanitary pads may contain dioxin:

Dioxin is used to bleach the cotton so that pads become ultra-white. Dioxin may cause skin darkening and alter the liver functions.

3. Sanitary pads can cause infertility and birth defects:

Sanitary pads contain odor neutralizers which contain chemicals that can interfere with the embryonic development and other health problems.

4. Sanitary pads are prone to infections:

Prolonged use of sanitary pad may attract overgrowth of *Staphylococcusaureus* in vagina. Some bacteria may release certain toxins which can cause sudden drop in blood pressure.

4.2. TRENDS OF SANITARY PADS DISPOSAL IN INDIA

The phenomenon of menstruation is considered a stigma in our society. As a result women try to hide the menstrual waste and try to dispose it in ways that may be detrimental to the environment. In rural areas, the dumping areas are defecation fields, water bodies or garbage dumps. Even if there are special facilities for menstrual waste disposal, women do not use them for fear of being tagged.

In urban areas, every woman habitually wraps the soiled pads in a newspaper or polythene bags and throws it with the normal domestic waste, such that it remains hidden. This waste is carried to the outskirts of the city and manually segregated by the rag-pickers and buried in landfills. The sanitary pads contain high amount of plastic which is non-biodegradable and destroys the land. Also, it is segregated by rag-pickers manually, resulting in health hazards for them **(thekachraproject.in)**.

As per **Municipal Solid Waste (Management and Handling Rules), 2000**, soiled sanitary napkins may be disposed of after segregation into biodegradable and non-biodegradable components. However, the **1998 Ruleson Bio-medical Waste (Management and Handling)** say that items that are contaminated with blood and body fluids are bio-medical wastes and should be incinerated, autoclaved or microwaved to destroy pathogens**(Hindustan Times Report, 2015)**.

Some women flush the soiled sanitary pads or throw them in open drains. Commercial pads contain a super-absorbent-gel which absorbs the fluids. This keeps on absorbing fluid and bloats if thrown in drains or sewers and finally chokes them. This has to be then manually cleaned, thus exposing the people involved at a greater risk of infections.

4.3. ENVIRONMENTAL RAMIFICATIONS OF DISPOSAL OF SANITARY PADS

4.3.1. Plastic in the sanitary pads:

The sanitary padshavehigh content of LDPE plastic polymers which makes them non-biodegradable and thus, they will remain in the soil for hundreds of years**(The keeper, 2008)**.Disposable sanitary pads also have a layer of polyacrylate, which is a super absorbant gel. If the pads are flushed down, they continue to absorb and clogs up the sewers and are finally removed manually by workers. Thus, they are a burden in the landfills and the sewer **(The keeper, 2008)**. As per the **PlasticWaste (Management and Handling) Rules, 2011,** the producers of the plastic are responsible for organizing and taking care of the methods to end the life of plastic by meeting all the expenses involved in eco-friendly ways(www.academia.edu).

4.3.2. Pathogenic microorganisms in sanitary pads:

Moreover, when the rag-pickers segregate biodegradable and non-biodegradable waste, they do not use face masks or gloves, hence they are vulnerable to various microorganisms which harbor used sanitary pads. Such pads may contain Hepatitis B and C viruses surviving on them and thus, expose them to people who come in their contact. Other microorganisms surviving on the used pads include *E.coli*, *Salmonella*, HIV and *Staphylococcus* **(Hindustan Times Report, 2015)**.

4.3.3. Air pollution due to sanitary pads:

Ifthe used sanitary pads are incinerated at temperatures below 800 degree Celsius, dioxins are released into the soil and air. Low temperature incinerators also release other polluting gases into the atmosphere. The residual ash may contain concentrated toxic chemicals and washed into soil and water bodies **(thekachraproject.in)**.

Municipal Solid Wastes (Management and Handling) Rules of 2000, in India, says that soiled pads are part of non-recyclable household waste, and not in bio-medical waste category, and should be incinerated at temperatures above 800°C. However, in India these rules are not followed and the used pads are burntinformally, thus releasing toxic gases like dioxins and furans. This causes air pollution and is not a sustainable method.

***Dioxin in sanitary pads*:**According to **World Health Organization (WHO)**, dioxin used in sanitary pads, belongs to the group of chemicals called 'persistent organic pollutants'*i.e.* **POPs.**The bleaching process during the manufacture of sanitary pads, to make them look more white and hygienic, releases dioxin in the environment**(Axel-Lute,).**The dioxin is known to cause serious medical conditions like endometriosis, impaired immune system, ovarian cancer, infertility, diabetes, hormone suppression etc. **(E Magazine, 2001)**. Numerous repeat exposures of dioxin are dangerous for human health and other organisms also, but Environmental Protection Agency (EPA) has not yet set any safe level of dioxin **(Axel-Lute).** Actually, there is no safe level for dioxin exposure and it is 10 times more likely to cause cancer than was believed in 1994 **(E Magazine, 2001)**.

4.4. BETTERMEANS AVAILABLE FOR DISPOSAL OF SANITARY PADS

1. **Using Incinerators:**Incineration of soiled sanitary pads can be done at 800°C and such incinerators may be installed at schools, colleges, other institutions and even at community level. However, as per Bio-medical Waste (Management and Handling) Rules, 1998, Schedule 1 says that chlorinated plastics shouldn't be incinerated (www.academia.edu).

2. **Use of special bins:** Special bins may be made available for throwing soiled sanitary pads such that they do not come in direct contact with anybody.

3. **Special disposable bags:**In India, few NGOs have prepared special bags for disposing menstrual waste but people are reluctant in buying them. Moreover, under the Corporate Social Responsibility (CSR) the manufacturing companies should provide such bags with each pack.

4. **Marking of the wrappers:** The sanitary pads may be wrapped in a newspaper and marked in such a way that the waste-pickers know that it is menstrual waste and without opening it they can segregate it. However, the scheme of marking should be uniform.

4.5. ALTERNATIVES TOCOMMERCIAL SANITARY PADS TO MAINTAIN SUSTAINABLE ENVIRONMENT

Companies which produce commercial sanitary pads should provide some solutions for their ecofriendly disposal. However, this is never addressed and no steps are taken by these companies regarding safe disposal of sanitary pads.

In view of this, few NGOs and few companies have come forward with some alternatives. There is a more sustainable approach to manufacture sanitary pads with biodegradable material. There are green menstruation products available like reusable pads, menstruation cups and sea sponges**(Borowski, 2011)**.

Women can use some eco-friendly absorbents during their menstruation which have been discussed as follows:

4.5.1. Menstrual cups: These cups are in the market since 1930s and are being used in the western countries. In India also, manufacturers have introduced SheCups which are made up of silicone and are worn internally. The cups can be worn for 12 hours or more. They collect the menstrual blood and when they are full, they can be emptied, washed and reused(ecoideaz.com).

Figure 3. *SheCup* **(***Image Source: Wikimedia.org*)

Themenstrual cups have been tested and reviewed for more than 30 years. The FDA has declared them safe and effective and are thus, well- established alternatives for menstrual hygiene **(divacup.com)**.These were re-introduced in 1980s and since then, there have been no problems **(Axel-Lute)**.

4.5.2. Reusable sanitary pads: These are made from several layers of cloth to suit the requirement of low or high discharge. They can be washed and reused. Since there are no chemicals used, they are safe. For example, Jayaashree industrieshave started production of such pads on a small scale(Figure 4).Goonj, an NGO in and around Delhi, uses waste cloth to prepare sanitary pads(Figure 5; Hindustan Times Report, 2015).

Figure 4. *Reusable sanitary pads[Image Source: be-abhi.tumblr.co]*

Figure 5. *Reusable cloth napkins produced by Goonj, for rural women.*

4.5.3. Biodegradable sanitary pads: towns and villages Few companieslikeAakar Foundation produce biodegradable pads under the name'Anandi'. This way there will be positive impact on soil, water, air, forests and thus, the health of people living in a city. The price of these pads is 40% lower than the commercial pads and are mainly available in small.

Figure 6. *Biodegradable sanitary pads[Image source: Aakar Innovations]*.

Anandi pads(Figure 6)can be disposed of by burying them in a pit as it is made of biodegradable material and is environmentally sustainable. Moreover, these pads do not leave any toxic chemical in the soil they are buried in (http://www.aakarinnovations.com/). .

Shriram Institute for Industrial Research in Delhi, have started production of sanitary pads using bamboo pulp. Bamboo pulp can be composted and it is 300% more absorbent than wood pulp. Hence, it is safer.

4.5.4 Sea sponges: They grow naturally in oceans and can be cultivated like a crop. After, they have been harvested, they can be re-shaped to fit the vagina and used in a similar way as tampons (The Keeper, 2008). The advantage of sea sponges is that they can be reused but only after proper disinfection, usually done by boiling.

4.5.5. Disinfection or incineration of sanitary pads: Sanitary pads may be disinfected/incinerated at 800°C before their disposal which will minimize the spread of infections to the rag-pickers. However, it will release chemicals like dioxins, which are air pollutants. Though, they are majorly released by incineration of household waste and other metallurgical processes (INSERM Collective Expert Reports, 2000), incineration of sanitary pads further adds to dioxin load on environment as the amount of sanitary pads disposed is alarmingly high!!!

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An era of Computer-Aided Research in medicinal plants

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Abstract: *The immense potential of medicinal plants to treat diseases has not remained unrecognized in human history and non-industrialized societies. Majority of the population in developing countries still depends on traditional system of medicine for their primary health care. Bioinformatics is an interdisciplinary field and provide tools and techniques to understand the biological data. In the era of high volume and high-throughput data generated across the biosciences; bioinformatics plays a crucial role. The available databases and bioinformatics tools help us in target identification; computer-aided drug discovery, designing and authentication; discovery of many fascinating and scientifically important compounds like secondary metabolites, pharmacologically important molecules, small molecules etc.; and identification of secondary metabolic pathway by integrating OMIC approach and using comparative genomics. The present paper reviews the current status of the Indian medicinal databases and the bioinformatics tools and techniques areused in various fields of herbal plants and medicines.*

Keywords: medicinal plants, databases, bioinformatics tools, omics.

1. INTRODUCTION

Due to our techno savvy lifestyle we are moving away from nature. Evidence exist that Unani Hakims, Indian Vaidas, European and Mediterranean cultures were using herbs for over 4000 years as medicine. Population rise, inadequate supply of drugs, prohibitive cost of treatments, side effects of several synthetic drugs and development of resistance to currently used drugs for infectious diseases have led to increased emphasis on the use of plant materials as a source of medicines for a wide variety of human ailments. Medicinal plants are considered very safe as there is no or minimal side effects; they are eco-friendly and locally available.Bioinformatics is emerging as an indispensableinstrumenttounderstand the complex biological systems of medicinal plants.

2. DATABASES

India has been known to be a rich repository of medicinal plants. The forests in India are the principal repository of large number of medicinal plants. Traditionally, lots of herbs were used to treat the ailments related to different seasons. Databases provide consolidated and integrated access to information regarding these treasure houses. In recent years, numerous databases on

medicinal plants and constituent compounds have been constructed. These databases allow users to gain information regarding medicinal plants.

Indian Medicinal Plants Database (http://www.medicinalplants.in/) has been developed and maintained by FRLHT(Foundation for Revitalisation of Local Health Traditions) and National Medicinal Plants Board (NMPB), Department of AYUSH, Government of India. It incorporates 7263 botanical names of Indian medicinal plants which have been correlated to more than 1,50,000 vernacular names in ten different languages of India. The medicinal plant species included in the database have been compiled and arranged under the six Indian Systems of Medicine namely Ayurveda, Siddha, Unani, Homeopathy, Sowa-Rigpa and Folk. It also incorporates bibliography, the geographic distribution maps of these medicinal plants and provides the list of traded and highly traded medicinal plants of India. Important features include 'Ayurvedic identity' and 'Shlokas'.

Envis Centre on Medicinal Plants(http://envis.frlht.org/indian-medicinal-plants-database.php),is another comprehensive database on Indian Medicinal Plants, developed by FRLHT.It consists of photo galleries which contain latest photographs and archive of Wild Medicinal Plants of Himachal Pradesh and Selected Red Listed Medicinal Plants of South India. It also includes data search on Indian medicinal plants nomenclature database, Traded medicinal plant database, Digital herbarium, Digital atlas–geo distribution maps corresponding to 1969 species, State wise checklist of medicinal plants, Conservation concern species and Raw drugs. It organizes educational programmes to Ethno medicinal garden (AmruthaVana).

National Medicinal Plants Board (NMPB) and Central Council for Research in Ayurvedic Science (CCRAS), under Department of AYUSH, Government of India, developed Database on Medicinal Plants(http://www.nmpb-mpdb.nic.in/) in which all the available published information on selected medicinal plants, covering every subject area can be accessed at one place. 16 important medicinal plants having high trade value were selected; exhaustive references and literature were collected in respect of these plants covering every subject area. Nearly 33,700 references were collected and these include the classical literature from Ayurveda, Unani, Siddha and Homeopathy system of medicine as well as modern literature from various books and journals covering basic and applied science and medicine.

In the Encyclopedia of Medicinal Plants (Herbs–medicinal plants usage and identification database) (http://herbs.indianmedicinalplants.info/)Ayurvedic Medicinal Plants including its Botanical names, morphology, classification, therapeutic uses, names in different languages, synonyms, habitat, Chemical present in Medicinal plants, Systemic action in nervous, digestive system etc., properties, parts used, dosage, formulations or Yogas in Ayurveda, research works, pictures etc. are present.

National Medicinal Plants Board (http://www.nmpb.nic.in/), set-up by the Government of India, has the primary mandate of coordinating all matters relating to medicinal plants and support policies and programmes for growth of trade, export, conservation and cultivation. Its major activities include Identification, inventorisation and quantification of medicinal plants; Promotion of ex-situ/in-situ cultivation and conservation of medicinal plants; Promotion of co-operative efforts among collectors and growers and assisting them to store, transport and market their produce effectively; Data-base system for inventorisation, facilitates the prevention of patents being obtained for medicinal use of plants which is in the public domain; handles matter related to import/export of raw material, as well as value added products either as medicine, food supplements or as herbal cosmetics.

NeMed Plant (http://bif.uohyd.ac.in/nemedplant/) is a curated database for proper digitization of the medicinal plants of North East India, developed by University of Hyderabad. The database includes the information about the medicinal value against the various types of diseases, industrial information, literatures etc. Using chemoinformatics approaches, active compounds are identified by using 3D-QSAR models for the corresponding disease for which the plant is being used. It provides us with structure and properties of natural products from North-Eastern region. The database with integrated information on herbs, natural products, structural physicochemical properties and analytical tools would be an ideal resource for information retrieval, pharmacological, bioinformatics and chemoinformatics analyses, to make new discoveries in the area, and direct further experimental investigations. Browsing can be done using plant name or compound name, maps of Manipur and Nagaland are marked for plants found, or regarding various diseases like cancer, diabetes,tuberculosis and others., or by part used like leaf, fruit, root, bark, flower etc. and active constituents of medicinal plants.

SRISTI (http://www.sristi.org/hbnew/plant_db.php) is a multi-language medicinal plant databaseguided by Honey Bee Network. In this database information is gathered through seeking information-ShodhYatra (A journey ofexploration), walking through the villages, village meetings, bio-diversity competitions, ShodhSankal - a local network of grassroots innovators, scanning of old literature, including scouting in course curricula, kite festival, identifying other interested networks and involving them in scouting and documentation. Receiving information through the honey bee network, through innovators, electronic submission, direct entries, collecting informationthrough survey of odd balls in villages by students, agricultural, cultural fairs and exhibitions, traditional food festival (satvik), scouting fellowships, sample/plant identification (in case of herbal entries) and documentation including video recording. Herbal Agro Products are also produced.

Database on Ethno-Medicinal Plants (https://www.dibru.ac.in/lifesciences/MedicinalPlant/#) was created and maintained by the Department of Life Sciences, Dibrugarh University, Assam, India. This information resource contains knowledge on traditionally used medicinal plants of upper Brahmaputra valley, Assam. Thisdatabase highlights some important medicinal plants and their active components which can be used for the development of new drugs of herbal origin.

2.1 Future Perspective

Medicinal plants based traditional systems of medicine are playing an important role in providing health care to large section of population, especially in developing countries like India. To obtain optimum benefit and to understand the way these systems function, it is necessary to have minimum basic level information on their different aspects.

The Ministry of Environment and Forests, Government of India have identified and documented nearly 10,000 plant species considering their importance in the pharmaceutical industry but the urgent need is to enhance research in medicinal plants and gather information about Evidence for Efficacy (Human Data) which includes Clinical Trials, Case Reports, Traditional and Folk Use; Safety Data which involves Adverse Effects & Toxicity, Interactions, Contraindications; Evidence of Activity involves Animal Studies, Pharmacodynamics, Analytical Chemistry, Pharmacokinetics (ADME), Genetics, Literature Reviews; Formulas/Blends including Modern Methods of Preparation and Patents. Information on individual herbs can be hyperlinked directly to the scientific literature primarily using PubMed, the freely available interface for MEDLINE, and to other research resources available through the World Wide Web. Database can contain information on plants used for treating animals and humans in rural areas. Information regarding drug uses, chemical structure, major metabolites, enzyme information, entriesin Genbank, transcript assemblies, cloned genes and PubMed recordscan also be included.A database can be establishedfor users to retrieve and analyze DNA sequences of herbal plants. Information can be catalogued related to one or more aspects of medicinal plants, such as ethnobotany, bioactive metabolites, pharmacological uses, genomic or transcript-based information, molecular targets of active ingredients, etc. Information related to medicinal plants can also be found embedded within the realm of general taxonomic, chemical and molecular data sources such as at the National Center for Biotechnology Information (NCBI) (Sayers et al,2010); Kyoto Encyclopedia of Genes and Genomes (KEGG) (Kanehisa andGotto, 2000) and KNApSAcK (Afendiet al, 2012).

3. BIOINFORMATICS TECHNIQUES AND TOOLS

Integration of different fields of sciences in natural sciences and emergence of new fields like biotechnology, nanotechnology etc. have led to the generation of large amount of data, so a new field bioinformatics has come up as a great help to the biological community to deal with the

huge datasets and extract meaningful information from these datasets. Bioinformatics tools and techniques are also playing a great role to enhance our knowledge about medicinal plants and use them in a sustainable manner.For example, CADD (Computer Aided Drug Discovery) is a bioinformatics technique that has emerged as a fast alternative method to bring down the cost involved in discovering a new drug. Its main focus is on identification and validation of drug targets, and is based on functional/structural annotation of genomes. The major functioning of CADD is dependent upon databases like UniProt (UniProt Consortium, 2012), PDB (Bernstein et al, 1977), NCBI and several software such as BLAST(Altschulet al, 1990), GPCRpred (Bhasin, Raghava, 2004), FASTA (Pearson, Lipman, 1988), ATPINT (Chauhanet al ., 2009), Clustal-W (Larkin et al, 2007), ESLPRED2 (Garg and Raghava, 2008), Psipred (McGuffin et al, 1999), which are used to compare and analyze the information in these databases.

TargetHunter is one of the online programs that assists in the identification of in-silicodrug target used for the prediction of therapeutic potential of small organic molecule. This online program is based on biologically annotated chemical genomic (chemogenomic) databases such as the ChEMBL database (Gaultonet al, 2011).It identifies the biological targets of a specified query compound by the TAMOSIC(Targets Associated with its MOstSImilar Counterparts) algorithm (Wang et al, 2013). It also helps in the data mining of the chemogenomics database through querying commercial drugs and predicting drug repurposing. Darifenacin, a selective antagonist of the muscarinic M3 receptor, is used to treat urinary incontinence (Bozkurt and Sahin-Erdemli, 2009). Blair et al(2007) found that UK-201844 similar toDarifenacin can inhibit the gp160 process of human immunodeficiency virus type 1 using TargetHunter. Although, these two compounds have different chiral centers and ring size, they share multiple features. Darifenacin, therefore, is predicted to be an inhibitor of HIV-1 gp160.

The classical methods of QSAR(Quantitative or Qualitative “structure activity” relationships) molecular modelling and virtual screening that are widely used to identify synthetic compounds in drug discovery, may be used for predicting the biological activity of medicinal plants if information about the structures of phytochemicals are available (Singla*et al*, 2013). The key components necessary for the creation of (Q)SAR models are data based on structure; biological activity of compounds; molecular descriptor; and machine learning algorithms (Laguni*et al*, 2014).In case of herbal medicines, the structural information for the different chemical constituents is generally not available; therefore, the QSAR approach cannot be applied on medicinal plants directly. However, relationship between chemical composition and biological activity can be analyzed quantitatively to predict the activity of herbal medicine through QCAR (Quantitative composition–activity relationship) approach (Zhao*et al*, 2004).This approach is based upon the concept that activity of a mixture of herbs can be associated with a relatively small

number of components. The precision of QCAR approach is higher than that of the QSAR approach, but the overall performance is still very low, which can be improved by more careful experimental design and precise bioassays (Wang *et al*, 2006).Laguni*net al* (2014) has reported that QSAR and docking techniques have been used to study phytocomponents of many plants. Yadav*et al* (2010) and Meena*et al* (2011) successfully studied immunomodulatory and inflammatory activities of coumarinolignoides in *Cleome viscosa*. Similarly, the cytotoxic activities ofurosolic acid analogue in*Eucalyptus*hybrid against human cancer cell has also been reported (Kalani*et al*, 2012).

There are number of software and algorithms that are frequently used to build QSAR models. Support Vector Machine (SVM) is a machine learning algorithm program which is based on statistical and optimization theory and has ability to handle structural feature data(Joachims, 1998).The SVM light software is an implementation of SVM and is widely used in chemoinformatics. Similarly, the WEKA package consists of a wide range of tools and algorithms for data analysis and modeling. WEKA is a complete data mining software that could be used for pre-processing of data, clustering, model building, visualization, and feature selection(Frank et al, 2004). Molecular docking technique is most preferably used tool to predict the preferred orientation of molecule within the active site of target molecule where it binds to form a stable complex. So, it is widely used in hit identification and lead optimization. It is of 2 types, protein-protein docking and ligand-protein docking (Singlaet al, 2013). Piccagliet al (2008) performed docking of 27 molecules identified fromtwo different bioactive medicinal plants extracts, into the p50 NF-kappaB transcription factor and validated their findings. Some of the tools employed in molecular docking are Dock (Moustakeset al, 2006; Lang et al, 2009), AutoDock (Morris et al, 2008), Hex (G Macindoeet al, 2010), FTDock (Jackson et al, 1998), AutoDockVina (Trott and Olson, 2009), HADDock (Dominguez et al, 2002).

The sequencing of genomes has revealed more of the gene functions. The knowledge on ancient medicinal plants has led to the formation of the large reserve of genomes. The inference of recent work on functional genomics and conception of systems biology for herbal medicine had led to the enlightenment of several important properties of some of the valuable plants of Ayurveda. A large amount of biomedical knowledge has led to the use of bioinformatics approaches for the analysis of genomics, proteomics and metabolomics data. Computer analysis techniques and special software has made it possible to analyze the existing OMICs data.Deocaris and co-authors (2008) have studied the functions of drug responsive genes using systems biology approaches and compared gene regulatory circuits in response to aherbal preparation against the responses to some of its bioactive components. For *Withaniasomnifera*, an anti-cancer therapeutic plant of Ayurveda, bioinformatics analysis was performed with Ingenuity Pathway Analysis to

explore how the identified gene targets functionally interact with each other and to gain insights from the differences in the networks that may correlate with the bioactivities of natural products. This study identified the critical signal transduction pathways involved in the biological response and also suggested that the minor changes in gene expression were sufficient to evoke major responses. Some of the bioinformatics and systems biology resources useful for the analysis of OMICs data are BiologicalNetworks (Kozhenkovet al, 2011), CellDesigner (Griecoet al, 2013), DAVID (Huang da et al, 2009), GSEA (Subramaniamet al, 2005) etc.

Basic Local Alignment Search Tool (BLAST) is a sequence similarity search program that can be used as a stand -alone tool to compare a user's query to a database of sequences. Several forms of BLAST compare all combinations of nucleotide or protein queries with nucleotide or protein databases. BLAST is a heuristic tool that finds short matches between two sequences and it attempts to perform sequence similarity alignments. BLAST is one most important bioinformatics research tool (Johnson et al, 2008).According to "The Medicinal Plant Consortium" the currently available BLAST server window (http://medicinalplantgenomics.msu.edu) provides searching capability for the version 1 transcriptome assembles for some of the important medicinal plant species that are *Atropa belladonna* sequence assembly (MSU v1), *Catharanthusroseus* sequence assembly (MSU v1), *Digitalis purpurea* sequence assembly (MSU v1), *Dioscoreavillosa* sequence assembly (MSU v1), *Echinacea purpurea* sequence assembly (MSU v1), *Hoodia gordonii* sequence assembly (MSU v1), *Hypericumperforatum* sequence assembly (MSU v1), *Panaxquinquefolius* sequence assembly (MSU v1), *Rauvolfiaserpentina* sequence assembly (MSU v1), *Rosmarinusofficinalis* sequence assembly (MSU v1), *Valerianaofficinalis* sequence assembly (MSU v1)

MMDBD (Medicinal Materials DNA Barcode Database; http://137.189.42.34/mherbsdb/index.php) is a database used for data retrieval and sequence similarity search(Lou et al, 2010). MMDBD contains over 1000 species of medicinal materials which are listed in the Chinese Pharmacopoeia and American Herbal Pharmacopoeia. MMDBD also contains useful information about the medicinal material, including their resources, adulterant information, medical parts, photographs, primers used for obtaining the barcodes and key references. It also provides a simple web-based interface for the retrieval of the barcode information. The database has already covered 66.5% and 84.5% of the medicinal materials listed in the Chinese Pharmacopoeia and the American Herbal Pharmacopoeia, respectively. It provides an open forum for further addition of medicinal materials barcodes. Researchers can enrich the database by contributing their DNA barcode sequences to MMDBD.

4. CONCLUSION

Medicinal plants are considered as a treasure to the human beings as they had been used since ages. Even in the present era they have led to the discovery of many pharmacologically valuable compounds that have proved to be beneficial to the entire world. Databases have become a warehouse that provides consolidated and integrated access to the information.The existing Indian Medicinal Plants databasescontain information such as botanical names, morphology, classification, therapeutic uses, names in different languages, geo-distribution maps, list of traded plants, conservation concern species, photo gallery, active constituents, parts used and formulations of medicinal plants.Indian medicinal databases were found to lack some important information about safety data, formulas or blends, Pharmacokinetics (ADME; absorption, distribution, metabolism, and excretion), genetics, chemical structure, major metabolites, enzyme information, secondary metabolites, pharmacological uses, genomic or transcript-based information and molecular targets of active ingredients. Bioinformatics tools and techniques play a significant role in providing information aboutmechanisms of action involved in active constituents of plant extracts. Taken together, these aspects pose serious challenges toward the validation of use of herbal remedies. Up to some extent, these interactions and contra-indications had been resolved using QCAR approach and still needs improvement.

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Recent Advances in the Application of Biotechnology in Medicinal Plants

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Abstract: *The use of plants as medicine predates written human history. The World Health Organization (WHO) estimates that 80 percent of the populations of many Asian and African countries are still using herbal plants for different aspects of primary health care. Biotechnology plays a vital role in the field of medicinal sciences. The biotechnological techniques like recombinant DNA technology (RDT) and genetic transformation increases plant productivity in terms of quality and quantity. In-vitro propagation, cryopreservation and plant tissue culture are helping in multiplication and preservation of the medicinal plants. It has also enabled us to use the plants as bioreactors for the production of secondary metabolites. Techniques like liposome encapsulation, chloroplast transformation and combinatorial biosynthesis are used for the production of rare and expensive natural products. The fields like nano-biotechnology and systems biology are gearing up our knowledge of medicinal plants. The present paper reviews the achievements and the recent advances in the application of biotechnology in medicinal plants and the use of DNA Barcode to identify different medicinal plant species.*

Keywords: Medicinal Plants, Genetic Engineering, Plant Tissue Culture, Secondary Metabolites, DNA Barcode.

1. INTRODUCTION

Plants have been an important source of medicine for thousands of years. The World Health Organization (WHO) estimates that 80 percent of the populations of many Asian and African countries are still using herbal plants for different aspects of primary health care. The application of herbal medicines is increasing in the developed countries also. It is essential to maintain biodiversity, avoid genetic erosion and promote sustainable utilization of plant resources. The preservation of rare and endangered herbs is the demand of time. Biotechnology has emerged as a strong tool to overcome such problems. Multiplication and genetic enhancement of the medicinal plants is possible through techniques such as in-vitro regeneration and genetic transformations.

The cryopreservation of in-vitro cultures of medicinal plants is a useful technique for their preservation. Analytical techniques are equally important to study different aspects of the medicinal plants and their proper utilization. Production of biochemically active substances on

industrial scale has become possible through bioreactors. Even in the identification of plants the biotechnology has a significant role in the form of DNA-Barcoding.

2. GENETIC ENHANCEMENT

Biotechnological tools and techniques have been successfully harnessed to enhance the productivity of the medicinal plants both qualitatively and quantitatively. Genetic transformation is one of such techniques in which the genetic material of an individual cell is altered by the incorporation of foreign (exogenous) DNA into its genome.Yun et al (1992) magnificently increased the production of scopolamine compound, an anticholinergic drug that acts on parasympathetic nervous system, in *Atropa belladonna* using *Agrobacterium* mediated transformation. The introduction of the hydroxylase (H6H) gene from *Hyoscyamus niger* under the control of the cauliflower mosaic virus 35S promoter into hyoscyamine rich *A. belladonna* and its constitutive expression converted the herbaceous perennial to a chemotype pharmacologically more valuable plant. Park and Facchini (2000) established efficient protocol for transgenic root culture of opium poppy (*Papaver somniferum*) and California poppy (*Eschscholzia californica*) through *Agrobacterium rhizogenes* and found that transgenic roots grew faster than the wild-type roots. They gave a simple, reliable and well-defined model system to explore the molecular and metabolic regulation of benzylisoquinoline alkaloid biosynthesis and to assess the genetic engineering potential of these important medicinal plants. Modol et al (2001) studied genetic transformation and hybridisation in tea (*Camellia sinensis).* They produced transgenic tea via *Agrobacterium*-mediated genetic transformation of somatic embryos. The natural ability of the phytopathogenic *Agrobacterium* for gene transfer to plants has also been exploited for the genetic engineering of almond trees.

Genetic transformation can also be achieved through electroporation, in which an electrical pulse is applied to cells to increase the permeability of the cell membrane by creating temporary pores and allowing DNA to be introduced into the cell.Rech et al (1987) studied the effect of electroporation on the viability and subsequent growth of protoplasts in culture of five different plant species namely, *Glycine Canescens*, *Prunus avium*× *pseudo-cerasus*, *Pyrus communis*, *Solanum dulcamara* and *Solanum viarum*.

Sanford (2000) designed another technique named biolistics (particle bombardment) to introduce foreign DNA into plant cells across the cell walls of the plant. Guleria and Gowda (2015) standardized an efficient regeneration protocol for an endangered medicinal species *Coleus forskohlii* and optimized the antibiotic concentration using biolistic gun transformation. Integration of exogenous gene into the genome of *C. forskohlii* was confirmed by GUS histoenzymatic assay and PCR analysis. They proposed that micropropagation studies combined with advances in

genetic transformation studies may eventually lead *C. forskohlii* into bioreactor for the production of subunit vaccines. Franklin et al (2007) used particle bombardment-mediated transformation procedure for *Hypericum perforatum*, an important medicinal species that remains highly recalcitrant towards *Agrobacterium*-mediated transformation and unlocked the opportunity of utilising particle bombardment-mediated transformation to elucidate biosynthetic pathways and to improve secondary metabolite production in *H. perforatum*.

Genetic engineering of chloroplast that leads to chloroplast (plastid) transformation is an important and exciting field in modern biotechnology and first achieved in the single cell green alga, *Chlamydomanas reinhardtii* (Kindle et al, 1990). This technique does not require any specialized equipment. High frequency plastid transformation in tobacco (*Nicotiana tabacum*) is reported by Swab and Maliga (1993) by selection of a chimeric aadA gene. The frequency of transformation with the aid of plastid makes the transformation efficient by hundred folds. The chimeric gene became homoplasmic in the recipient cells and is uniformly transmitted to the maternal seed progeny.

For synthesis of rare and expensive compounds from plants, a new technique is introduced named combinatorial or combitorial biosynthesis. It comprises a series of methods that establish novel enzyme–substrate combinations in vivo and, in turn, lead to the biosynthesis of new, natural product-derived compounds that can be used in drug discovery programs (Pollier et al 2011). Runguphan et al (2010) successfully introduced chlorination biosynthetic machinery from soil bacteria into the medicinal plant *Catharanthus roseus* (Madagascar periwinkle). They made prokaryotic halogenases to act in accordance with the plant cell to generate chlorinated tryptophan, which is then shuttled into monoterpene indole alkaloid metabolism to yield chlorinated alkaloids. They proved that the introduction of halides into medicinal plant metabolism would provide the opportunity to rationally bioengineer a broad variety of novel plant products with altered, and perhaps improved, pharmacological properties. In 2003, Martin et al gave an alternative method to produce high-value terpenoid compounds, such as the antimalarial drug artemisinin, in a microbial host. They engineered the expression of a synthetic amorpha-4,11-diene synthase gene and the mevalonate isoprenoid pathway from *Saccharomyces cerevisiae* in *Escherichia coli* and increased the production of amorphadiene, the sesquiterpene olefin precursor to artemisinin.

3. PRESERVATION

The preservation of rare and endangered species is the demand of the time.The cryopreservation of in-vitro cultures of medicinal plants is a useful technique in this direction. It is essential for maintaining biodiversity, avoiding genetic erosion and promoting sustainable utilization of biological resources. It is based on non-injurious lowering and subsequent

interruption of metabolic functions of biological materials by temperature reduction to the level of liquid nitrogen, i.e. at -196°C. Ray and Bhattacharya (2008) successfully cryopreserved the roots of *Rauvolfia serpentina* by nodal culture. The roots of *R. serpentine* are the source of alkaloids (primarily reserpine, ajmaline, ajmalicine, serpentine, serpentinine, yohimbine, etc.) that are widely used for treatment of cardiovascular diseases especially in relieving hypertension. They used the method of vitrification in which major part of intracellular water is driven off from tissues at nonfreezing temperature. The process is done with extra care so that less injury can occur and then finally cryopreserved in liquid nitrogen. They effectively regenerated the plant from Cryopreserved nodal segments of *R. serpentine* by rapidly warming, detoxifing and then platting on recovery medium. The new buds start emerging from nodal segments after 15-20 days.

Along with cryopreservation a recent technique liposome encapsulation, ensures great conservation of medicinal plants. Sebaaly et al (2015) employed Liposome Encapsulation Technique (LET) in clove *Syzygium aromaticum* plant. It aimed to improve the stability of essential oils present in clove and its main component, eugenol using suitable formulations of natural soybean phospholipid. These essential oil constituents gains the high encapsulation efficiency values and loading rates. Liposome is a spherical vesicle having at least one layer of lipid and protects eugenol from degradation induced by UV exposure and maintained the DPPH (2,2-diphenyl-1-picrylhydrazyl) scavenging activity of free eugenol. Hence, the encapsulated eugenol can be preserved for future use. After preserving these species, rapid multiplication of stock plant material can be done to produce a large number of progeny plants for various research purposes using modern plant tissue culture methods.

4. IN VITRO PROPOGATION AND REGENRATION

In vitro has been proven to be an effective technique for rapid propagation of plant species including rare and endangered plant species. Sudha et al (2003) studied the hairy root culture of a rare and endemic medicinal plant *Rauvolfia micrantha* for the in-vitro synthesis of indole alkaloids, ajmaline and ajmalicine under the influence of auxins using of *Agrobacterium rhizogenes*. Rahman and Bhadra (2011) developed the protocol for in-vitro propagation of *Widelia chinensis*. Three different explants of *W. chinensis* namely nodal segment (NS), shoot apex (SA) and leaf segment (LS) were grown on Murashige and Skoog (MS) basal medium supplemented with different combinations and concentrations of cytokinin (6-Benzylaminopurine and kinetin) and auxin (Indole Acetic Acid and Naphthalene Acetic Acid). The complete seedlings thus produced by in vitro culture were finally planted in small earthen pots containing a mixture of soil and compost (2:1) through successive phases of acclimatization.

Plant regeneration can also be assured by somatic embryogenesis from single cells, which can be induced to produce an embryo and then a complete plant. Plant regeneration by somatic embryogenesis from single cells has been demonstrated in many medicinal plant species. In vitro multiplication of *Podophyllum hexandrum* via somatic embryogenesis is reported by Arumugam and Bhojwani (1989). Sahrawat and Chand (2001) developed an expeditious protocol for large scale production of plants via somatic embryogenesis in *Psolarea corylifolia* and plant produced by this method are normal, healthy and produce viable seeds. Deb et al (2014) established in vitro culture of *Cinnamomum tamala* (tejpat) using the nodal segments as explant. It is a spice yielding plant rich in many secondary metabolites including phenols. They studied the effects of different factors on in vitro axillary shoot proliferation and plant regeneration.

The preservation of plant species can also be done by micropropagation. In-vitro propagation of plants holds tremendous potential for the production of high-quality plant-based medicines. Plant regeneration from shoot and stem meristems has yielded encouraging results in medicinal plants. It is a rapid and effective tool for clonal regeneration. In vitro regeneration of medicinal plants could provide a means of disease free healthy clones for extraction of pure drugs. Joshi and Padhya, 2010 mass propagated *Withania somnifera* from leaf explants on Murashige and Skoog's medium supplemented with Kinetin (Kn) and 6-benzylaminopurine (BAP) alone or in combination. Similarly, through in-vitro propagation, Ramesh and Padhya (1998) produced 12-15 plantlets within six months from a single leaf disc of the mature neem *Azadirachta indica*.

Rout and Das (2002) studied micropropogation in *Plumbago zeylanica*. The roots of *P. zeylanica* are the main source of alkaloid, plumbagin and used as anti-cancer drug. Micropropagation of roots of plant is done by nodal culture to assess the genetic integrity and fidelity of plant. To check the genetic variability, they used RAPD (random amplified polymorphic DNA) as molecular marker, which helped them to successfully evaluate the genetic fidelity of micro-propagated plant.

5. ANALYTICAL TECHNIQUES

In the early 1900s, a Russian botanist named Mikhail Tswett became interested in the individual chemical compounds in plants and invented chromatography. The analysis of bioactive compounds present in the plant extracts involves the applications of common phytochemical screening assays, chromatographic techniques such as High Performance Liquid Chromatography (HPLC) and Thin-layer Chromatography (TLC). Heuskin et al (2009) describes a completely validated fast Gas chromatography (GC) method for the analysis and the quantification in less than 5 min of different mono- and sesquiterpenes. Three main fractions with high degree of purity in E-β-farnesene were isolated from the oil of *Matricaria chamomilla*. The chemical composition of *M.*

chamomilla and *Nepeta cataria* essential oils was determined by Gas chromatography mass spectrometry (GC/MS) on an apolar stationary phase by comparison of the characteristic fragmentation patterns with those of the Wiley 275L database. Essential oils were then fractionated by column chromatography packed with silica gel.

Wang et al (2014) investigated the anti-inflammatory properties of Ethanol Extracts from Chinese Propolis (EECP) and Ethanol Extract of Poplar Buds (EEPB) from *Populus canadensis*. Phytochemical analysis of EECP and EEPB was performed via total phenolic and flavonoid content measurements followed by high-performance liquid chromatography (HPLC) analysis. The results shown the free- radical scavenging activity and in-vitro anti-inflammatory properties of Chinese Propolis and Poplar Buds, and also provide biological information for developing suitable substitute(s) for Propolis in the prevention and treatment of inflammatory diseases.

Along with chromatographic techniques, Northern Blotting is also used in molecular biology research. It involves the study of RNA for the expression of genes and has been used for various analyses. *Catharanthus roseus* has been analysed by Nothern blotting and purified by SGD (Strictosidine b-D-glucosidase) for the synthesis of Terpenoids Indole Alkaloids (TIAs) (Geerlings et al., 2000).

Other achievement in the field of biotechnology is the application of Polymerase Chain Reation (PCR). It is a unique technique for in vitro amplification of the DNA or RNA of an organism or gene. It takes advantage of a heat-stable DNA polymerase, such as Taq polymerase. It relies on thermal cycling and includes three steps- denaturation, annealing and primer extension. Modol et al (2001) used PCR while studing genetic transformation and hybridisation in *Camellia sinensis* obtained by *Agrobacterium*-mediated transformation of somatic embryos.

6. NANOBIOTECHNOLOGY

Nanobiotechnology is a discipline in which tools from nanotechnology are developed and applied to study biological phenomena. It is a field with great potential for countries rich in biological diversity, such as India, whose biodiversity may be used as a key resource for biotechnological products and processes that are suitable for large-scale synthesis. Murugun et al (2014) combined the inherent antimicrobial activity of silver metals with the bark extract of the traditional medicinal plant *Acacia leucophloea* and produced stable silver nanoparticles (AgNPs) free from toxic byproducts. They reported a broad-spectrum antibacterial activity of this biocompatible antibacterial AgNPs against the common bacterial pathogens *Staphylococcus aureus, Bacillus cereus, Listeria monocytogenes,* and *Shigella flexneri*. This opened the possibility of various applications for these NPs of producing effective antibacterial agents for the management of emerging multidrug-resistant pathogenic bacteria.

7. BIOREACTORS AND SECONDARY METABOLITES

A large number of plant species produce secondary metabolites such as alkaloids, flavanoids, phenols, gummy polysaccharides, terpenes and quinones that are used in food, pharmaceutical, cosmetic and pesticide industries. Plant tissue culture approaches represent a promising renewable source of these valuable secondary metabolites, which cannot be produced by microbial cells or chemical synthesis. In-vitro production of secondary metabolites has been reported from various medicinal plants and bioreactors are indispensible tools for commercial production of these secondary metabolites by plant biotechnology. Genetic engineering techniques like *Agrobacterium* mediated transformation, particle bombardments, chloroplasts transformation are influential means of enhancing the productivity of existing and novel secondary metabolites.

8. DNA BARCODE

Prevalent Indian traditional medicinal systems like Ayurveda, Sidhha and Unani uses crude extract of parts of usually more than one herb. The major problems to deal with phytomedicinals are its correct identification and substitution of rare, expensive medicinal plants with the cheaper and easily available ones. Hence, there is a need for the tool that gives correct identification of plants at the molecular level. DNA barcoding has been employed effectively as an ethno-genomics tool to identify the cryptic species, phytomedicinals, and biological authentication of materials that add value to both traditional ethno-botanical and scientific knowledge. DNA barcoding uses state-of-the-art biotechnology to identify plant species in a rapid, accurate, and cost-effective manner. This technique is not restricted by morphological characteristics, physiological conditions, and allows species identification without specialist taxonomic knowledge. It involves the identification of DNA sequences of a given species and then assigning them to that species.

The concept of DNA barcoding for the identification of global species was first proposed by Hebert et al (2003). Herbert et al (2003) first proposed that the CO1 (the mitochondrial gene for Cytochrome C Oxidase subunit 1) is suitable barcode to identify animals. There are many loci that are present in plants and can be used as barcodes including, ITS (nuclear ribosomal internal transcribed spacer region), rbcL (the chloroplast gene for RuBisCO large subunit), psbA-trnH, and matK. The plant working group of the consortium for the barcode of life recommended that rbcL+matK as a plant barcode. The region ITS2 is considered as most suitable region for identification of plant species and also it is complementary locus to CO1 for identifying animals. ITS2 (Internal Transcribed Spacer 2) region of nuclear ribosomal DNA is considered as universal DNA barcode for plants (Yao et al, 2010). It has many valuable characteristics which help us to identify even closely related species. The results show that the inter-specific divergence of

congeneric species in plants and animals was greater than its corresponding intra-specific variations. The success rates for using the ITS2 region to identify dicotyledons, monocotyledons, gymnosperms, ferns, mosses, and animals were 76.1%, 74.2%, 67.1%, 88.1%, 77.4%, and 91.7% at the species level, respectively.

Vassou et al (2016) created a reference DNA barcode library called Ayurvedic Pharmacopoeia of India - Reference DNA Barcode Library (API-RDBL) of the medicinal plants that are listed in the Ayurvedic Pharmacopoeia of India (API) using rbcL marker and to use the same to authenticate the raw drugs that are sold in markets. DNA barcoding revealed that only 79 % raw drugs were authentic, and the remaining 21 % samples were adulterated. It clearly showed that unauthentic medicinal plant raw drugs are sold in the herbal markets, and DNA barcoding will be highly useful to identify the same.

9. CONCLUSION

Plants have been an important source of medicine for thousands of years. Creation of new transgenic varieties with the help of biotechnology serves as green production lines for pharmaceuticals. Gene enhancement is possible through transformation using *Agrobacterium rhizogenes*, biolistics and chloroplasts transformation. The field of biotechnology is not only involved in genetic enrichment, but also plays a vital role in the preservation and propagation of rare and endangered plants. Preservation of in-vitro culture is possible through cryopreservation. The phytoproducts can be preserved through the unique technique of liposome encapsulation. Plants are extremely rich source of bioactive natural products and continue to possess a huge potential for drug discovery. The combinatorial biosynthesis methods are used to generate novel molecules from plants. The production of secondary metabolites can be increased by multiple folds using bioreactors. DNA barcode, a state-of-the-art biotechnology technique helps to identify plant species in a rapid, accurate, and cost-effective manner. This technique is not restricted by morphological characteristics, physiological conditions, and allows species identification without specialist taxonomic knowledge. It also helps in authenticating the raw drugs.

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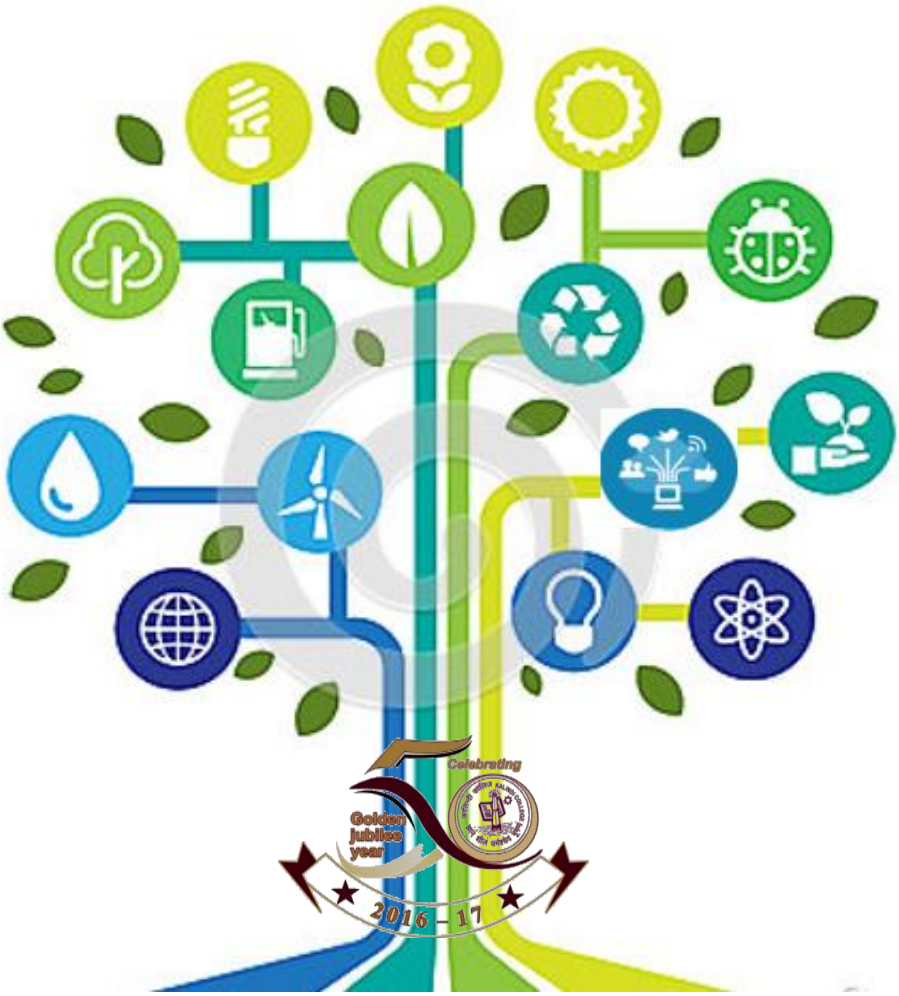

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