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# PLASMA PROCESSING UPDATE

Issue 73

October 2015

## MESSAGE FROM DIRECTOR

*It gives me immense pleasure to share with you about recently held one day workshop on 'Applications of Cold Plasmas in Surface Engineering' at FCIPT-IPR. The aim of this workshop was to generate awareness in the society about various plasma technologies and their potential for mankind. Fruitful interaction with different industrial sectors took place during this workshop. Institute plans to organize*



*such workshops frequently to popularize Indigenous **GREEN & CLEAN plasma technologies** among Indian industries.*

**Prof. Dhiraj Bora**  
Director, IPR

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## EDITOR'S NOTE



**Dr. S. Mukherjee**  
Head, FCIPT Division

The major attraction of October 2015 issue of Plasma Processing Update is the announcement of Tech Transfer Meet to be held on December 11, 2015. I am pleased to express that FCIPT-IPR has developed four new green technologies for the society which are ready for transfer to Indian industries. Apart from this, Issue – 73 throws light on advantages of plasma processed medical plastics and how plasma process can help to dispose floral waste which is generated in huge amount in religiously important cities of India.

For more details, please visit us on

[www.plasmaindia.com](http://www.plasmaindia.com)

### Co-Editors



Mrs. Purvi Dave



Mrs. Nisha C.

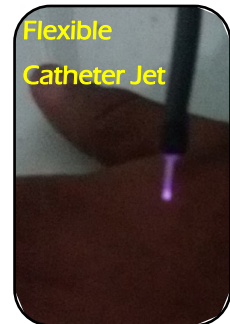
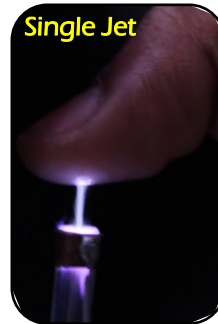
# NEW PLASMA TECHNOLOGIES - AVAILABLE FOR INDUSTRIES

Technology Transfer Meet: December 11, 2015

Industries interested in Technology Know-How Transfer Can Contact Us in Advance for Invitation in Above Event.

## Atmospheric Pressure Plasma Jet

(FCIPT)-IPR, has developed state of art atmospheric pressure plasma jet using dielectric barrier discharge. The plasma jet so formed is touchable by bare hands and can be used for bio-medical applications. Besides this plasma jet array is also developed for the surface modifications of larger areas. Much of this work has been done in house. Plasma apparatus is portable and operated by 24 V battery. It uses Argon gas . It operates at 2.5 W power and 25-55 kHz frequency .



### Possible Applications :

- Blood Coagulation
- Skin Disease
- Pesticides Removal
- Seed Germination
- Surface Activation of Polymers

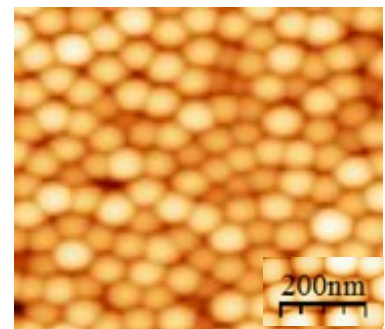
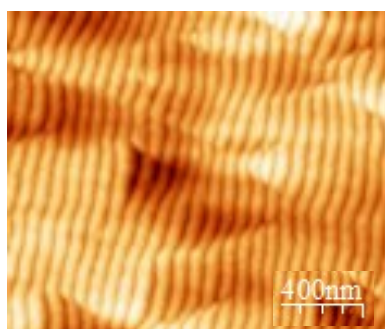
## Low Energy Ion Source & Nano Patterning

A low energy Ion source broad beam with ion flux of developed by up to 10 mA/cm<sup>2</sup>. It uses 0.13 T magnetic field . These type of ion sources are nearly maintenance free. These qualities make it also suitable for academic use.

FCIPT-IPR is *These are very low cost Indigenously developed Ion Sources.* very simple and easy to use. It works on the principle of magnetron and offers low energy ions of ~ 1 keV energy and

### Possible Applications :

- Molecular Sensor
- Disease Identification
- Forensic
- Surface Cleaning
- Film Deposition
- Nano Patterning
- Plasma thrusters in satellites



## Low cost, user friendly Langmuir Probe for Plasma Diagnostics

Langmuir Probe is commonly used device for measurement of plasma parameters such as plasma density, electron temperature, plasma potential etc. FCIPT-IPR developed Langmuir Probe has programmable probe movement, spatial resolution of less than 0.2 mm. Using this probe it is very easy to

measure plasma parameters in different positions over 250 mm distance. Cost and efforts for development of plasma process can be saved by using such type of probe. This Plasma Diagnostic Probe can be useful to the researchers who are working in the field of plasma processing.



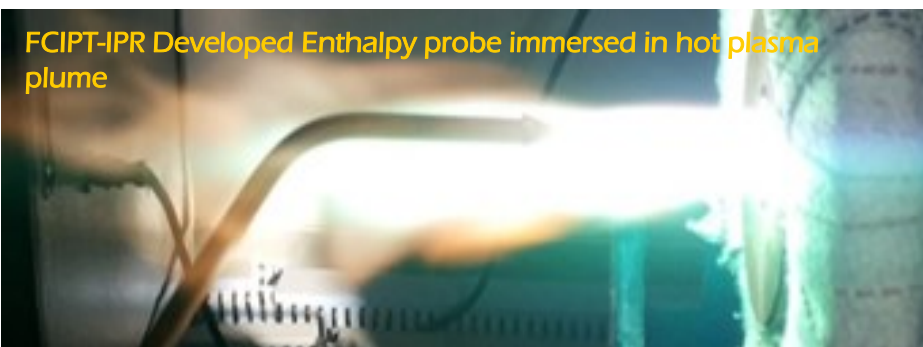
## Enthalpy Probe diagnostics for hot gas Measurements

For any application which involves use of hot gas / thermal plasma, a precise knowledge of tempera-

*Enthalpy ~ few 1000's cal/g*  
*Temperature ~ 3000 - 10000 K*  
*Velocity ~ 200 - 2000 m/s*

ture and enthalpy of the plume in two or three dimensions would be of great advantage

because it can reduce design cycle times and fabrication costs. This diagnostic probe survives inside the hot gas / plasma plume and gives information about temperature, enthalpy and flow profiles.



FCIPT-IPR Developed Enthalpy probe immersed in hot plasma plume

- Possible Applications :**
- Hot gas Exhaust
  - Thermal Spray System
  - Plasma Torch Design & Development
  - QC in Industries
  - Fundamental research





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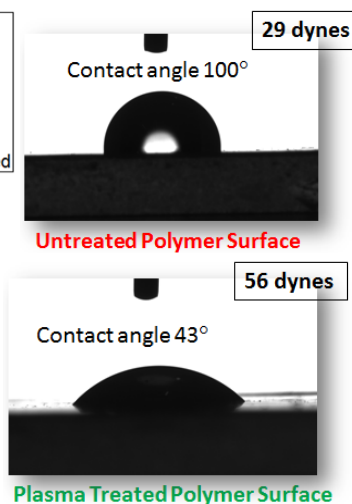
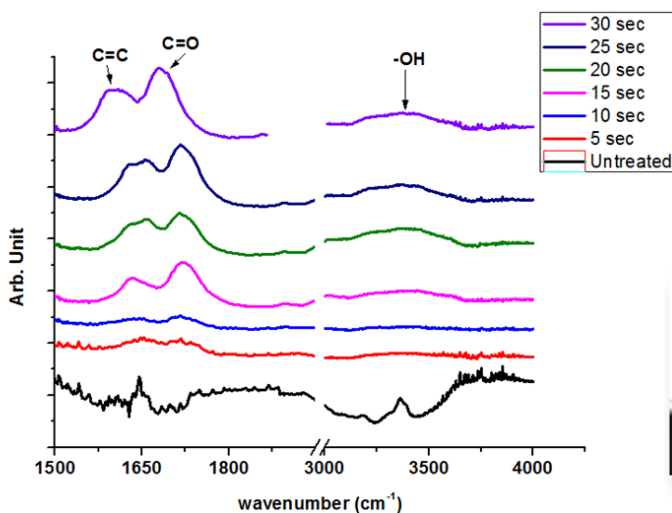


# PLASMA FOR BETTER MEDICAL PLASTICS

Bio-polymers / medical plastics are widely used for biomedical applications such as artificial organs (Prosthetic Materials) and cell scaffolds. **Surface properties** of the material play an important role in determining overall biocompatibility of the materials because the surface of the materials will first come into contact with biological environment. In order to obtain optimal biological performance, it is usually necessary to apply surface treatments or coatings to biomaterials. Plasma treatments are used to incorporate chemically reactive functional groups

on to the polymer surface and thus make them hydrophilic. Hydrophilicity plays an important role in cell and bacteria behavior. It is reported that enhancing the surface hydrophilicity by introducing oxygen containing functional groups such as **hydroxyl (-OH), carbonyl (-COOH), ketone (-C=O)** leads to reduction in bacterial infection, improves cell attachment and reduces platelet adhesion in cardiovascular implants. At FCIPT-IPR, Polyethylene surface has been functionalized using plasma & it has shown improved hydrophilicity as shown below.

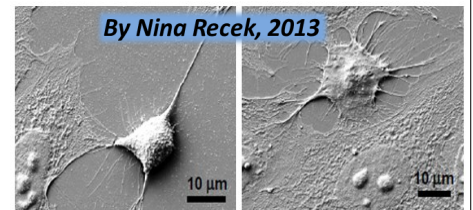
## FCIPT-IPR Results



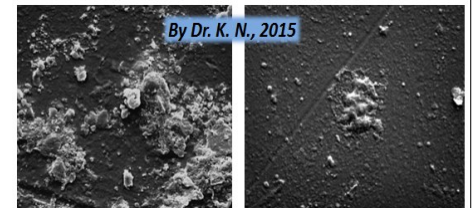
## Globally Reported Results Plasma Treatment Improves Biocompatibility



By Sulin Wu, 2011  
**Less bacterial infection** on Plasma Treated polymer implant in right hand side image

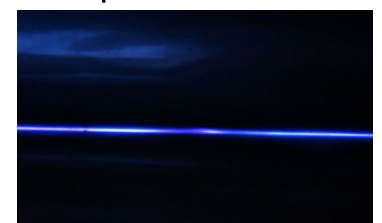


By Nina Recek, 2013  
**More Cell Attachment** on Plasma Treated polymer surface in right hand side image



By Dr. K. N., 2015  
**Less Platelet Adhesion** on Plasma Treated polymer surface in right hand side image

## Atmospheric Pressure Plasma



## Low Pressure Plasma





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## PLASMA PYROLYSIS : A WASTE -TO- ENERGY TECHNOLOGY FOR FLORAL WASTE DISPOSAL

Flowers come as waste from hotels, marriage gardens, temples, dargahs and various cultural and religious ceremonies. Specifically, religious places such as temples generate large quantities of floral waste on daily basis. Many such religious floral offerings due to religious beliefs are also thrown in rivers resulting in water pollution or are thrown near 'sacred' trees without any mode of disposal. For instance, Banaras or Varanasi, one of the holiest cities of India generates tonnes of floral waste, but has no specific policy on disposal of floral waste generated by the temples. As reported floral waste measuring 3.5-4 tonnes per day is left behind in Varanasi. Such floral waste so generated comprises of flowers, leaves, leafy packaging, cotton threads, plastic bags, papers, milky substances and

food items (e.g. Prasad) etc.



All these substances are organic in nature and segregation is just impossible. Hence, such waste demands a holistic technology which caters to disposal of all such sub-components of floral waste. This leads to a waste management challenge for the district administration. '*Clean Ganga Mission*' and '*Swatchh*

*Plasma Pyrolysis System Developed by FC IPT-IPR*



*Bharat Mission'* announced by the prime minister also emphasize the need of effective waste management technologies in this field.

**Plasma pyrolysis, a green technology** is one of the most attractive options that can be used for **safe disposal of floral waste and energy recovery**. This technology disintegrates waste in oxygen starved environment by thermal

### Salient Features of Plasma Pyrolysis Technology

- High waste disposal rate with minimum footprint
- No Transportation of Floral Waste required
- No Foul smell
- Energy Recovery
- Prevents pollution of river— leads to cleaner river and other water bodies

plasma. FC IPT has demonstrated safe disposal of hospital waste as well as paper and plastics. & energy recovery in the form of electricity.





## SUMMARY OF ONE DAY WORKSHOP HELD AT FCIPT-IPR ON 'APPLICATIONS OF COLD PLASMAS IN SURFACE ENGINEERING'

A one day workshop was held at FCIPT on 11<sup>th</sup> Sep 2015, with an objective to demonstrate eco-friendly plasma technologies to Indian Industries and Institutes and work jointly with them for the '*Green -India*' mission.

The workshop was attended by delegates from various industrial sectors like Polymers, Textiles, Medical Devices, Machinery manufacturing, Professional Bodies and Institutes. Apart from this, Dentists and Doctors also embarked their presence in the program. The workshop was inaugurated by **Prof. Dhiraj Bora** (Director, IPR) and

**Shri. R. N. Raval** (Joint Commissioner of Industries, MSME, Gujarat).

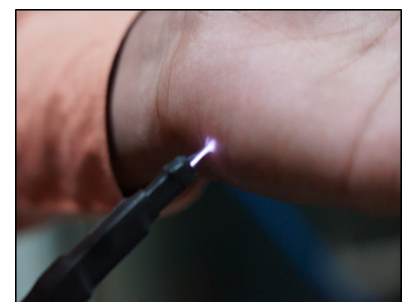


**Shri R.N. Raval** explained about **Gujarat state funding** opportunities for development of new technologies. The details for the same can also be seen from the site <http://ic.gujarat.gov.in/>.

**Prof. Bora** emphasized on the how plasma technologies can fulfill future energy requirements.

A wide spectrum of plasma based applications like blood coagulation, plasma sterilization, bio-medical implants, pesticide removal, seed germination, polymer packaging, eco-friendly clothing, hardening of automobile parts and specialised coatings were discussed in the workshop. The most **exhilarating** part of the workshop was the live demonstration of Plasma Technologies like Plasma Torch, High Density Atmospheric Plasma and Plasma Nitriding.

Delegates were really excited to feel the plasma in their hands.



A Participant feeling plasma torch on his hand

## TECHNICAL SESSIONS IN THE WORKSHOP

Dr. S. K. Nema initiated the Technical Sessions by giving an **Introduction to Plasma Processing**. He familiarized the audience about 'Plasma' by giving examples of natural plasmas around us such as sun, lightening, tube light etc. He also briefed about usefulness of plasma for different industrial sectors.



Mr. Akshay Vaid gave a talk on **"Biomedical & Agricultural Applications of Plasma"**. He discussed about applications of atmospheric pressure plasma jet like blood coagulation, curing of skin diseases, pesticide removal from vegetables and fruits, enhancing seed germination.

Dr. Suryakant Gupta talked about **"Plasma Sterilization"**. In his presentation he educated about existing sterilization process and how plasma sterilization can be a unique solution.



Mrs. Purvi Kikani Dave discussed about **"Plasma Surface Modification of Polymers"**. Her presentation has thrown light on how plasma processed polymer surfaces exhibit unique and improved properties which make them suitable for water based printing, improved food packaging and biocompatible medical implants.

Mrs. Nisha Chandwani presented **"Eco-friendly Textile Processing"**. She explained how plasma processing can help textile industries to eliminate the use of hazardous chemicals and their disposal issues. Using plasma process it is possible to combine some of the major conventional processing steps such as Desizing and Scouring and save time, energy and chemicals as plasma process is a dry process.





Mrs. Alphonsa Joseph presented 'Eco-friendly Processing for Better Machinery & Automobiles'. She emphasized on importance of Plasma Nitriding process for improving surface hardness and corrosion resistance of machinery components.



Mr. Ramakrishna Rane gave a talk on "Plasma Coating Applications: Thin Films & Nano Patterning". His presentation discussed about types of films which can be deposited using plasma process and their applications in medical implants, brass decorative articles, solar cells, satellite antenna etc.

### Interaction by Participants....



### Media Coverage in Leading Newspapers

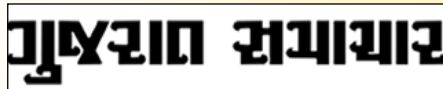


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