

PLASMA PROCESSING UPDATE

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MESSAGE FROM DIRECTOR

It gives me immense pleasure to share news about FCIPT's progress in developing plasma based technologies for societal benefits. Over the **last one year, six Indian industries** have absorbed **FCIPT-developed technologies** for commercialization. These technologies include a wide spectrum of industrial sectors such as **Textiles, Heat Treatment, Waste Management, Nano Particle Production and Plasma Medicine**. In the coming year, we welcome more industries to collaborate and make commercial use of indigenously developed environment friendly plasma technologies.

Dr. Shashank Chaturvedi,
Director, Institute for Plasma Research

EDITOR'S NOTE



Dr. S. Mukherjee
Head, FCIPT Division

Welcome to the 78th issue of **Plasma Processing Update**, an e-Newsletter. You can read it online, download it, can share with your colleagues and friends. This issue showcases a newly developed plasma technology for water activation . This new technology has potential applications in food preservation. This issue also covers how plasmas can be helpful in solving the burning issue of waste management in India. . A glimpse of recent tech-transfers, workshop and FCIPT's participation in various forums is also given.

For more details, please visit us on

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Plasma Activated Water

In the last decade researchers have discovered a new way of achieving plasma sterilization using only water which is exposed to cold plasma. It has been established that cold plasma generates active species which are dissolved in water and provide plasma activated water (PAW). *In our recent experiments FCIPT, Institute for Plasma Research has synthesized plasma activated water (PAW) and tested it for different applications.* Fig. 1 shows that tomato washed with plasma activated water remains fresh for longer period. In the case of potato, plasma activated water has increased germination (Fig. 2). *Plasma-activated water* is defined as the water

exposed to non thermal plasma or thermal plasma where chemical species formed interact with water during the exposure or after the plasma discharge is switched off.

The plasma exposure of water produce long-lived reactive species transferred from the discharge into the liquid. The PAW so generated, is known to have antimicrobial characteristics. Recent research has shown that microbial cells can be killed when they are exposed to plasma activated water. OH· radical, atomic oxygen, ozone and hydrogen peroxide are the main **reactive oxygen species** (ROS) generally accepted to play the dominant role in the inactivation process

in non-thermal atmospheric-pressure plasma systems. Researchers also suggest the presence of O_3_{aq} is the key for observed microbial deactivation.

Important Features:

- pH : 2.5 to 8.0
- NO_2^- , NO_3^- , O_3 (aqueous), H_2O_2
- Oxidation–Reduction potential: -250 to -650 mV

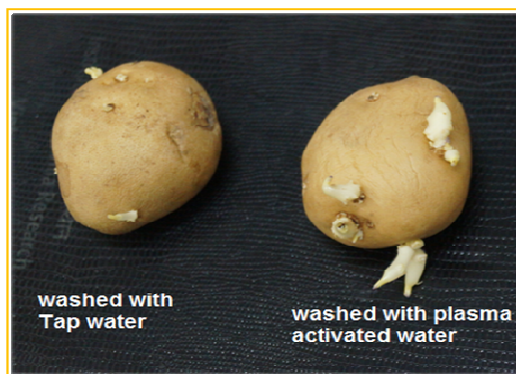
Applications:

- alternative to pesticides
- can kill bacteria, fungi, microorganism
- oral hygiene, teeth whitening,
- food preservation,
- enhanced seed germination

Plasma activated Water Tap Water



Washed Tomatoes after 40 days



Washed Potatoes after 7 days



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Plasma Gasification Technology : an environment friendly approach to manage solid waste

India is producing approximately 1.4 Lakh tons of Municipal Solid Waste (MSW) every day. MSW is finally dumped at open site at the outskirts of the city which has resulted in pil-



Deonar dump yard fire at Mumbai seriously affected air quality for 3 days

ing up of waste over a period of time and formed waste mountains for example, Deonar dumping site, Mumbai, Pirana at Ahmedabad and Bhilaswa at Delhi etc. Sometime, these sites catch fire and generate huge smoke. The smoke carries toxic pollutants which poses serious health risks. The stinking waste can also contaminate ground water in the vicinity of the dump yard. Therefore, there is a necessity of destroying waste in environment friendly manner. Plasma gasification technology developed by FC IPT, Institute for Plasma Research is one such

technology which can dispose waste safely as well as it can recover energy from the waste. Municipal solid waste carries large percentage of debris (typically 40-60%) which has to be separated prior to its disposal. The organic mass of MSW is exposed to high temperature plasma in a controlled oxygen environment which disintegrates the waste into smaller gaseous mole-



Graphite plasma arc system generates high temperature

cules such as carbon monoxide, hydrogen and methane. This gas mixture comes out at high temperature (~ 700 – 900°C) and carries significant calorie. The energy is recovered using heat exchangers and gas generator.

It has been reported that the plasma gasification becomes self sustaining at more than 10 ton per day waste disposal ca-

Tech-Transfer Partners

- ◆ M/s B. L. Engineering Pvt. Ltd, Ahmedabad
- ◆ M/s Bhakti Energy, Rajkot
- ◆ M/s G.P. Green Energy, Kolkata

capacity provided waste carries calorific value of minimum 3000 kcal/kg.

Features

- No toxic compounds
- Maintains uniform temperature
- Wall Temperature – as per demand (no dependency on fuel's burning value)
- Core temperature – in the order of 5,000 – 10,000°C
- Monitoring - working and performance of system
- Waste to Energy.
- Doesn't produce leachable bottom ash or fly ash

Application Areas

- Medical Waste
- Approved by MoEF and CPCB for BMW disposal.
- Municipal Solid waste (MSW)
- Plastic waste
- Toxic Chemical waste from Pharma and Fertilizer industries
- Off gas emission control in industrial exhaust for environment protection
- Contaminated PVC waste
- Hazardous waste etc.
- Generation of electricity from organic waste



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Plasma Pyrolysis for Solvent Waste Disposal

Safe disposal of hazardous waste is a serious concern in the chemical industries. Hazardous waste includes the chemicals that are used in the day to day production of the chemical products. Used solvents / expired solvents is one of the major in hazardous waste stream. This solvent waste is generally disposed off in open air or diluted in running tap water which leads to adverse effects on environment.

Pyrolysis is a chemical process, which disintegrates the carbonaceous material into

small fragments in the oxygen-starved environment. Gasification is the process, which disintegrates the carbonaceous substances with controlled supply of Oxygen, which produces the syn gas ($\text{CO} + \text{H}_2$). Both these process are very useful to recover energy from the wastes that contains organic molecules or to convert waste into other useful by-products.

FCIPT has signed a MoU with Central Salt and Marine Chemicals Research Institute (CSIR-CSMCRI) Bhavnagar,

to design fabricate, install and commission a plasma pyrolysis / Gasification system to dispose the liquid solvent waste and generate useful fuel gas.

The system has been installed at CSIR-CSMCRI,

Features:

- Safe disposal of hazardous waste
- Waste to Energy
- Environment friendly indigenous technology

Bhavnagar. Joint study will be performed by FCIPT, IPR and CSIR-CSMCRI. Mixture of solvents/expired solvents will be disposed in high temperature environment produced by graphite based thermal plasma torch in the absence of oxygen. This will be a promising solution for laboratories and R&D institutes that handles huge amount of solvents in day to day activities.



*Plasma Pyrolysis / Gasification System installed
 at CSIR- CSMCRI*

Technology Transfer : Atmospheric Pressure Plasma

A technology transfer agreement for '*Atmospheric pressure inline plasma treatment technology for textiles*' was signed by and between IPR and M/s **Arshad Electronics Pvt. Ltd. (AEPL)**, Mumbai on 9th November 2016 at IPR, Bhat, Gandhinagar. This novel atmospheric pressure plasma technology shall enable moderate speed (40mtrs/min) processing of textiles/polymers.

The transferred technology will be absorbed



Atmospheric Pressure Plasma in 2.5 m Electrode



Mr. Aslam Moolji, Director AEPL and Dr. Chenna Reddy, Associate Dean, IPR exchanging Tech –Transfer documents.

by AEPL and used for inline treatment of textiles and plastic films. AEPL has been into the business of manufacturing corona treaters for textile and plastic film processing and the atmospheric pressure inline plasma

Technology Transfer : Plasma Pyrolysis

FCIPT, IPR as a part of its contribution to Swachh Bharat Mission is expanding the use of Plasma Pyrolysis technology for the waste disposal. FCIPT transferred technical –know how for '*Plasma Pyrolysis technology for disposing organic waste*' to M/s **G.P. Green Energy Systems Pvt Ltd , Kolkata** on 7th December 2016 . G.P. Green Energy Systems Pvt Ltd, which is presently engaged in the business of biomass gasification, is planning to use the plasma technology for municipal solid waste as well other types of paper and plastic waste.



Mr. J.H.Jangada ,Technical Director ,G.P Greens and Prof. Amita Das ,Dean IPR exchanging tech-transfer documents

A one day Workshop on “Plasmas for Societal Benefits”



Dr. S. Mukherjee, Head FCIPT and Dr. Dileep Mavalankar, Director IIPH.



A one day workshop was held on at FCIPT, IPR on **21st October 2016** to increase aware-ness of new developments in Plasma Technologies and its benefits to the society in various industrial sectors. There was a special focus on applications of **Plasma in Healthcare sector**. Dr. Dileep Mavalankar, Director, Indian Institute of Public Health (IIPH) was invited as a chief guest for this event. Participants from various industrial sectors and academic institutes participated in this informative workshop. The topics covered in this workshop were Plasma Jet for Medical, Plasma Sterilization, Nano-patterned sensors, Bio-compatible surfaces, Plasma Nitriding, Plasma Surface modification of Polymers & Textiles, Plasma based coatings, Plasma Pyrolysis and coal gasification. The workshop also included a live demonstration of Plasma Jet, Atmospheric Pressure Plasma for Textiles and Plasma Nitriding.

FCIPT-IPR @ WASTECH 2016

FCIPT-IPR participated in **Wastech 2016** Summit and Expo, an event organized by Gujarat Pollution Control Board (GPCB), Department of Forests and Environment, Govt. of Gujarat. The event was scheduled from 02-04 Dec, 2016 at Mahatma Mandir, Gandhinagar. The summit and exhibition was aimed at showcasing the latest developments in waste disposal and environmental technologies. Plasma pyrolysis is one of the key technologies developed by FCIPT, IPR and has gained popularity with the central government's 'Swatchh Bharat' campaign. Further, FCIPT-IPR is also setting up a prototype plasma pyrolysis plant at GIFT City, Gandhinagar. FCIPT's tech transfer partner **B.L.Engineering** showcased a **proto-type model** of Plasma Pyrolysis plant to be installed in **GIFT city, Gandhinagar**. A huge crowd of visitors visited the exhibition and specifically, the exhibits of IPR were one of the centres of attraction generating interest amongst the visitors. The plasma pyrolysis technology was the most enquired information and the model was the most sought demonstration. **Shri Shankarbhai Chaudhary** Hon'ble Minister of Forests and Environment, Government of Gujarat, endorsed his positive remarks in the guest book, during his visit to the IPR stall.

