FACILITATION CENTRE FOR INDUSTRIAL PLASMA TECHNOLOGIES

INSTITUTE FOR PLASMA RESEARCH

PLASMA PROCESSING UPDATE

July 2016

MESSAGE FROM DIRECTOR

I am pleased to present the 76th issue of Plasma Processing Update. FCIPT, a Division of IPR is a multidisciplinary research center devoted to develop plasma based technologies for societal & Industrial benefits. It gives me immense pleasure to declare that Ministry of Environment and Forest (MoEF) has included Plasma Pyrolysis for Biomedical Waste as an accepted process of incineration in the gazette brought out in the month of March 2016. Considering plasma technology's potential for better future, a two day start up workshop was organized jointly by Gujarat Technological University (GTU) and FCIPT to introduce plasma project opportunities for young entrepreneurs.

Prof. Dhiraj Bora
Director, IPR

Inside this issue:

EDITOR'S NOTE

Dr. S. Mukherjee
Head, FCIPT Division

Welcome to the 76th issue of **Plasma Processing Update,** an e-Newsletter. You can read it online, download it, can share with your colleagues and friends. In this issue you will find information on how plasma can be helpful to cure skin disease and fabricate high strength fiber composites. This also includes information about development of microwave power source by our engineering experts. There was an overwhelming response by industries across the country in a one day workshop on "*Thermal Plasma & its Industrial Applications* " held at FCIPT on April 29th by us.

For more details, please visit us on

www.plasmaindia.com

Co-Editors

Mrs. Purvi Dave

Mrs. Nisha C.

Mr. Chirayu Patil
Engineer – SC, FCIPT-IPR
Chirayu@ipr.res.in

Dr. Abhijit Majumdar
Assistant Professor , IIEST
majuabhijit@googlemail.com

Treatment of skin diseases using plasma jet

FCIPT has developed atmospheric pressure plasma jet for bio-medical applications, the plasma jet which can be touch by bare hands and the technology has been successfully transferred to M/s Aditiya High Vacuum Pvt. Ltd. This is for the first time after taking the ethical permission by one of our colleague plasma jet is directly put on human for the treatment of Tinea Cruris (Fungal disease) in India. The test is done at PG medical college Kolkota under the supervision of skin specialists. The patient is treated with plasma jet for 20 minutes. The treatment will go on for one month once a week. After 1st and 2nd treatment, patient is in good state of heath and fungal infection is improving.

Final results would be evaluated after the completion of one month. Fig-1, Fig-2, Fig-3 shows the images of the treatment given. .

Fig-1: Plasma jet on feet Tinea Cruris (1st treatment)

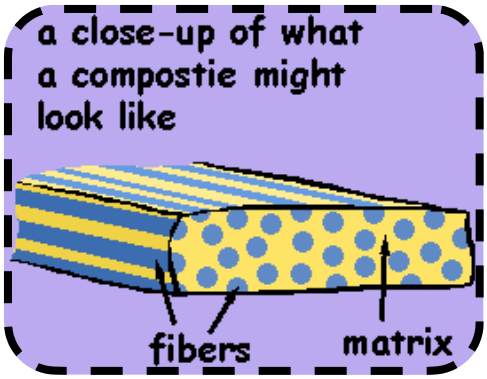
Fig-2: Plasma jet on feet Tinea Cruris (2nd treatment)

Fig-3 Plasma jet on Abdomen Tinea Cruris

Dr. Nirav Jamnapara
Engineer SF , FCIPT-IPR
nirav@ipr.res.in

Plasma Treated Fibers for High Strength

Composites, by definition, are those materials made up of an amalgamation of separate parts or micro-structural elements. This amalgamation combines the attributes of each of the separate materials involved, typically resulting in improved properties for the system as a whole. In day to day life we see such composites in the form of FRP helmets, sheets, tanks; Cement Concrete etc.



Over the past quarter-century the technique of re-engineering polymer surface properties through exposure to a gas plasma has been extended to virtually all polymers. A variety of results can be easily obtained, specific to the polymer and the gas species employed. The effect of a plasma on a given material is determined by the chemistry of the reactions between the surface and the reactive species present in the plasma. At the low exposure energies typically present in glow-discharge plasma systems the interactions occur only in the top few molecular layers. The majority of plasma activation processes are related to preparing the surface for subsequent operations such as printing or altering the surface wetting characteristics. The reinforcing fibres prior to the manufacturing stage (i.e. mixing with resin) is exposed to plasma for activation of the fibre surface. The properties achieved on the fibres are driven by processing parameters such as plasma power density, residence/exposure time, frequency, geometry of exposure, homogeneity of plasma etc. At FCIPT, preliminary experiments have been carried out on Kevlar® fibres for studying the changes in surface morphology. It had been observed that the surface roughness has been increased as compared to the untreated fibres. The plasma treatment not only increases micro-roughness on the surface of the polymeric fibre providing a mechanical grip with the matrix, but also creates active functional groups as active sites on the surface, which chemically bonds with the matrix upon mixing with the resin material during manufacturing of such composites.

Property	Un-treated	Plasma treated	Improvement
Flex Strength (MPa)	129.60	389.60	3 times
Flex. Modulus	24.70	32.40	1.3
ILSS (MPa)	–	34.80	–

Mr. Vishal Jain
Engineer – SF, FCIPT-IPR
vishal@ipr.res.in

Design and Development of IGBT Based Power Supply

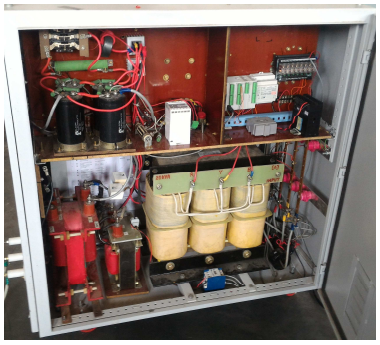
A 10kV$_{peak}$, 1.1A supply was designed, fabricated and successfully tested on water load. This power supply generate half wave ripple of more than 10kV amplitude with the feedback to control and regulate the output current. The power supply is controlled and operated from Human Machine Interface (HMI) and PLC automation and interlocks. A DC link is generated and fed to high frequency IGBT (Semikron make) based inverter with using indigenously designed driver. The frequency of inverter switching is 8kHz. The switching of inverter is based on full wave ZCS and snubber protection design is based on hard switching.

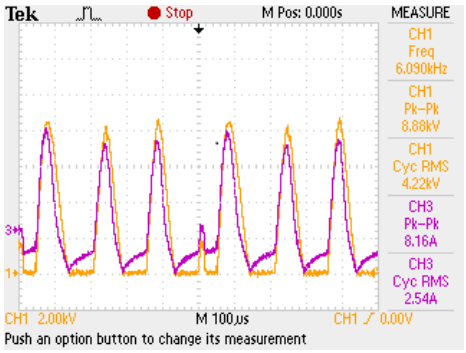
The parallel resonant converter components are selected such that it provides a Q factor of around 2—3. The high frequency transformer is designed such that it has full load current at 8 to 10 kHz. The secondary of this high voltage ferrite core transformer generate 7kV rms that is rectified using half wave rectifier configuration with using diodes of 3A max rating and 20kV PIV.

The feedback amplifier has phase shift improvement of 100 degree with unity gain. There are two poles and two zeroes in feedback transfer function. That can improve phase up to 180 degree. The right hand size zero is prevented using suitable LC resonant converter after inverter. This supply was successfully tested on water load.

The Main features of Microwave power supply are:

1. It can supply 33A, 5V current to filament.
2. Filament current is always interlocks with HV between anode and cathode.
3. Water cooling, water flow, stack temperature and door are interlocked using PLC and HMI.
4. It can supply 10kW CW power to Magnetron.
5. Indigenous IGBT driver and protection





Schematic of IGBT based 6kW Magnetron power supply and output waveforms.

Technology Transfer for Atmospheric Pressure Plasma Jet

The Institute for Plasma Research through it's FCIPT wing transferred the proprietary Atmospheric Pressure Plasma Jet Technology for biomedical applications to Ahmedabad based M/s Aditya High Vacuum Pvt. Ltd. The Atmospheric pressure plasma jet technology will enable to open new avenues of plasma technology applications in bio-medical and medical sector. The non-exclusive technology transfer agreement was signed on 23rd June, 2016 at Director's Office at the Institute for Plasma Research, Gandhinagar. High Vacuum Pvt. Ltd.

Shri A. Varadarajulu from IPR (Left) &
Dr. N. Venkatramani from Aditya High Vacuum

A One-day Workshop on Thermal Plasma & its Industrial Applications

A one day workshop with a theme on Thermal Plasma and its Industrial Applications was organized by FCIPT in association with ASM International ,Gujarat Chapter and SPFU, Gujarat on **29th April 2016.**The aim of this workshop was to sensitize industries about unique properties of thermal plasmas such as highly concentrated reactive medium , highest energy density with temperatures upto 20000 °C and their technological applications.

Workshop Participants at FCIPT

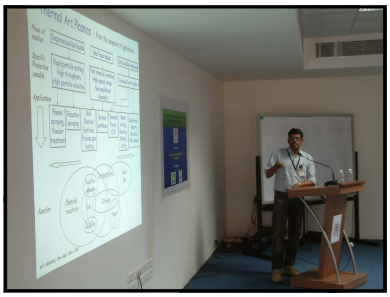
Dr. S.K.Nema explaining about Plasma Pyrolysis

The workshop was attended by around 50 participants from various industries, institutes and Universities. .A wide spectrum of plasma based applications such as **Plasma Pyrolysis for waste disposal**, **Waste-to-Energy power plant**,**Coal gasification**, **Plasma spraying**, **Mineral Processing** **Powder treatment**, **Metal melting**, **Smelting**, **Welding, Cutting** and in production of variety of Nano Particles such as oxides, nitrides , ceramics and metals . The most **exhilarating** part of the workshop was the live demonstration of Plasma Torch, Plasma Pyrolysis, and Nano-particle production

TECHNICAL SESSIONS IN THE ONE DAY WORKSHOP

Dr. Nirav Jamnapara initiated the Technical Sessions by giving an **Plasma Processing & Potential Applications of Thermal Plasma** . He familiarized the audience with 'Plasma' and its usefulness for different

Dr. S.K,Nema gave a talk on **"Waste Disposal in Environment Friendly Manner using Thermal Plasma Technology ".** He shared about the progress made by FCIPT in development of this technology.



Dr. G.Ravi talked about **"Plasma Torch - Heart of Thermal Plasma ".** In his presentation he educated about basics on thermal plasma torch & its architecture

Mr. Vishal Jain presented **"Coal Gasification using Microwave Plasma ".** He explained how plasma gasification can make Indian coal usable for power generation.

Mr. Ragesh Batteriwala presented **"Thermal Spray Process Plasma Transferred Arc ".** He discussed case studies of various plasma sprayed products.

Dr. Balasubramanian discussed about **"Nanoparticle generation & their applications ".** He showed various types of nano-particles produced at FCIPT and their possible applications.

Two days workshop on

Start Up Issue and Opportunities (Plasma Technology Case Study)

A Seminar on Plasma Technology was arranged by Gujarat Technological University (GTU) on March 5, 2016 at GTU in association with Institute of Plasma Research, Gandhinagar to create awareness of plasma high tech applications to faculty and students.

Seeing the phenomenal response, it was decided to hold two days training workshop jointly by GTU and IPR. Consequently Start up workshop with plasma case study was jointly organised by GTU and IPR on 19th & 20th May, 2016 to introduce plasma start up opportunities along with practical demo at FCIPT at Gandhinagar.

Response of GTU and local university's graduate engineering/technology students was excellent. Workshop included exposure on Plasma technology opportunities in SME sector with demo on Plasma Pyrolysis, Plasma Nitriding, Nano particles Generation by Plasma, Plasma Jet for Biomedical Applications, Plasma for Textiles. Apart from plasma technologies there were sessions on Start up ecosystem and challenges, Incubation and mentoring, Sources of finance for start up, Strategic options for adoption of plasma projects as start up. It was gratifying that some young engineers showed keen interest in start -up initiative.

Prof. Amita Das delivering key note address

FCIPT-GTU organizing committee

Participants at FCIPT along with Shri Abhay Mangaldas,, Founder Director House of MG

Times of India, Ahmedabad - 5th May 2016

Centre gives nod to plasma tech for waste incineration

Paul.John@timesgroup.com

Ahmedabad: It took six years and several trials to convince the ministry of environment and forests (MoEF) of the environmental advantages of plasma pyrolysis — breaking down of biomedical and municipal solid waste by using plasma. The process breaks down any form of waste to water, carbon monoxide, hydrogen and methane. These gases can be harnessed to produce energy.

Times View

The Pirana dump will soon be turned into a garden. But that's not a solution. Every day Ahmedabad generates 4,200 metric tonnes of unsegregated waste, out of which just 700 metric tonnes gets recycled or converted to useful refuse-derived fuel pellets. This forces the AMC to stack up tonnes of waste into landfill sites. This will only create another Pirana-like dump. Its high time that AMC ensures enforcement of stringent waste segregation rules and employ green technology like plasma pyrolysis to incinerate waste which cannot be recycled.

PLASMA POWER

Plasma pyrolysis emission standards are lower than CPCB standards and even the US emission norms

Pollutant	CPCB standard (mg/cubic metre)	Plasma System (mg/ cubic meter)
➤ Carbon monoxide	less than 1,000	40 to 85
➤ Nitrogen oxides	less than 400	7 to 25
➤ Particulate matter	less than 150	31 to 52
➤ Dioxin and Furan	less than 0.1	0

BIOMEDICAL APPLICATION

Plasma pyrolysis can be used to break down human anatomical waste, animal waste, discarded medical and toxic drugs, items contaminated with blood, body fluids and cotton dressings

ADVANTAGES OF PLASMA PYROLYSIS

- ➤ Hazardous and toxic compounds broken down to elemental constituents at high temperatures
- ➤ Inorganic materials converted to vitrified mass
- ➤ Organic materials gasified
- ➤ Fuel gases like hydrogen, carbon monoxide and methane are released. Can be used for energy

The MoEF has now included plasma pyrolysis as an accepted process of incineration and a few weeks ago brought out a gazette accepting the new process. There are in the country 11 such plasma pyrolysis facilities installed by the Facilitation Centre for Industrial Plasma Technologies (FCIPT), a division of the Institute for Plasma Research (IPR) in Gandhinagar.

The waste is heated, melted and finally vaporized at temperatures as high as 5,000 degrees celsius using a special nitrogen plasma torch, which uses electricity. At these superheated conditions, waste breaks down complex molecules into individual atoms. The resulting elemental components after pyrolysis are in a gaseous state — especially water, carbon monoxide and methane. These gases can be harnessed for energy. "Traditional incinerators use diesel to burn waste which causes emissions of non-environmentally friendly gases. Plasma breaks down complex molecules of waste – like plastic or other such waste into individual constitutents," says head of FCIPT division S Mukherjee.

The 11 plasma pyrolysis units that have been installed also include one at Gujarat Cancer Research Institute in Ahmedabad.

Times of India, Ahmedabad - 3rd May 2016

IPR rolls out tech to make self-cleaning cloth

Nano Particles Allow Cloth To Remove Stains On Its Own

Paul John @timesgroup.com

Ahmedabad: For housewives, working women and even men struggling with stubborn stains from clothes, help has come from an unexpected quarter. The Facilitation Centre for Industrial Plasma Technologies (FCIPT), a division of Institute for Plasma Research (IPR) in Gandhinagar, has manufactured a technology wherein a cloth can be rendered stain proof.

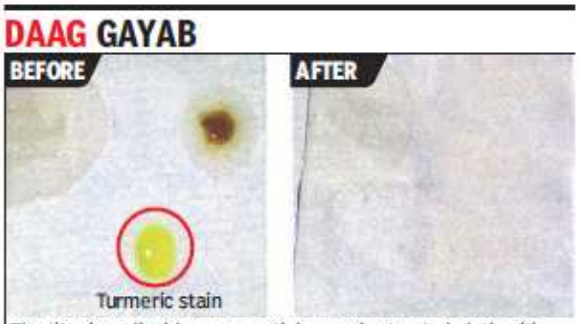
The FCIPT has developed nano particle powder wherein titanium metal is vaporized with plasma to form titanium dioxide (TiO2). These nano particles, when mixed with alcohol — like in case of deodorants — and sprayed on clean clothes prove to be excellent stain cutters.

"The TiO2 nano particles get trapped between fibres of the cloth and form a protective coat. The moment a tough stain like say turmeric enriched curry falls on the your nano-treated shirt or top, one just has to leave it in the sun for two to three hours and the stain vanishes instantly," says C Balasubramanian, senior scientist at FCIPT.

"The sun's ultraviolet rays activates the TiO2 which help oxygen from atmosphere to convert to radical oxygen that reacts with stain molecules and breaks it down -- thereby removing stains. This process is called a self-cleaning cloth," Balasubramanian explained. The process was demonstrated on Friday at FCIPT center an industry interaction event.

Once sprayed, the TiO2 coat remains for more than 20 washes. Balasubramanian adds, "Normally, preparing TiO2 through a chemical process involves several steps over many days. At FCIPT we have prepared a process to produce nano particles of high purity in large quantities through plasma treatment in 2 to 3 minutes flat," the scientist said.

▶Continued on P 4



The titanium dioxide nano particle powder treated cloth with stain (left) and after being exposed to sun (right)

FCIPT to sign MoU with MMTRA

▶Continued from P1

On Tuesday, FCIPT will sign an MoU with Man Made Textile Research Association (MMTRA), Surat, to implement in-line plasma treatment in textile manufacturing.

The project is funded by department of science and technology and headed by Engineer-SF, FCIPT, Vishal Jain.

"We have developed a system where textile rolls are passed through plasma which modifies the surface of the textile up to a few nano meters.

This drastically reduces shrinking of woollen cloth as well eliminates the woollen cloth's prickly properties.

This process also improves sweat absorption in cotton and enhances colour depth in clothes," says Dr S K Nema,senior scientist at FCIPT

Times of India, Ahmedabad - 4th May 2016

IPR, Mantra to bring plasma treatment in textile biz

Times News Network

Ahmedabad: A major step was taken on Tuesday towards improving quality of textile processes in one of country's largest textile hubs — Surat. Institute for Plasma Research (IPR) signed an MoU with Man Made Textile Research Association (MANTRA) for introducing in-line plasma treatment facility in the existing textile manufacturing process. MANTRA is a research organisation for fulfilling quality control needs of a growing textile industry in Surat and in South Gujarat.

The IPR, through it's Facilitation Centre for Industrial Plasma Technologies (FCIPT) in Gandhinagar, will develop a plant that can treat synthetic textiles with plasma at the rate of 30 to 40 metres per minute. The facility will be developed by October 2017, or even earlier, claim IPR officials. Director MANTRA VI Bachkaniwala told TOI. "IPR's Plasma treatment facility will be 6 to 10 times cheaper than what is available in Europe or US and improve our fibre strength and colour enhancements of textiles."

"Plasma improves the fibre quality, drastically reduces shrinking of fabric and is a clean technology with no chemicals involved. Plasma will surely provide a major boost for quality improvement in textile manufacturing. In case of wool, plasma treatment nearly eliminates the prickly feel and entanglements of the fibre," said IPR director D Bora. He also suggested MANTRA members to look into plasma nitriding—a process to improve hardness of machine tools and parts of textile units by treating them with plasma.


TOI

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