FACILITATION CENTRE FOR INDUSTRIAL PLASMA TECHNOLOGIES

INSTITUTE FOR PLASMA RESEARCH

PLASMA PROCESSING UPDATE

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Issue 75

April 2016

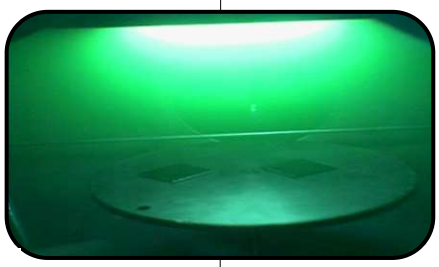
MESSAGE FROM DIRECTOR

*I am very happy to inform you all that on 17th February 2016, the Indian Union Cabinet chaired by our honorable Prime Minister Shri Narendra Modi has given in principle approval to the Rs. 1,260 Crore LIGO-India Project. IPR is the part of a group consisting of IUCCA & RRCAT in India that will design, construct and operate the LIGO (**L**aser **I**nterferometer **G**ravitational Wave **O**bservatory) India Project. The LIGO - India vacuum systems, which would be one of the largest in the world with a massive volume of almost 10^6 liters to be evacuated down to an ultra high vacuum. I also would like to mention about a recently held 2-day workshop on advances in surface engineering and welding technology at FCIPT, IPR by ASM International intended to enhance networking amongst academic faculties, researchers & Industries.*

Prof. Dhiraj Bora

Director, IPR

Inside this Issue:



EDITOR'S NOTE

Dr. S. Mukherjee

Head, FCIPT Division

The current issue of Plasma Processing Update throws light on some industrial problems such as oxygen diffusion through a polymer film, quality issues with Indian coal and adhesion between two aluminum joints and their plasma based solutions. Researchers at FCIPT, IPR are engaged to find out plasma based eco-friendly solution to these industrial problems in order to enhance the quality of the product. With a mission to create awareness about Eco-Friendly Plasma Technologies, a seminar was organized at GTU on 5th March, 2016. FCIPT-IPR is again organizing a one day workshop on "*Thermal Plasma & its Industrial Applications* " at FCIPT on April 29th with an aim to have interaction with relevant industries.

For more details, please visit us on

www.plasmaindia.com

Co-Editors

Mrs. Purvi Dave **Mrs. Nisha C.**

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

Energy recovery from Indian Coal

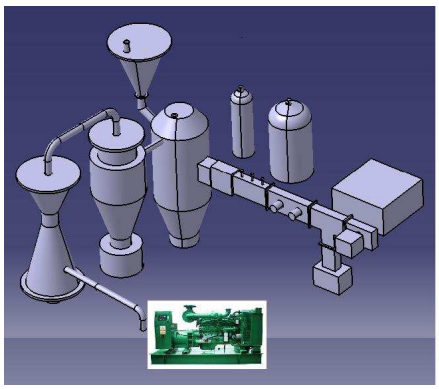
We are aware that there will be scarcity of non renewable resources such as coal in future. In India, we have huge stock of coal that can supply our demand for more than 100 years. However, the economical viability of using this coal is poor due to its quality. India coal has high ash content and hence, less calorific value. This limits its use in current days as complexities on handling of ash is involved while using India coal. Further, the ash carries lots of heat energy from the system. Therefore, FCIPT has initiated activities for gasification of coal using most efficient microwave (MW) coal gasification method. In method, fine coal particles are injected in to high temperature (~1200 °C) environment that also contains steam. In this condition, the carbon gets converted into CO and H_2 (Syngas) due to following reaction.

$$C + H_2O \xrightarrow{1200\ ^\circ C} CO + H_2$$

Microwave has advantages that it can generate large uniform column of plasma compared to plasma jet of same power rating. Therefore, coal powder finds sufficient time for the reaction and therefore, the process becomes very efficient. FCIPT has successfully demonstrated 1 kW MW plasma arc earlier and now, FCIPT is working on 5 kW coal gasification system that is shown in the figure below.

The Main features of MW coal gasification are:

1. Large uniform Plasma column of more than 1000 °C.
2. It is an electrode-less plasma source.
3. Efficient conversion from coal to syngas.
4. It can handle ash very easily as ash does not absorb microwave power.
5. It requires very less oxidation of coal as compared to conventional process.

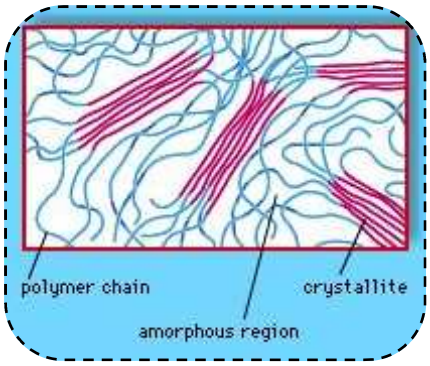


Schematic of 5kW MW coal gasification system and photos of experimental set up at FCIPT

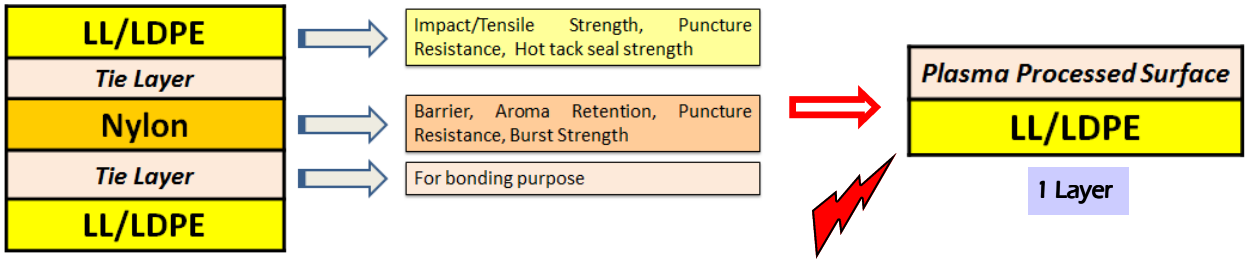
Mrs. Purvi Dave
Scientist - SD , FCIPT-IPR
purvi@ipr.res.in

Oxygen Diffusion Barrier Coating for Packaging & Flexible Electronics

Oxygen Diffusion Barrier coating on polymeric substrate is an essential part of modern packaging for protection of food and pharmaceutical products against outside environment. For the past few decades the trend of replacing traditional materials such as glass, metals and paper by polymeric materials has been growing continually in the field of packaging. **Cold Plasma Technology** is an emerging, green process offering many potential applications for food and pharmaceutical packaging as well as for flexible electronics. Most high performance semiconducting organic compounds show degraded performance when they are exposed to environmental oxygen and moisture. Thus gas diffusion barrier coating is again unavoidable part of such devices.



Polymers in general are semi crystalline nature as shown in the figure-1. Due to the presence of amorphous regions in the polymer structure, a huge amount of oxygen and water vapor travels through single polymer film and therefore can not be used for packaging. To overcome this problem, multi-layered (3-11 layers) film structures are being used for flexible pouch packaging. This adds the cost to packaging as well as disposal issues due to non-recyclability. At FCIPT, IPR we have developed a very thin coating ~ 100 nm thickness using plasma process which is able to prevent oxygen diffusion through polymer film. Oxygen Transmission Rate (OTR) value of **virgin polymer** (for this case polyethylene) is **3300 cc/m²/day** and **plasma processed polymer** is **less than 300 cc/m²/day** which is almost 10 times lower. Research is still underway at FCIPT, IPR to further reduce OTR value.

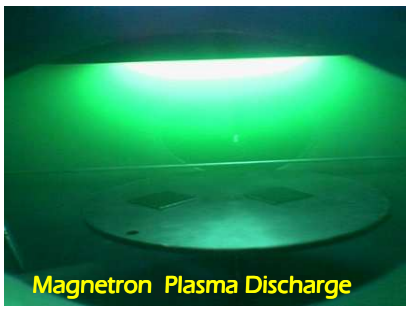


5 layer to single layer polymer with Low Oxygen Permeation Rate using Plasma Process

Mr. Ramkrishna Rane
Scientist – SE , FCIPT-IPR
ramu@ipr.res.in

TiN coating for Better Aluminum Joints

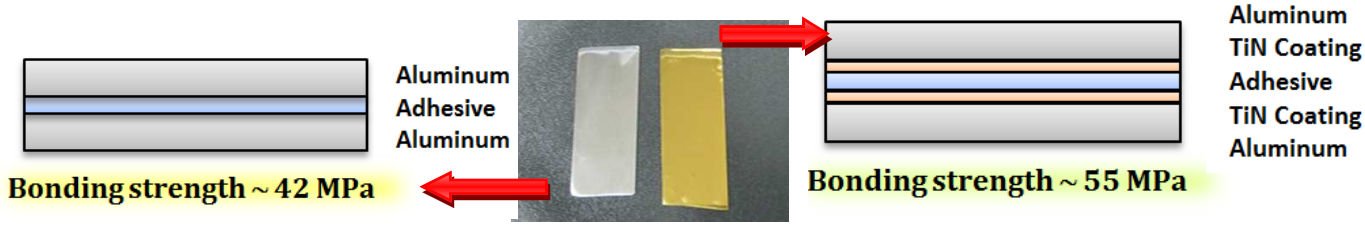
Aluminium (Al) is widely used material in the aerospace industry due to its low weight. Al alloys have found applications as liquefied gas storage tanks in supersonic as well as civil aircrafts, wing spars, floor beams, engine pylon support structures, extrusions and castings, skin of wings and other parts which demand low weight and resistance to corrosion. Since Al components are often joined by adhesives rather than by welding or riveting in order to prevent stress concentration and improve fatigue life, effective structural bonding between two Al surfaces is very important.


Magnetron Plasma Discharge

The hardness, corrosion and wear resistances of Al alloys are inferior to those of steel or titanium. Hence, it becomes important to modify the Al surface in order to improve these properties. Titanium nitride is a very hard ceramic material and thus coating of titanium nitride is useful for improvement of corrosion resistance and wear of Al, steel and titanium alloys. Due to these properties, TiN coating is useful to improve Aluminum surface properties to make it suitable under aerospace climatic conditions.

In the present work, TiN coating on Al is done using plasma based magnetron sputtering technique. Titanium nitride coating alters the chemical & mechanical properties of the aluminium surface, leading to substantial improvement of the aluminium surface against corrosion. TiN coating on Al surface increases surface roughness significantly, which can be seen from below results. High surface roughness increases effective surface area and thus improves mechanical interlocking between adhesive and TiN coating surface consequently results in higher bonding strength between two Al joints.

Surface Type	Average Roughness (nm)	RMS Roughness (nm)
Bare Aluminium	68	77
Titanium Nitride coated Aluminium	202	224



POPULARIZING PLASMA TECHNOLOGIES...

Seminar on Plasma Technologies at Gujarat Technological University (GTU)

As a part of FCIPT's mission on creating awareness among people about Eco-friendly Plasma Technologies, a seminar was organized on **5th March 2016** at Gujarat Technological University (GTU). Dr.S.Mukherjee, gave a fascinating glimpse of wide spectrum of Plasma Based Applications in introduction. This

Prof. Dhiraj Bora, Director IPR sharing about Fusion as a future energy resource

Dr. S. Mukherjee, Head FCIPT explaining novel applications of Plasmas to students and Faculty of GTU

was followed by detailed presentations on **Plasma Pyrolysis for waste management and energy recovery- Dr.S.K.Nema , Textile Processing– Mrs. Nisha Chandwani, Nano-patterning and Nano particle– Dr.Mukesh Ranjan, Plasma Nitriding—Mrs. Alphonsa** . In conclusion, Dr.Nirav Jamnapara shared about various funding opportunities for collaborative R&D.

Workshop on Advances in Surface Engineering and Welding Technology at FCIPT

ASM International organized a two day workshop about latest development in the field of Surface Engineering and welding technologies. The workshop was conducted on 29th Feb & 1st March 2016 at FCIPT, with an objective to give exposure of Live Plasma Technologies to participants. International speakers Prof. Zoltan Kolozvary,MD-Plasmaterm; Dr. Sudarshan, CEO-Materials Modification ; Dr. Antonello ,Faculty –University of Naples and Presenters from India Dr.S.K.Nema, FCIPT; Mrs. Alphonsa, FCIPT & Prof. Vishwesh Badheka, Faculty PDPU were part of this event.

Prof. Zoltan Kolozvary , interacting with Mrs. Alphonsa & Dr. Gupta during live Demonstration of Plasma Nitriding Technology at FCIPT.

FACILITATION CENTRE FOR INDUSTRIAL PLASMA TECHNOLOGIES

Institute for Plasma Research

Organizes one day workshop on

Thermal Plasmas and its Industrial Applications

In association with

ASM INTERNATIONAL, GUJARAT CHAPTER

Gujarat Chapter

Introduction:

Thermal plasmas are of great technological interest because they are a processing medium with one of the highest energy density, highly concentrated reactive medium and high temperatures. Thermal Plasmas are generally operated in the temperature range between 2000 °C to 20000 °C. These unique properties of thermal plasmas can be used in wide range of applications such as Plasma Pyrolysis, Coal gasification, Plasma spraying, Powder treatment, Chemical Vapor Deposition (CVD), Metal melting, Smelting, Welding, Cutting and in production of variety of Nano Particles such as oxides, nitrides , ceramics and metals .

Date: April 29, 2016

Time: 10:00 – 16:00 Hrs

Click Here ...

REGISTER NOW COMPLETELY FREE!

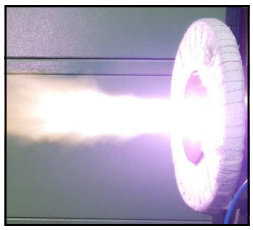
Contact person:

Nisha Chandwani : 079-23269033

Purvi Dave : 079-23269058

Email: fcipt@ipr.res.in

Program Lay-out



Session 1

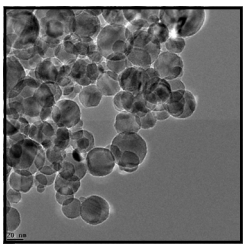
Plasma Torch - Heart of Thermal Plasmas

Session 2

Power of Plasma in Waste Management and Coal Gasification

Laboratory Visit

Plasma Torch, Nano Particle Generation Plasma Pyrolysis and Gasification.



Session 3

Nano Technology and Metal Processing

(Applications of Nanoparticles ; Melting & Smelting)

Facilitation Centre for Industrial Plasma Technologies (FCIPT)

Institute for Plasma Research (IPR)

Plot No:-A-10/B

Sector 25 ,GIDC Electronics Estate

Gandhinagar– 382044

Gujarat

Phone: 079-23269000

Fax:079-23269001

Web: http://www.plasmaindia.com/

Any Questions? Do contact us at fcipt@ipr.res.in or call at 079-23269033 / 23269058