FACILITATION CENTRE FOR INDUSTRIAL PLASMA TECHNOLOGIES
INSTITUTE FOR PLASMA RESEARCH

PLASMA PROCESSING UPDATE

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EDITOR'S NOTE

I am glad to share the 80th issue of Plasma Processing Update, an e - Newsletter with all esteemed readers. The objective of Plasma Processing Update is to increase the awareness about plasma technologies and its industrial / societal benefits among the Indian industries and society. This issue of plasma processing update talks about applications of plasma based organosilicon coatings and our recent experimental results on interaction of cancer cells with plasma using plasma jet.

Prof. S. Mukherjee
Head, FCIPT Division

A team of enthusiastic researchers at FCIPT , IPR are continuously involved in development of various applications using plasma based technologies. I wish all readers are enjoying the updates on these technologies , which is released time to time in the form of a News Letter.

CO-EDITORS

Mrs. Purvi Dave

Mrs. Nisha Chandwani

Inside this issue:

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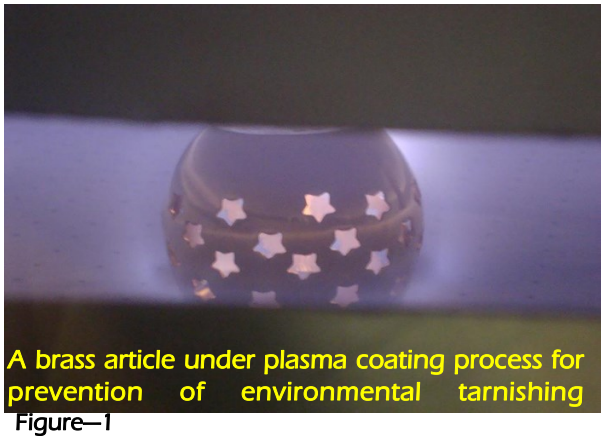
fcipt@ipr.res.in

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

Plasma Based Organosilicon Coatings by PECVD method & its Applications

Organosilicon coatings (SiOx / SiOxNy / SiOxCyHz) are increasingly used for numerous applications ranging from optics, opto-electronics, automotive, packaging, metal's corrosion protection, water repellent coating for textile and polymers, anti—reflection coating for solar cells, biocompatible coatings and many more. Coatings can be deposited using different techniques such as physical vapor deposition (PVD) from a solid primary source (i.e. thermal or e beam evaporation, magnetron or ion beam sputtering etc.), chemical vapor deposition from a gas phase primary source, plasma enhanced chemical vapor deposition (PECVD) from a gas phase source with chemical reactions in a glow discharge environment and other vacuum and non-vacuum techniques such as sol-gel, flame hydrolysis, electrochemical and electroless deposition, cold spraying etc.

Among the above processes, PECVD has received particular attention as it is 'dry' solvent less technique. Organosilicon coatings are deposited by PECVD method under vacuum using volatile precursors like silane (SiH_4), Hexamethyldisiloxane (HMDSO), Tetramythyldisiloxane (TMDSO), Tetraethoxisilane (TEOS). The plasma fragments the precursor molecules and depending on the deposition conditions, a wide variety of film chemistries are achievable , from highly organic organosilicon coating (with high carbon content generally > 30%) to a silica like coating (carbon content < 10%). PECVD offers some potential advantage over wet coating processes such as reduced curing requirements and reduced amount of volatile organic by-products.



A brass article under plasma coating process for prevention of environmental tarnishing
Figure—1

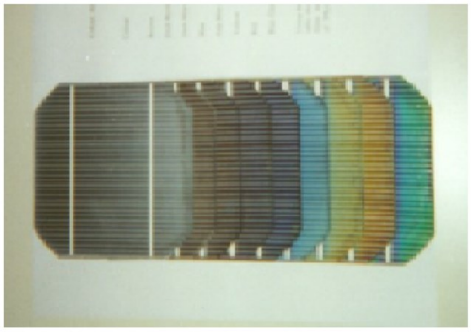
Figure—2 plasma coated brass articles

At FCIPT, IPR organosilicon coatings have been deposited for various applications. These applications are anti-reflection coating on silicon solar cells, protective coating on headlight reflectors, protective coating on silver mirrors, oxygen diffusion barrier for packaging polymers, water repellent coating on silk fabric, jute fabric, polymer films etc.

Plasma Based Organosilicon Coatings by PECVD method & its Applications ….Continue….

Inorganic Organosilicon Coatings With Hydrophilic Nature

Inorganic / glass like organo silicon coatings with less carbon content in the film chemistry can be deposited using PECVD method by adjusting process parameters from organosilicon precursors mentioned before. Such coating is highly cross-linked and behaves as a oxygen and moisture diffusion barrier to the substrate material. Which protects metals such as brass, aluminum, silver, copper etc. from tarnishing. This coating is also used as anti-reflection coating on solar cells which helps to improve the efficiency.



Figure– 3 SiOxNy coating on Solar Cell

Figure-4 SiOx coating on Aluminum Reflector

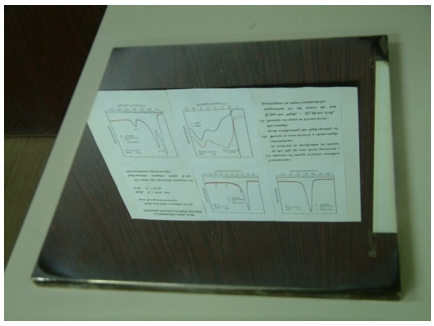
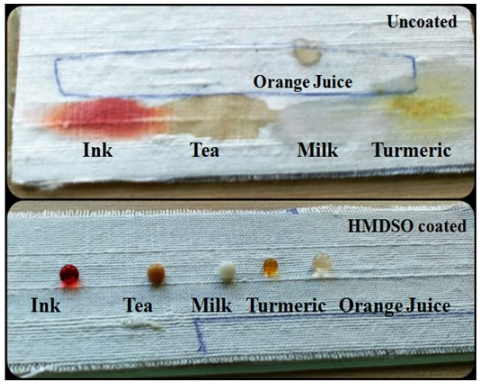


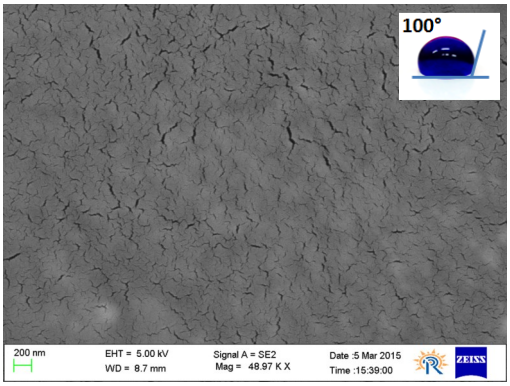
Figure –5 SiOx coating on Silver Mirror

Organic Organosilicon Coatings With Hydrophobic Nature

Similar way by tuning of process parameters organic coating with higher carbon contents can be deposited by the same method and using same precursor. Such coating has hydrophobic nature and thus repels water. This has promising applications in the field of polymers and textiles. In figure –6, droplets of ink, tea, milk, turmeric , orange juice etc. are put on untreated and pp-HMDSO coated silk fabrics. We can see that in the upper image, all of them get absorb where as in the lower one they do not absorb at all on plasma coated fabric surface. Figure –7 is untreated polyethylene surface scanning electron micrograph which shows water contact angle of 100 ° where as figure—8 is plasma coated polyethylene surface and which is hydrophobic due to plasma based coating.



Figure– 6 Hydrophobic plasma coated Silk fabric



Figure—7 untreated polyethylene

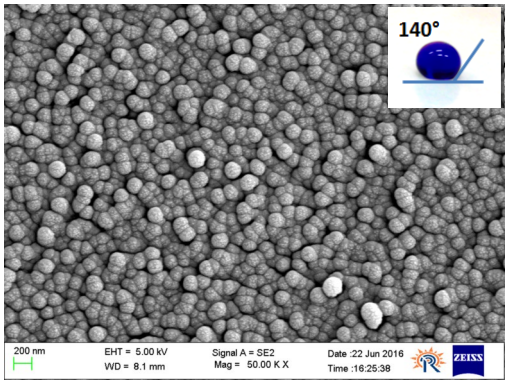


Figure –8 Plasma coated polyethylene

Akshay Vaid
Scientist - SD, FCIPT –IPR
akshay@ipr.res.in

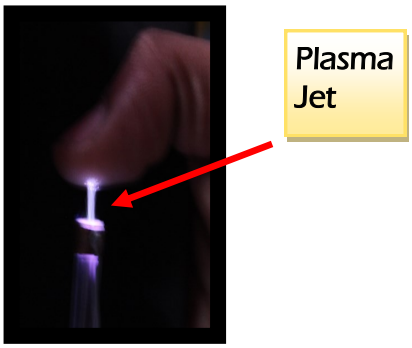
Interaction of Cancer cells with non-thermal plasma jet

Cancer is the for most disease in the world these days. As the general treatment procedure, chemotherapy, radio therapy and surgeries are the means by which the cancer can be controlled, but in many cases even after the treatment, cancer regenerates and proves to be fatal. Many number of new drugs are being made available in the world to fight against cancer and some proved to be beneficial to control up to some extent. As a result of which new treatments are explored.

One such method is non-thermal plasmas. These plasmas are produced at atmospheric pressure at room temperature.

IPR has developed plasma jet which can be used for various applications. IPR with BSG group, BARC is working on plasma jet to study its interaction with lung cancer cells.

Fig-1 shows the plasma jet so developed.



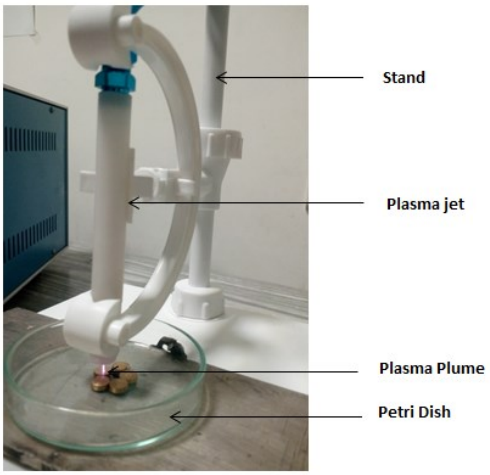


Figure - 1 Plasma Jet Developed by FCIPT, IPR

Fig-2 shows the relation between cells viability vs. plasma treatment and helium gas treatment.

The cancer cells are treated for the various time intervals such as 2 min, 5 min and 10 min.

It has been observed that the cell viability goes to about 50% after 5 minutes of helium plasma treatment.

Further experiments will be carried out in the form of Direct treatment of cancer cells with plasma jet after growing on petri dishes and check for viability.

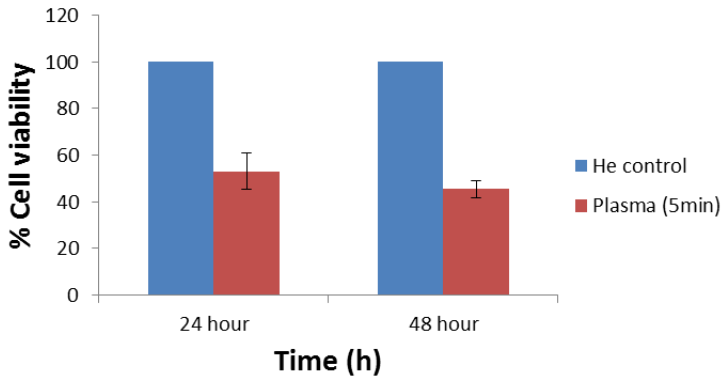


Figure - 2 Experimental Results

Nano-Powder Production Tech. Transfer

Nanotechnology is the enabling technology for next generation advanced machines and processes. FCIPT's efforts have been focused on developing industry specific nanotechnologies using plasma technology. One such technology is nano-powder production technology developed at Institute for Plasma Research, FCIPT Division. Based on the interest of an Ahmedabad based company M/s Vishal Engineers & Galvanizers Pvt. Ltd. (VEGPL), a non-exclusive Technology Transfer agreement was signed by and between IPR and VEGPL on 14th June 2017 at IPR, Bhat, Gandhinagar premises. The agreement was signed by Mr. Vikalp Joisar, Director, VEGPL and Shri A. Varadarajulu, Chairman, SPC, IPR in the presence of Director, IPR. A photograph of the event along with the technology developer team is attached.

Campaign for Plasma Nitriding at Nagaland

With the assistance of Department of Science and Technology (DST), New Delhi, a new advanced process called radical nitriding process has been developed in FCIPT. In this process, the material which is at floating potential is kept in a cathodic cage having many holes. Plasma of nitrogen/hydrogen gas mixture is formed on the cathodic cage. The active species are released from the plasma and get deposited on the material which than diffuses in to the material with time. As a result, the surface hardness of the material increases without leading to any significant change in surface roughness. This technology can help the industry for reducing the operating cost of process and retaining the sharpness of the cutting tools which is a very effective factor for the cutting industries. We have demonstrated this process on agricultural cutting tools supplied by DST, Nagaland and found that there was a factor of increase by three compared to the conventionally plasma nitrided components. In order to propagate this technology, which was one of the objectives of this project, two campaigns were held in Dimapur and Kohima in Nagaland.

Contact us:

Facilitation Center for Industrial Plasma Technologies

Institute for Plasma Research

A-10/B, Electronics Estate, GIDC, Sector-25

Gandhinagar, Gujarat, India

079-23269033 / 17 fcipt@ipr.res.in www.plasmaindia.com