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**PSSI Workshop On "Physics & Fusion Technology Programmes On Tokamak ITER : An Indian Perspective"**

**First Announcement**

The year 2005 - 2006 has been a very special year for the Indian Fusion Community when India joined the ITER project as a full partner. An introduction about the ITER project has already been published in our Newsletter (see Vol.20, No.3).

Keeping this in view, the Plasma Science society of India (PSSI) is planning to organize a workshop on "Physics and Fusion Technology Programmes on Tokamak ITER : An Indian Perspective" sometime during August/September 2006. One of the prime objectives of the workshop is to bring together people working in Indian Universities and Institutes in the area of physics/technology which are and could be of relevance to Fusion. This includes areas in which our National fusion programme would evolve and in which India would be interested in utilizing the capabilities of a tokamak like ITER (once it is commissioned) for research campaigns. For this purpose, PSSI wishes to develop a definite research plan and encourage interactions within various groups existing in India who are working in areas which are relevant to Fusion and/or which seek offshoot of fusion technologies for their research objectives. To initiate an activity with such an objective, the following areas have been identified:

- (I) **Basic Physics studies :**  
(i) MHD (ii) Energetic particles (iii) Transport (iv) Pedestal region (v) Divertor Physics (vi) Diagnostics (vii) Steady state issues.
- (II) **Enabling Technologies :**  
(i) Magnets (ii) Cryogenics (iii) RF systems (iv) Plasma Control (v) Neutral beam and ion sources.
- (III) **New materials :**  
(i) New materials for high heat flux handling on the divertor and first wall of fusion reactors (CFC, Be-coated Tungsten etc.). (ii) New materials for anti corrosive coatings meant for tritium-breeding blankets of the liquid-Lithium type and new structural materials based on SiC and its fibres, ceramic pebbles for solid-type fusion blankets.
- (IV) **Exploiting Nuclear Techniques :**  
Development of novel diagnostic concepts, transmutation studies to search for low or reduced activity materials and alloys, material damage studies at high thermal cycle (e.g. ductile - to - brittle transition temperatures at micro and macro levels).

(Cont ...)

**E-mail:** info@pssi.in

**http://www.pssi.in**

**Plasma Science Society Of India**

(Regn. No. F-828, Ahmedabad)

**Institute For Plasma Research, Bhat, Near Indira Bridge  
Gandhinagar 382 428, Gujarat**

**Tel : 91-79-23969031-35**

**Fax: 91-79-23969017**

PSSI is aiming at organizing a 3-day workshop, in which a series of talks will be given by experts in these areas. It is also being planned to identify separate working groups who can formulate and initiate activities in definite research plans and all/some of these areas.

Professor P. K. Kaw, the Director of Institute for Plasma Research has kindly given his consent to host such a workshop at IPR. We would soon make available further details about the workshop on our web site. Please watch the PSSI website for further information. PSSI members are requested to actively participate in this workshop.

**Facilitation Center For Industrial Plasma Technologies,  
Institute For Plasma Research, Gandhinagar**

**&**

**The Plasma Science Society Of India**

**Announces a Two day Meet on**

**PLASMA PROCESSING – INDUSTRY INTERACTION**

**27-28 July, 2006**

**Facilitation Center for Industrial Plasma Technologies (FCIPT), Institute For Plasma Research (IPR) and the Plasma Science Society of India (PSSI) are jointly organizing a two day meet on “Plasma Processing – Industry Interaction” from 27 – 28 July 2006 at the Institute For Plasma Research, Gandhinagar.**

**The meet is intended to make the participants from the industry aware of the advantages of plasma based technologies which has proved to be one of the most innovative technologies compared to the other techniques used today.**

**Eligibility** Entrepreneurs, Industry and R & D representatives, Employees interested in gaining more knowledge on this subject.

**Registration Fee** Participation fee for the course are as follows : Participants from R & D establishments & Industries **Rs. 4000/-** per head. The registration fee covers course materials, lunch and tea on both days of the meet. Registration fees should be paid by Demand Draft, payable to PLASMA PROCESSING-2006 at the State Bank of India, Ahmedabad-Cantonment Branch.

Last date for receiving application is **15 June 2005**. The number of participants is limited to **40** only (on a first come, first serve basis). **Interested participants may apply with their company details and the objective for participating in this meet. The participants will be invited personally upon screening of the request.**

**Contact** For further details, kindly contact : Ms. Alphonsa Joseph, Scientist, FCIPT.

**E-mail :** <[alphonsa@ipr.res.in](mailto:alphonsa@ipr.res.in)> **Tel :** 079-23235018 **Fax :** 079-23235024

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

For further details and updates, please also visit the PSSI website : <http://www.pssi.in>

**Newsletter Content : Contributions From Members**

In spite of repeated requests, members do not seem to be forthcoming in submitting articles for publication in this Newsletter. I once again request the esteemed members to generously contribute towards the contents of this Newsletter. I would also request you to use this forum and media to highlight the plasma related research work being carried out by your Institution. Please see the PSSI webpage on how to submit articles for the Newsletter ..... Editor

<http://www.pssi.in/Main%20html/NL/index-nl.php>

## Report Of The PLASMA-05 Conference Held At Cochin University Of Science & Technology, Cochin In December 2005

Amita Das, Secretary, PSSI

The PSSI 2005 symposium was held in the city of Cochin at the International School of Photonics (ISP) from 5th to 7th December 2005. This is the first time that a PSSI symposium was held in Kerala. Professor P. Radhakrishnan from ISP Cochin University Of Science & Technology, Kochi, was the convener of the symposium. The focal theme of this symposium was chosen as 'Ultra fast Optical processes'.

The Keynote address of the symposium was delivered by Professor Abhijit Sen, the Dean of the Institute for Plasma Research (IPR), Bhat Gandhinagar on "*Coherent nonlinear structures in laser plasma interactions: physics and applications*". There were 5 Plenary talks in which certain frontier research activities in various specialized fields of Plasma Physics and Technology were reviewed, and around 8 invited talks discussing the current research trend in this area within the country. The PSSI EC this year too emphasized on the choice of young and active research scientists for the plenary and invited talks to the extent it was possible. There was an overwhelming participation in the symposium which could be gauged from the 250 contributory papers in the symposium. These papers were presented during the three poster sessions and a few (around 30) 10 minutes oral presentations. The selection of oral contributions were largely on the basis of giving adequate representations to various institutions/colleges in the country.

The PSSI objective of giving opportunities to the younger generation of scientists within the country and encouraging those coming from small universities/colleges were adhered to by the PSSI office bearers. The selection for oral contributions and providing travel allowance to the participants were made keeping this in view. This year since the number of participants who finally sought travel support turned out to be small, PSSI executive committee (EC) decided to waive the registration fees also for some of them.

The competition amongst young scientists for the Buti award for best presentation has been introduced since the last PSSI symposium at Jhansi. This year too it was successfully held. There were 7 presentations in this session. The paper on "*Power balance at cathode in glow discharges*" by Mr. K. S. Suraj from IPR was adjudged to be the best by a panel of judges.



Mr. K.S. Suraj receiving the Buti Young Scientist award for the year 2005 from Professor B. Buti.

Other added attractions of this year's symposium were the boat trip in the backwaters of Kerala and a cultural evening introducing the participants to the folk music and dance of Kerala. On behalf of the PSSI the EC office bearers thanked the Convener and his team in the General Body Meeting and also during the concluding session for taking the initiative of organizing the PSSI symposium in Cochin and for the success of the symposium.

Certain issues which were not well received by the participants is also worth pointing out here to avoid their recurrence in future. The local organizing committee (with consent from PSSI EC) had this year tried two new variations in the structure of the PSSI symposium. The duration of the symposium was reduced from the usual 4 to 3 days this year. A special tutorial session was held by the local organizers for

students and younger participants a day ahead of the symposium to acquaint them with some preliminary concepts. However, both these changes did not seem to go very well with the participants. The general opinion was that the sessions were excessively packed due to lack of time. The participants also indicated that some topics such as space and astrophysical plasmas were rather poorly represented in this symposium. Furthermore, though the concept of the tutorial session was appreciated by the participants, there was a general feeling that it could have been planned better. Although an entire day was dedicated to the tutorial session, there were only two lectures. Also the timings of the lectures were preponed with no prior announcements.

There were certain disturbing revelations made by the Convener (Professor P. Radhakrishnan) at the concluding session of the symposium. He mentioned receiving 'threatening calls' from some of our colleagues within the plasma physics community who questioned the basis of selection of the papers for oral presentations and were demanding that they be given a chance for oral instead of poster presentation. The EC expresses grave concern over this issue. The EC is also extremely shocked to learn that some of our esteemed plasma physics colleagues would go to the extent of making 'threatening calls' to the Convener over this matter. The EC deplores this kind of action and takes a strong note of this.

Some issues raised at the concluding session concerned (i) restricting the symposium duration for three days only (this was tried for the first time in the Cochin PSSI 2005 symposium) (ii) need for holding parallel sessions to accommodate all aspects of plasma science and technology in three days (it was pointed out by some PSSI members that in the Cochin symposium the space and astrophysical plasma had a very meagre representation) (iii) the policy of accommodating majority of papers for oral presentations. The EC discussed these issues in a meeting convened at



The Vice-Chancellor, CUSAT inaugurates the symposium by lighting the lamp.

IPR on 16th of December 2005 and arrived at following conclusions: (i) A duration of three days puts severe constraint on smooth conduction of the symposium. In fact it makes the program too packed. In the presence of a large number of contributions, it necessitates parallel sessions. (ii) Parallel sessions are not preferable in a small group such as ours, and in view of the fact that majority in the plasma research community have interest in all interdisciplinary aspects of plasma science. (iii) The EC felt that the poster presentation should be given more prevalence.

The EC members felt that there was a need to provide a continuity in the organizational structure of the PSSI symposium. Each year the Convener being different (in some cases he/she does not even have much exposure by

the way of attending any past PSSI symposia) issues of similar nature crop up which need to be avoided. The PSSI executive committee members also change every two years. This necessitates for a formulation of a set of written guidelines to help the organizers. It was further decided to separate the programmatic and the organizational aspects of the symposium. The scientific program of the symposium would be organized by a 'Programme Committee' appointed by the National Advisory Committee. It was suggested that the Convener (or one representative from the local venue), and some PSSI office bearers be chosen as the members of the 'Programme Committee' along with other members nominated by the National Advisory Committee.



View of the podium during the inaugural function of Plasma-2005.

**Members may please intimate PSSI regarding changes in their postal address/e-mail by visiting the PSSI website and using the on-line member-data update facility.**  
<http://www.pssi.in>

This committee would be responsible for the selection and correspondence with the speakers, screening of contributions and selection for oral/poster presentations, approval for travel allowance (TA) for the young participants etc. The Local Organizing Committee would be responsible for all organizational details of the symposium. The guidelines will be put up on web soon.

The PSSI EC takes this opportunity to welcome everybody to the next PSSI symposium in 2006 in Jaipur at the Malviya National Institute of Technology (MNIT). Professor R. P. Dahiya, the Director of MNIT has kindly given his consent to organize the conference at MNIT. The first announcement of the symposium would be dispatched to the PSSI members in a couple of months time.



Professor Abhijit Sen delivering the keynote address



Release of the Conference Souvenir. L-R : Prof. P. Radhakrishnan, Prof. Abhijit Sen, Dr. P.K. Abdul Azis, Prof. C.P.G Vallabhan, Dr. Amita Das. Mr. P.K. Atrey and Prof. V.P.N.Nampoori.



Poster session in progress



Interactions during the poster session

## PLASMA-2006

The 22<sup>nd</sup> Plasma Science & Technology Symposium (PLASMA-2006) will be held at the Malaviya National Institute Of Technology, Jaipur from **19-22 December, 2006**. More details will be posted on the PSSI website soon.

# Plasma Diagnosis For Controlling Growth Of Thin Films

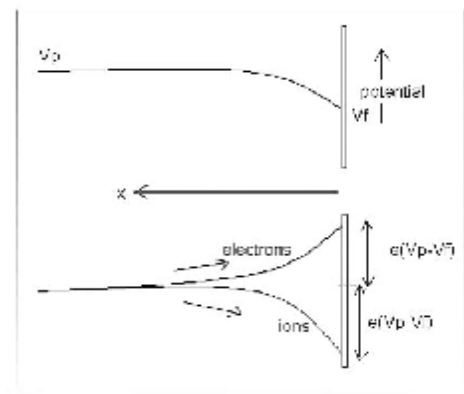
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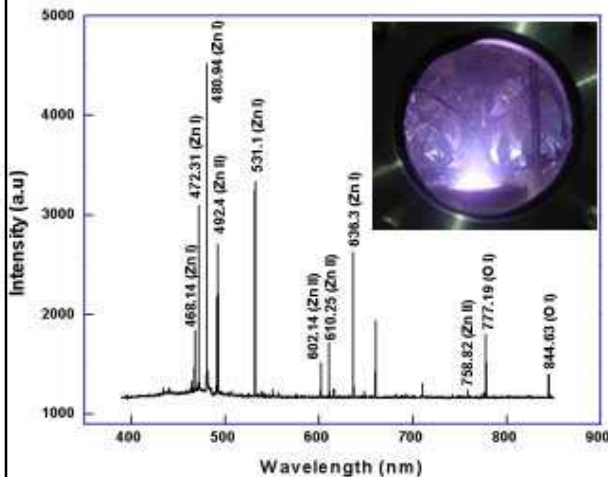
Knowledge of the plasma parameters and the variety of atomic species in different energy states present in the plasma is of great advantage in the growth of thin films using plasma assisted film deposition. Optical emission spectroscopy and Langmuir probe technique can be effectively used to map the plasma properties both spatially and temporally with very good accuracy. Plasma generated by pulsed laser ablation and rf magnetron sputtering have been rigorously analyzed using the above two techniques and the optimum conditions favorable for high quality film growth have been suggested.

When an electrically isolated substance (here substrate for film deposition) is introduced in to the plasma, the electrons present in the plasma will strike the substance first owing to its very high velocity compared to that of ions and neutral atoms. Since the electron current density ( $J_e$ ) is very much greater than the ion current density ( $J_i$ ), the substrate immediately starts to build a negative charge and hence -ve potential with respect to plasma. Immediately the quasi-random motions of the ions and electrons in the region of our object are disturbed. Since the substrate gets charged -vely, electrons are repelled and ions are attracted. Thus the electron flux decreases, but the object continues to charge negatively until the electron flux is reduced by repulsion just enough to balance the ion flux. The plasma is virtually electric field free, except around the perturbations, and so is equipotential. Let us call this potential as plasma potential  $V_p$ . Similarly there associate a floating potential  $V_f$  with the isolated substrate. Because of the charging of the substrate, it is as though a potential energy 'hill' develops in front of the substrate. It is a down hill journey for ions from the plasma to the substrate, but uphill for the electrons. The magnitude of  $V_p - V_f$  represents a barrier to electrons. To surmount this barrier, an electron must acquire  $e(V_p - V_f)$  of potential energy. Hence only electrons that enter sheath from the

plasma with kinetic energy in excess of  $e(V_p - V_f)$ , will reach the substrate. In practice, the sheath



Variation of electrical potential (upper) and the potential energies of electrons and positive ions (lower) in the vicinity of an electrically floating substrate.



Optical emission spectra of ZnO plasma during laser ablation. Inset shows the picture of ITO plasma during RF sputtering.

above an electrically isolated substrate varies from one or two volts upwards. The resulting kinetic energies must be compared with inter-atomic binding energies in a thin film or an etching process on an electrically isolated surface in the plasma, and might be much affected by ion impact. We used a RF compensated Langmuir probe for analyzing different plasma parameters when indium tin oxide (ITO) thin films are deposited by RF sputtering. In our analysis,  $V_p - V_f$  is found to be decreasing with increasing RF power. This is a favorable condition for film growth since the damage due to ion impact is less in this case [1]. More number of

particles in the plasma with sufficient thermal energy at high RF powers also favors the film growth. Optical emission spectroscopic (OES) studies are carried out on laser ablated zinc oxide (ZnO) plasma plume to identify the different species present in the plume and to study the spatial variation of electron density and temperature [2]. Relative population variation of different species with distance from the target surface and the effect of ambient oxygen gas pressure are also studied. Analysis shows that to obtain stoichiometric crystalline ZnO films the target is to be ablated in the presence of oxygen ambient gas and the substrate should be placed at a few centimeters away from the target. There is a pressure-distance and pressure-temperature scaling (lower pressure at large distance as well as at higher temperature) in order to obtain crystalline ZnO films.

[1] M. Nisha, K.J Saji, R.S Ajimsha, N.V.Joshy and M.K *J.Appl.Phys.*, **99**, 033304 (2006).

[2] K.J. Saji, N.V.Joshy and M.K.Jayaraj, To appear in *J.Appl.Phys.*

## A Fast Responding, High Current IGBT Inverter Power Supply for Vertical Stabilization of SST1 Plasma

A. Varadarajulu,  
Institute For Plasma Research, Gandhinagar

The control of vertical position by the active position control (APC) coil of the plasma in SST-1 requires a fast responding, high current, four-quadrant (dual current and voltage polarity) inverter power source. A base line topology with ac-dc rectifier input stage followed by full-bridge, IGBT-based, dc-ac inverter output stage suitable to deliver  $\pm 12$  kA at  $\pm 50$  V on the coil with a random perturbation frequency up to 100 Hz was decided based on simulation results from the physics modeling. Other critical requirements include fast responding controller (within 100 msec.), high current slew rate (up to 1 MA/sec.) and precise regulation and stability (within 0.1 %). This source is of unique kind as it combines very high inverter output current, fast control response and exceptionally high slew rate.

Veeral Controls, Gandhinagar, Gujarat executed the power supply as a total system. The ac-dc rectifier is a SCR controlled unit in a standard 12-pulse configuration and water-cooled design for compactness. The rectifier is rated for 9 kA continuously up to 150 V dc output. With IGBTs of moderate current rating of 400~600 A as the prescribed choice and for a high current rating of 12 kA the dc-ac inverter stage requires a large number of modules in parallel; 72 modules in this case. It is a difficult engineering task to accomplish the specified parameters of fast response and current ramp rate amongst such large number of physically distributed inverter modules. Several electrical, mechanical and thermal issues in the static and dynamic conditions are of concern. They have hence ironed out all these issues and has achieved commendable output performance – viz. a) capability to ramp at 1.7 MA/s as against 1 MA/s rate specified on rated load, b) ability to handle a maximum current of 18 kA as against 12 kA specified for the rated duty with all modules are operating at nominal current, c) ability to adapt to flexible device switching speeds (2.5 kHz to 7.5 kHz) to achieve a wider output bandwidth for random plasma vertical perturbation within the thermal dissipation limits of the modules, d) dedicated inter-module Ethernet bus and embedded module digital controller with optic connectivity to achieve fast and reliable control response, and e) highly symmetrical physical arrangement and distribution of electrical and thermal parameters to achieve a stable performance. The power supply is delivered and installed at the Institute and all performance tests were carried in a similar nature dummy nature.



IGBT-based Inverter Power Supply for SST1 Plasma Vertical Position Control. (A) SCR Controlled AC/DC Converter with Filter Choke. (B) Dry type converter transformer. (C) IGBT-based DC/AC Inverter Stacks. (D) Water cooled inductive test load.



Individual module of the inverter stack –One of the 72 modules, retracted out for access - Each module includes DC CAPs, IGBT Inverter, Embedded Digital Controller with Ethernet.

For further information, contact :  
<avraju@ipr.res.in>; <vcpl@icenet.net>



Plasma-2005 : A section of the audience



Plasma-2005 : Poster session in progress

### From the Editor's Desk

This listing of plasma science and engineering conferences is sponsored by the *Plasma Science and Applications Committee* of the *Institute of Electrical and Electronics Engineers*. It is intended both to inform the plasma research community of relevant professional meetings and to assist conference organizers in avoiding schedule conflicts. Thus, listings from the past are retained as a guide to the future. Organizers are encouraged to submit information about their conferences as early as possible, even if incomplete.

[http://ewh.ieee.org/soc/nps/PlasConf/plasma\\_meetings.html](http://ewh.ieee.org/soc/nps/PlasConf/plasma_meetings.html)

### PSSI Fellowship

Applications are invited for the PSSI research fellowship for the year 2006, from research scholars wanting to pursue collaborative plasma-related research work at any national institute/university. Please see the PSSI website for details regarding this fellowship. You may also contact [info@pssi.in](mailto:info@pssi.in) if you have any queries.

<http://www.pssi.in/Main%20html/scholarship/scholarship.php>

### GBM Decision On Memberships

The PSSI-GB has decided to do away with the various kinds of Individual memberships. From January 2006, only Life Membership (one-time payment of Rs.800/-) would be available for individuals. **Students however, can avail the membership at a yearly rate of Rs.200/- On completion of FOUR consecutive years of student membership, the membership will be converted automatically to Life membership.** The Institutional and Donor membership schemes remain unchanged. Please see the PSSI website for further details.

<http://www.pssi.in/Main%20html/member/category.php>

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