Facilitation Centre for Industrial Plasma Technologies
Institute for Plasma Research

Plasma Processing Update

Issue 81 Oct 2017

Editor

Dr. S Mukherjee
Division Head, FCIPT

Co-Editors

Purvi Dave

Nisha Chandwani

Kushagra Nigam

Inside this Issue

Articles

Image Processing for Anode Spot Analysis
An Image processing based algorithm that 2

Know The Genesis, Evolution &Anatomy Of The Processing Plasma Using Light Emissions 3

Plasma Nitriding for spacecraft components
ISRO Inertial System Unit (IISU) using plasma Nitriding technology for space applications 5

Upcoming Events & Interactions

PTBT-2017
Plasma and Allied Technologies for Better Tomorrow 7
7th - 8th December 2017

Past Events & Interactions

Textile India –2017,Gandhinagar
Parliament Exhibition, New Delhi
Indian National Exhibition-Cum-Fair 2017, Kolkata 8

Kushagra Nigam
Scientist-SC
IPR,FCIPT
kushagra.nigam@ipr.res.in

Important Highlights

- **Image processing provides a reliable method for accurately measuring spot dimensions.**
- **Algorithm is highly flexible for analyzing various possible structures that can be formed in plasma.**

Image Processing for Anode Spot Analysis

Plasma offers interesting phenomenon for study. One of the limiting factors in Plasma Characterization is lack of direct contact with the medium. If we were to analyze various structures formed in a simple liquid say oil or water one could analyze those structures by direct contact. Unfortunately this is not the case with plasma owing to the extreme conditions under which it is formed.

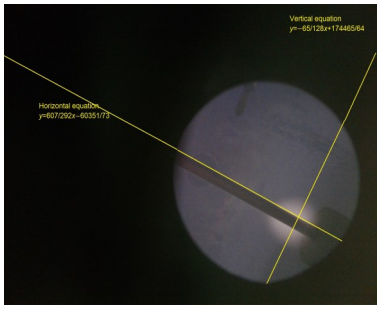
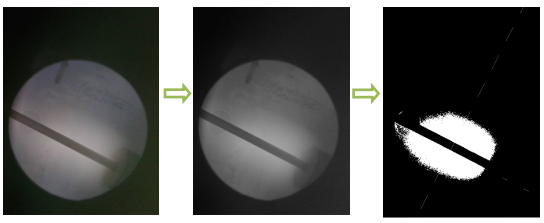


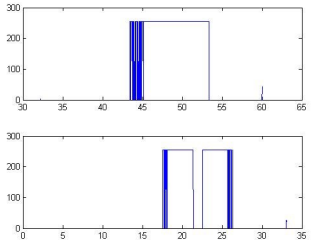
Image with Reference Axes

One of the interesting structures that we see in plasma is Anode Spot. It develops in a typical range of magnetic field for a given voltage and pressure. What is interesting is to see how the shape of this spot evolves as one changes magnetic field. The main challenge is to accurately measure the dimensions of the spot.

We have developed an Image processing based algorithm that offers a reliable way to accurately measure spot dimensions. The idea is to get a reference object (in this case central rod) dimension as an input from user. This reference dimension is then used to calculate all other dimensions. To achieve this, we first convert an RGB image to a grayscale image matrix. The gray image is then thresholded for a fix intensity value. Then we select our reference object and find out it pixel length. The pixel length is then extrapolated to object dimension.



RGB Image | Gray Image | Threshold Image



Dimensions along reference axes

Know The Genesis, Evolution & Anatomy Of The Processing Plasma Using Light Emissions

Ms.P.Bharathi
Scientist –SF
IPR-FCIPT
bharathi@ipr.res.in

Important Highlights

- **Non invasive technique (does not disturb plasma)**
- **Easy to perform .**
- **Diagnostics is not much affected by Electromagnetic noise .**
- **Good spatial and temporal resolution**
- **With efficient data analysis tools, every thing about the processing phenomena can be understood.**

It is now understood that 99% of the visible universe is made of a fourth state of matter called "plasma" which was first identified by William Crookes using the light emissions produced by the cathode rays. Since then plasmas are percieved (seen/felt) and studied by the light they emit. The low temperature plasmas having electron temperature Te < 10eV, used for industrial applications, contain a cocktail of reactive species: ions, electrons, atoms, molecules and radicals and categorized as thermal and non-thermal plasmas. In case of thermal plasma, the electrons and heavy particles are at the same temperature while in later case, they are at different temperatures.

For the plasmas which are to be used in industrial applications, it is important to understand how these reactive species are produced in the processing chamber (genesis) and transported from their birth point to a zone where they interact with the material, medium, living cells or tissues etc which are being processed (evolution). And it is also important to understand different emission zones and estimate the spatial and temporal variation of plasma parameters such as plasma density, plasma temperature, gas temperature, species concentration etc.

Optical emission spectroscopy (OES) is the most commonly used diagnostic technique for studying these processing plasmas. They are non-invasive, simple and relatively low cost in comparison with other diagnostics methods. OES measures the excited level population (intensity) of different ionic, atomic or molecular species present in the plasma. The temporal and spatial variation of plasma temperature and density are derived from the absolute and relative line intensities and the line widths of the spectral lines, respectively. Presence of reactive species can be found out by identifying the observed spectral lines and comparing them with the standard spectral database. While the molecular emissions can be used as thermometers for the measurement of gas temperature of these processing plasma.

For plasmas in thermal equilibrium, interpretation of optical emission spectra is relatively straight forward as the population of the probed energy level of an excited species is related to its final decayed states via the Saha equation and the Boltzmann distribution. For non-thermal plasmas, the characterisation could be challenging. As the strong non-equilibrium makes it difficult to interpret the measured spectra. However, there are several techniques which are specially developed for tackling non-thermal plasmas. At our institute, we have expertise in performing OES, analyse and interpret the data using various data analysis tools (suite of programs). In the following figures, example spectra and results for plasma torch (thermal plasma) and plasma jet (non-thermal) plasma are presented.

OES needs : Spectrometer, light coupling lenses and fibers and data processing tools for analysis

Outcome of OES: Identification of reactive species , spatial and temporal variation of plasma parameters.

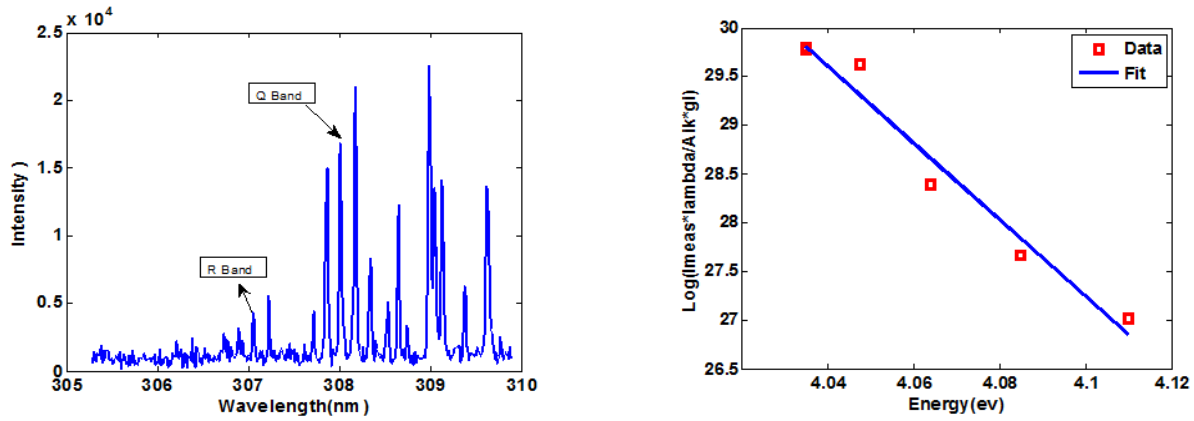


Figure.1:The OH band is used for gas temperature measurement by Boltzmann plot technique. The temperature at 2.72kv and 15lpm is found to be at room temperature ~300 K .

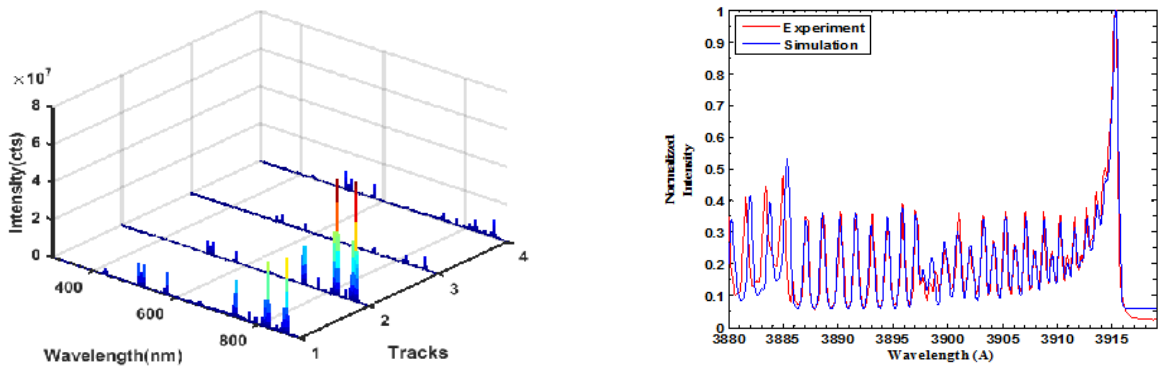


Figure.2.The Nitrogen(N2+)0-0 band at 391.5 nm is used for gas temperature measurement using band simulation method. The temperature of the torch when operated at 95 A and 30lpm is found to be at ~7000K .

Dr. Alphonsa Joseph
Scientist-SG
IPR-FCIPT alphon-sa@ipr.res.in

Team Members

1. Dr.Alphonsa Joseph
2. Mr.GhanshyamJhala
3. Mr.AkshayVaid
4. Mr.NareshVaghlea
5. Mrs.KeenaKalaria
6. Mr.ChirayuPatil
7. Dr.Suryakant Gupta
8. Mr. Vijay Chauhan
9. Dr. S. Mukherjee

Plasma Nitriding for spacecraft components

Plasma nitriding is a surface hardening process done on precision mechanisms elements undergoing relative motion, in order enhance their life, reduce wear and to ensure stringent performance quality throughout their life. The spacecraft mechanisms, like Solar Array Drive Mechanisms, utilize gear systems to transform and transmit motion. As these components need to perform their indented operation without degradation, they need to be wear resistant during their entire life cycle.

The Solar Array Drive Mechanism gears are usually made of 17-4 PH stainless steel and fabricated to a class of AGMA 13 (DIN 5) quality through precision gear grinding process. Considering the mission requirements from these spacecraft systems it was realized that,plasma nitriding process could be used for surface hardening.

Figure 1 : Plasma Nitriding System

FCIPT a division of IPR has done considerable research and arrived at the optimum process. FCIPT is now providing service to get the gears plasma nitrided. The typical components that are nitrided using this facility are: Spur gears, motor shaft, gear shaft, ring, sun, planet and outer gears.

Considering the increased demand on the quantity of components to meet the enhanced mission needs, it was realized to establish a plasma nitriding facility at IISU. The space quality plasma nitriding system was built for IISU as per the specifications laid down by them as shown in Fig. 1. The pre-dispatch of the system has been carried out by IISU Engineer, and the system is ready to be dispatched for installation and commissioning in IISU, Trivandrum.

Upcoming Events

PTBT-2017

Plasma and Allied Technologies for Better Tomorrow

7th - 8th December 2017

Introduction of Conference

The two day conference on "Plasma and Allied Technologies for Better Tomorrow" is being organized to show case technologies mainly aiming to enhance the quality of life. The presentations will emphasize on societal and industrial applications viz. health care, agriculture, food, water and waste management. This conference will help in meeting the main objective of our organization which primarily focuses on translating the research findings in to tangible deliverables so as to reach the common people. Finally it will also act as a platform for not only disseminating green technologies but also to fulfill the initiative of "Swachh Bharat Abhiyan" and "Make in India".

Conference Topics

Plasma Medicine

Medical diagnostics

Surface Modification

Hard Coatings

Plasma in agriculture

Waste management

Plasma Sterilization

Textile applications

Nano science

Food preservation

Water purification

Organic solvent Disposal

Venue:

Institute for Plasma Research,
Bhat Village, Near Indira Bridge,
Gandhinagar -382 028,
Gujarat, India

Tentative Speakers

Dr. H. Barshilia (NAL)

Mr. R. Rane (IPR)

Dr. M. Ranjan (IPR)

Dr. P.B. Jhala (NID)

Dr. S.K. Ghorui (BARC)

Dr. A. Mukhopadhyay (CGCRI)

Dr. S. Mukherjee (IPR)

Dr. S.K. Nema (IPR)

Dr. S. Maiti (CSMCRI)

Dr. L. Varshney (BARC)

Dr. Venkatramni (PlasVac)

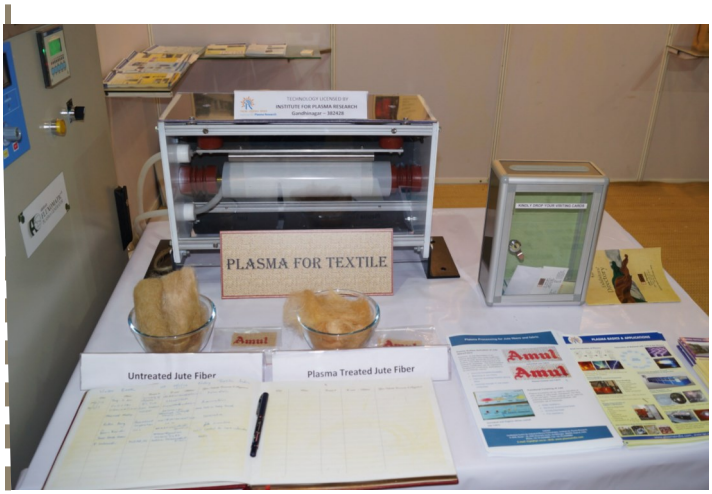
Dr. S. Kar (IITD)

Past Events

Textile India 2017

Textiles India-2017 was a mega exhibition where there were about 1,500 exhibitors, 20,000 participants including 2,500 foreign buyers and sellers from countries such as USA, China, UK, Australia, Germany, Bangladesh, South Korea, UAE, Vietnam. The event was aimed to showcase innovative and sustainable textile products and machinery. The event was scheduled from 30th June -02nd July 2017 at Mahatma Mandir and Helipad Ground, Gandhinagar.

Front View of IPR-NID Stall; Mr.Aslam Moolji, Director-AEPL, Mr.Vishal Jain, Engineer- FCIPT and Mr.Venkatesh, Engineer-AEPL



Live Atmospheric Pressure Air Plasma System displayed in exhibition

FCIPT, IPR show cased plasma processing applications for Textiles.such Jute fibers bleaching, desizing & scouring of cotton, improvement in dye-uptake, shrink proofingof wool. A live atmospheric **Pressure Air Plasma System ,**was displayed in exhibition. A crowd of visitors visited the exhibition and specifically, the exhibits of IPR were one of the centres of attraction generating interest amongst the visitors.

Past Events

Science & Technology Innovations by Scientific Ministries and Departments of Govt. of India

The exhibition was organized by the Chairperson - Department related Parliamentary Standing Committee on Science & Technology, Environment & Forests on 28-July to 11-August 2017 .

The exhibition included departments such as Department of Space (DoS) / ISRO, DSIR/CSIR, Department of Atomic Energy, Dept. of Science & Technology, Dept. of Bio-Technology, Ministry of Earth Sciences. The purpose of the exhibition was to showcase home grown technologies to Member of Parliaments who can further help dissimination of the technology to general public.

Dr. Sanjay Jaiswal (Loksabha MP) (seated) and Shri Giriraj Singh (MP and Minister of State - MSME) (seated) being briefed about plasma textile and plasma pyrolysis technologies.

Group photo of Second batch of DAE representatives (DAE, BARC, IPR, ECIL, AMD, IGCAR) from 07th August to 11th August 2017 along with Dr. Sekhar Basu, Chairman AEC and Secretary DAE.

The DAE stall included showcasing of posters and model from units such as BARC, IGCAR, AMD, IPR, and ECIL. Models were displayed by BARC, IPR, IGCAR and mineral samples were showcased by AMD. IPR showcased plasma pyrolysis system model for plastic waste to energy and samples of plasma processed wool and jute displaying the property enhancement using plasma.

Past Events

Indian National Exhibition-Cum-Fair 2017, Kolkata

Indian National Exhibition-Cum-Fair 2017 is an event organized by Bengal Human Resource Development Foundation. The summit and exhibition was aimed at showcasing the latest developments by various science and technology establishments of India. The event was scheduled from 17-20 Aug, 2017 at Dinabandhu Andrew College grounds. FCIPT showcased its posters on Plasma based coating Methods, Plasma for Swasth Bharat and Agricultural Applications, Plasma Pyrolysis and Eco-Friendly Textile processing using Plasma.

Dr. Sutapa Ranjan,IPR explaining Deep CXR to the Smt. Satabdi Roy, MP

Mr. Pramit Dutta,IPR explaning Robotic Arm to Prof. Banerjee, Javadpur University

Come explore with us ,

Potential of Plasma...

For more details visit us at:

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