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Ion & Plasma Surface Interactions Group

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Welcome to the 2017 Ion and Plasma Surface Interactions (IPSI) Group Newsletter

Welcome to the rather delayed 2017 edition of the Ion & Plasma Surface Interactions group newsletter. Taking on the editorship of any publication, however small, can be quite a daunting task and when I agreed to edit the group newsletter I don't think I really knew exactly what I was getting into, or quite how busy the rest of the year would become! So my apologies for having taken so long to produce this edition, and I hope it has been worth the wait.

The annual Plasmas Surfaces and Thin Films Early Careers meeting once again took place at Loughborough University, and was as ever a great success with a fantastic range of talks and posters. Congratulations to Juliet Ojiako for winning the poster prize! Thanks to Roger Smith and Alan West for organising the event. This event will be run again in June, and further details will be announced through the IPSI group website (<http://www.iop.org/activity/groups/subject/ipsi/index.html>).



Presentation of the 2017 IPSI Outstanding Thesis Award

The IPSI group Outstanding PhD Thesis Award was introduced in 2016, and is presented annually. A two page summary is submitted to the committee, who then judge the submissions and choose the best one. The 2017 award went to Andrew West from the University of York for his thesis entitled "Optical and Electrical Diagnosis of Atmospheric Pressure Plasma Jets".

Andrew's work studied the densities of reactive species in the output plume (effluent) of an atmospheric plasma device using helium as the working gas and small amounts of nitrogen and oxygen as the source of these reactive species. He achieved this through use of a process called two-photon absorption laser induced fluorescence, working with a picosecond pulsed laser and high-speed CCD. By careful calculation of the applied power, he was able to devise a means for determining the total device efficiency, enabling tailoring of the plasma for specific industrial purposes. Andrew demonstrated this technique by using it to optimise the plasma to maximise atomic oxygen generation, and using this for high-rate etching of photoresist. The IPSI committee would like to take this opportunity to congratulate Andrew for a superb entry and excellent contribution to the field!

If you would like to apply for the IPSI group Outstanding PhD Thesis Award, please email a two page synopsis of your thesis to v.vishnyakov@hud.ac.uk by the 6th of April 2018.

Finally if you would like to contribute to the next edition of this newsletter, please email your submission to me at P.J.M.Isherwood@lboro.ac.uk by the 31st of May 2018. Submissions can be on anything from experiences of working in areas of physics relevant to the group through to technical articles and conference reports. There is a prize for the best article, which is announced in the following issue.

Patrick Isherwood, 25th January 2018

Materials and Surface Coatings for use in Extreme Environments: Applications in Tribology

John Colligon (J.Colligon@hud.ac.uk)

During my time on the IPSI committee (which began with the name "Atomic Collisions in Solids Group" and was brought into the IOP Group structure circa 1970) the subject did not have a major link with Tribology which is the study of Corrosion, Friction and Wear of materials. There were of course studies of thin film coatings, in those days by ion plating, which were seen to have other important engineering applications. This technique was a predecessor to present-day ion-assisted thin film coating methods.

Technology has moved on and, whereas coatings were required for components and tools operating at fairly moderate temperatures, the challenge now is to find methods to form new thin film coatings which are durable at temperatures up to 1000°C and above.

The late Professor Jost, who was well known in the Tribology field, pointed out some years ago that over 50% of our energy in running machines is used in overcoming friction [1]. More gains in energy-saving can be obtained by operating engines at higher temperatures where, not only fuel efficiency increases, but also, a fuller combustion process is completed which minimises ejection of unused fuel in the exhaust gases. Other areas of concern are machines which require coolants which also offer environmental problems and could be avoided if improved materials with high temperature stability and low friction could be found. Wind farms at sea have the further challenge to provide corrosion-resistant materials for bearing components and the medical supplies industry must have anti-bacterial and non-poisonous materials for prostheses and other implanted devices.

New coating methods, such as High Pulsed Impact Magnetron Sputtering and other ion-assist methods, allow formation of new surface layers, such as MAX Phase materials [2]. These coatings do withstand high temperature [3], and bring the challenges of Tribology into the realm of IPSI expertise. Bearing surface topography can dictate how a lubricant can be entrained efficiently. This is also important for implant prostheses of mobile joints such as artificial hips where correct entrapment of body fluid to reduce friction is important. The situation is likened to so-named "planing" where a car tyre tread on a wet road can trap water leading to water on water (~zero) friction.

As a member of the IET Tribology Steering Committee I am setting up the programme for day 2 of our third IET conference on New Challenges in Tribology to be held at IET Austin Court, Birmingham. Day 1 is also of interest as it highlights industrial problems and new achievements in machine operation. Both days offer opportunities to researchers in the IPSI area to meet engineers and discuss how their work could pro-

vide solutions to some of the problems.

For those interested, the conference dates are 14-15 March 2018. There will be a poster competition with a prize for research students.

Details are on the IET web-site: www.theiet.org/tribology-challenges

If you or colleagues wish to receive further information please send your name and contact details to Mr Robert Allen at IET (RobertAllen@theiet.org).

References

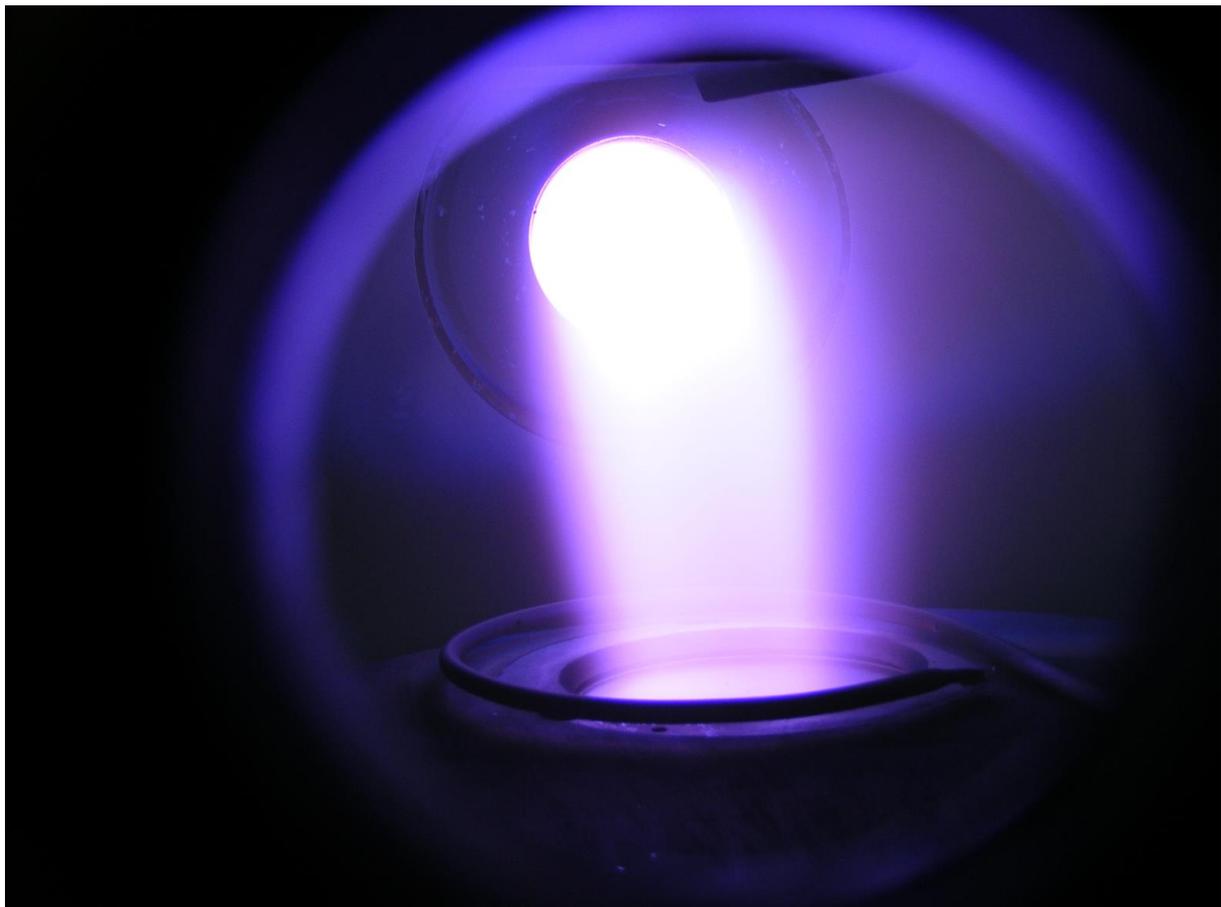
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- [2] M. W. Barsoum, "Synthesis and characterization of a remarkable ceramic: Ti_3SiC_2 ," *Journal of the American Ceramic Society*, vol. 79, no. 7, pp. 1953--1956, 1996.
- [3] V. V. Vishnyakov, J. Lu, P. Eklund, L. Hultman, and J. Colligon, "Ti₃SiC₂-formation during Ti-C-Si multilayer deposition by magnetron sputtering at 650°C," *Vacuum*, vol. 93, pp. 56--59, 2013.

Experiencing Physics--Removing the Tunnel Vision

Joshua Ellingford

A year ago I was a first year undergraduate at the University of Sheffield who was looking for summer work. I eventually found Plasma Quest Ltd (PQL) - a small R&D firm that specialises in thin film depositions using the HiTUS sputtering method - who took me on as a research assistant.

As I had just finished the first year of my undergraduate degree, I had very little knowledge of thin films, plasmas, vacuum systems etc. It wouldn't therefore be unreasonable to feel a little bit nervous and excited about what challenges lay ahead. The summer that followed was one that was full of new and exciting physics that would go on to captivate my interest in solid state physics, plasmas, thin films and condensed matter. I watched in awe as I was given a brief tour of the lab and shown an example deposition process. There was something about seeing a plasma strike for the first time that made me feel like I was watching something that only belonged in a sci-fi movie.



Plasma inside a HiTUS sputter coater vacuum chamber during thin-film deposition

After a few weeks of shadowing my colleagues' work, I was given a project that would

see me running my own processes for the first time. It is this project that really allowed me to develop an understanding of how thin films are made, and how subtle changes to processing conditions can lead to films possessing very different properties. It also allowed me to understand how thin films are used in industry and why certain films are best suited for particular applications. My overall experience of working at PQL has led to my general laboratory technique improving, as well as becoming competent using standard equipment found in thin film laboratories such as surface profilers, ellipsometers and spectroscopes. Being someone who benefits most from kinaesthetic learning (something which I feel is often lacking in the education system), running thin film processes and helping to dismantle a system for a routine clean of the deposition chamber have enabled me to learn about how HiTUS sputter deposition systems work, as well as a little bit about vacuum systems. I felt like a child playing with Lego all over again! This opportunity has allowed me to engage with physics in a way which experience suggests is often overlooked as an undergraduate – the way physics is used every day in the real world, and the opportunity to experience it first hand on a daily basis rather than once a week in a short lab session.

Having finished my second year I am back at PQL, this time in a position of more responsibility. I face even bigger, more exciting challenges that continue to push me further, test and increase my understanding, and invoke the passion that I have had for science since I was a child.

Plasmas, Surfaces and Thin Films: Early Careers Researchers' Meeting

The meeting was organised by The Ion and Plasma Surface Interactions (IPSI) Group and was co-sponsored by the Vacuum and Thin Films & Surfaces Groups of the IoP. It was held on the 22nd of June 2017 at Loughborough University in the Schofield Building.

This meeting has become an annual event at Loughborough and has taken over from the former Plasmas Surfaces and Thin Films Meeting, which was held in London for many years. The initial reason for the change was the unavailability of suitable rooms at the Institute during the refurbishment move, and the new format has been highly successful.

This meeting proved no exception with good invited talks, excellent audience participation and a great show of posters. The standard of posters proved to be as high as ever, as testified by the two judges, which made deciding the winner very difficult.

The established format was followed, with the meeting starting with invited speakers 'setting the scene' and then followed by contributed talks and posters.

The Programme was as follows:

Invited talks by established Researchers:

- 10.30 Christian Bradley, *Tokamak Energy, UK*, Plasma Challenges and Glow Discharge Vessel Conditioning in the Tokamak Energy ST40
- 11.00 Chris Walker, *Diamond Hard Surfaces Ltd*, Diamond Hard Surfaces; Successful technology implementation; from idea to commercial success
- 11.30 Ben Beake, *Micromaterials*, Improved characterisation of DLC coatings for automotive applications
- 12.00 Konstantza Lambrinou, *SCK-SEN, Belgium*, Radiation damage to materials and developments towards next generation of nuclear reactors
- 12.30 Houzheng Wu, *Loughborough University*, Microstructure and mechanical property characterisation of zirconium nitride, carbide and boride after heavy ion irradiation
- 13.00 *Lunch, poster session and AGM of the Ion and Plasma Surface Interactions Group of the Institute of Physics*

Young Researcher talks

- 14.10 David Shaw, *University of York*, Modelling deposition removal from fusion optics
- 14.25 David Meehan, *University of York*, Laser ablation of metal and metal-oxide targets, and applications towards plasma enhanced-pulsed laser deposition

- 14.40 Aisyah Zanai, *University of Surrey and Plasma Quest Ltd.*, An introduction to HiTUS technology with application to multilayer depositions
- 15.55 *Tea break and poster prize winner announcement*
- 15.15 Sibel Yilmaz, *CREST, Loughborough University*, The microstructure of CdS/CdTe solar cells fabricated using magnetron sputtering
- 15.30 Gerald Womack, *CREST, Loughborough University*, The design, performance and durability of broadband anti-reflection coatings for solar modules deposited using magnetron sputtering
- 15.45 Mateus Tunes, *University of Huddersfield*, Ion beam sputter-deposition of high-entropy alloy thin films on zircalloy-4 for potential use in accident-tolerant fuel systems
- 16.00 Adam Bennett, *Cranfield University*, Atmospheric pressure plasma technology for ultra-precision engineering of optics for applications in aerospace, defence and science
- 16.15 Jingcheng Guan, *Loughborough University*, Atomistic modelling of zinc oxide thin film growth by different deposition techniques
- 16.30 *Close*

Poster titles were:

1. S. Robertson, *Loughborough University*, Structure and mechanical performance characterisation of zirconium nitride after heavy ion irradiation
2. C. Chalmers, *Loughborough University*, Modelling the dewetting of inkjet printed drops
3. C. A. Herr, *Oxford University*, Deposition of organic layers by roll-to-roll coating in vacuum
4. B. Maertz, *Loughborough University*, Microstructure of isostatic pressure-moulded graphite (iso-graphite)
5. A.-A. Harbi, *Loughborough University*, Radiation damage in glasses
6. M. Watts, *Loughborough University*, Understanding CdTe/CdS solar thin film structures through ab initio modeling
7. F. H. Montazersadgha, Space averaged mathematical model of pulse powered atmospheric pressure air plasma
8. J. Ojiako, *Loughborough University*, First steps in modelling plasma interactions with liquids
9. O. Ogunyinka, *Loughborough University*, Enhancement of mass transfer rate of plasma reactive species in gas-liquid phases with a microfluidic plasma reactor
10. S. Kurdi, *Cambridge University*, $\text{Fe}_{2-x}\text{Mn}_{1+x}\text{Al}$ Heusler films showing a large exchange bias shift

11. A. Wright, *Loughborough University*, Development and comparison of ozone measurement techniques
12. M. Shaban, *Loughborough University*, Plasma liquid interface using a microfluidic plasma device
13. D. Billcan, *Barcelona*, Synthesis of porous BiFeO₃ films with ferromagnetic-like behaviour by electrodeposition followed by heat treatment
14. W. Huettene, *Cambridge*, Sustainable magnetostrictive thin film alloys

The poster prize was won by Juliet Ojiako from Loughborough University, and was announced after the afternoon tea break. The prize was presented by the IPSI Group Chair Glen West.



Presentation of the poster prize

The Plasmas Surfaces and Thin Films meeting format may revert to that originally conceived once the move to the new IoP building has taken place. There is still clearly a need for a Young Researchers' Meeting however, as demonstrated again this year by the enthusiastic response and the high quality of the presentations.

The event was organised by Roger Smith and Alan Webb.

The Committee

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The IPSI Group welcomes ideas from members for topics for future events, including conferences, meetings and workshops. Please contact the Chairman or Secretary. This newsletter is also available on the web and in larger print sizes. The contents of this newsletter do not necessarily represent the views or policies of the Institute of Physics, except where explicitly stated. The Institute of Physics, 76 Portland Place, W1B 1NT, UK. Tel: 020 7470 480 Fax: 020 7470 4848