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# Ion & Plasma Surface Interactions Group

# Welcome to the 2022 Ion and Plasma Surface Interactions (IPSI) Group Newsletter

It is impossible to ignore the biggest challenge of our time - Covid pandemic. Over two years this cloud hangs over all of us and, while it has not stopped the overall progress in our discoveries, it definitely slowed it down somehow and painted the background into dark colours. Significant part of research is concentrated at universities. Closure and limited access to campuses and labs expressively delayed and slowed down experimental work. Undoubtedly health related research fared much better or even flourished but it is only partially overlapping with physics and technology. The biggest area of concern was difficulty of communication on all levels. Majority of academic staff missed face-to-face interaction with students, students missed significant part of lab-based activities and we all have missed great part of daily interaction with students and colleagues. It is possible to say that the most difficult time was encountered by our PhD students. Lost access to the lab work and daily communications is impossible to substitute. It is some comfort in knowledge that some universities offered to extend studies time. Many students faced financial hardship and we all have to hail everybody and the IOP bivalent fund in particular for stepping in with the significant support.

We have done our best to keep channels of information open. Meetings and lectures have moved onto Zoom and Teams. It works somehow but we all suffer from missing tête-à-tête conversations.

It is great satisfaction to report that the group created at the initial form as Atomic Collisions in Solids in nineteen seventies is still going strong. The IPSI group has continued usual activities over the whole challenging times. You will be able to see from the reports later in this newsletter that all our meetings have been held at usual times but this was done with the remote participation. We have done our best to keep open communication with our colleagues and students. It was great to see that despite difficulties we persist in moving forward with new results, with new achievements, with new ideas.

Apart from just reporting on the past activities we would like in the upcoming newsletters to talk about most interesting, from our point of view, developments within our group major interest area. For this we have chosen so far quantum computing, challenges related to fusion energy production and recent developments in cluster beams technology which includes water cluster beams. We would welcome our reader comments and suggestions for the future issues.

You will also see program of events organised or supported by the group. It is not clear at the moment if the events will be confined to the remote participation only. We just hope that over time we will move to mixed, remote and physical, participation models and eventually we will return to mainly physical participation model.

## Fusion energy

*Vladimir Vishnyakov*

Excess energy is one of the fundamental requirements for our society existence and we need energy to survive and to move forward. Energy production almost always leads to an inevitable environmental impact. Electrical energy is merely 10% of the overall energy used by our society. What makes electrical energy so important is in the ease we can convert electrical energy into other energy forms. It is not without a controversy how to assess environmental impact of electrical energy production. Fusion allows in principle to produce electrical energy with the minimal, so far, environmental impact.

Fusion nuclear reactions proceed by combining two element nuclei. The reaction has very high energy barrier as both nuclei are positively charged. The lowest barrier and most easily achieved reaction conditions are for the lightest nuclei of hydrogen isotopes – deuterium and tritium. Deuterium can be extracted in abundance from sea water and tritium can be produced in the fusion reactor during running, when neutrons, product of the fusion itself, interact with lithium. The overall reaction products are noble gas helium and neutrons. Both products carry out reaction energy. The reaction energy is finally captured by the reactor materials. Infinite availability of fusion fuel will make fusion reaction a truly renewable green source of (electrical) energy when the technology is fully established.

It is said that fusion energy production faces six challenge areas: plasma confinement, plasma exhaust, materials, innovative engineering, robotics and fuel handling. Our ICF group attention focuses on at least on two of them – plasma exhaust and materials. The interest is based on the processes at plasma facing material interaction with high energy reaction products and energised plasma impurities. Reactor materials are subjected to the extensive neutron bombardment and should retain predefined functionality over long time. The reactor chamber exhaust system, named diverter, will be subjected to extremely high flux of helium bombardment. At the same time materials for the diverter need to satisfy long list of requirements. So far only tungsten seems to be an optimal choice. From point of ability to withstand high energy deposition, up to  $20 \text{ MWm}^2$ , tungsten looks almost ideal. The problem is that tungsten is not good heat conductor. High energy deposition will inevitably lead to temperature rise on the surface even above that even tungsten can handle. Ion high flux on the diverter materials will lead to significant ion erosion. There is a hope that new tungsten alloys will survive the exhaust conditions better than just pure tungsten. Material development is underway so watch this space.

## Summary on IoP Plasmas Surfaces and Thin Films: Early Carriers Virtual Meeting

Held on 14-16 April 2021

Vladimir Vishnyakov

The meeting was attended by approximately thirty colleagues and consisted of video presentations (talks), followed by two two-hour web-based discussions on the topics presented.

### Invited talks

*How IOP Membership can help you advance your career*

*Gaynor Gardner, Institute of Physics, UK*

*Relation of bonding and structure in high entropy alloys – use of thin films to confirm theoretical models*

*Erik Levin, Uppsala University, Sweden*

*Characterisation of diamond-like carbon coating systems using the nano-scratch technique*

*Sam McMaster, Coventry University, UK*

*What can the UK National Ion Beam Centre Do For YOU?*

*Prof Roger Webb, University of Surrey, UK*

### Contributed talks

*Modelling the optical emissions of a Helicon-ICP glow discharge for plasma diagnostics*

*Beaujolaïs Bussell, University of Surrey, UK*

*Origins of void formation in sputtered CdSe*

*Rachael Greenhalgh, Loughborough University*

*Inert Gas Bubble Formation in Magnetron Sputtered Thin Film CdTe Solar Cells*

*Peter Hatton, Loughborough University, UK*

*Microstructure and corrosion performance of equiatomic FeCrMnNiC amorphous high entropy thin films alloys*

*Waleed Muftah, University of Huddersfield, UK*

*Winner of the IPSI Early Carrier presentation was PhD student Beaujolaïs Bussell from the University of Surrey for her presentation during the meeting*

## Summary on IoP Plasmas Surfaces and Thin Films (virtual meeting)

Held on 9<sup>th</sup> June 2021 (half day)

*Hayley Brown*

Like many meetings, this was the first Plasma, Surfaces and Thin Films meeting to be held virtually. The meeting consisted of a very strong invited program:

### **Why is the deposition rate low during reactive sputtering?**

Professor Diederik Depla, Ghent University, Belgium

### **Finding bugs and killing them with nanomaterials**

Professor Alistair Kean, Nikalys, UK

### **Atomic layer etching**

Dr Mike Cooke, Oxford Instruments Plasma Technology, UK

### **Adoption of plasma dicing**

Dr Janet Hopkins, SPTS Technologies Ltd, UK

This was interluded with 6 short industrial presentations from UK National Ion Beam Centre, Plasma Quest Ltd, Gencoa, Hiden Analytical, Henniker Scientific Ltd and Prevac, Nikalys Ltd.

The event also included a 90-minute Gatherly (*online event software*) poster presentations, exhibitor stands and networking session.

The presentation sessions worked very well virtually and each presentation was followed by a series of questions from the audience. Unfortunately, this was not the same for the Gatherly session, which experienced many technical difficulties, and was not compatible with different internet browsers. Steps have been taken since this meeting to improve the service.

***Winner of the IPSI student poster prize was Alexander Rubinstein from the University of Surrey with the title "Molecular Dynamics Modelling of Dynamic XPS Cluster Sputtering"***

The IPSI committee would like to thank all who attended and supported the meeting in this experimental format.

For this year, the **Plasmas, Surfaces & Thin Films meeting will be held on the 9<sup>th</sup> June 2022**, in IoP HQ (COVID permitting) and will also include a Young Researchers section.

## **Advances in Photovoltaics - REGISTRATION NOW OPEN**

23rd March 2022, Institute of Physics, 37 Caledonian Road, London N1 9BU

This one-day in-person meeting at the Institute of Physics provides a forum to help assess the current state of the art in solar cells. It brings together a list of distinguished invited speakers whose expertise covers the range of photovoltaic technologies.

Organised by the Ion and Plasma Surface Interactions Group and co-sponsored by the Energy Group and the EPSRC Supergen SuperSolar Network+.

### **Invited Speakers**

The Future of Thin Film Photovoltaics, **Dr Gang Xiong, First Solar Inc.**

Understanding nanoscale recombination and instabilities in halide perovskite photovoltaics, **Dr Sam Stranks, University of Cambridge**

On future prospects for perovskite-on-silicon tandem solar cells, talk title TBC, **Dr Laura Miranda Perez, Oxford Photovoltaics**

How hybrid organic inorganic perovskites can be enhanced through structuring, **Dr Steven Hepplestone, University of Exeter**

Metal halide perovskites: links between electronic transport, ion migration and microstructure, **Professor Laura Herz, University of Oxford**

**Further 10 minute oral presentations and posters are invited. A title should be sent by Friday 21<sup>st</sup> January 2022 to: [c.e.malins@lboro.ac.uk](mailto:c.e.malins@lboro.ac.uk)**

# The Committee

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## **Chair**

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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.

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