

ICOPS/SOFE 2011 Mini Course

Plasma-Material Interactions in Fusion and Industrial Plasmas

Overview

The aim of the mini-course is to provide a comprehensive introduction of plasma-material interactions with emphasis on fusion and industrial plasmas. This mini-course will address rising interest in the area of plasma-material interactions and will in part introduce the breadth and depth of the subject in areas including: plasma-surface interactions in fusion edge plasmas, plasma processing of micro and nanoelectronics with industrial plasmas, biomaterials plasma treatments, plasma propulsion applications and other relevant areas where the plasma/material interface plays a crucial role in materials performance and behavior. A unique aspect of this mini-course is to bring instructors that not only have an expertise in plasma-material interactions but also extensive experience both in PMI experiments and atomistic/multi-scale computational PMI modeling. The course will uniquely describe the challenges of PMI experiments and computational modeling and the areas in which these two thrusts can complement each other. The title of the course uses the concept of “*industrial plasmas*” to include all non-fusion areas where plasmas play a critical role on the modification and processing of materials. This area has also included the use of both plasma and ion-beam interaction with advanced material surfaces modified at the nanoscale. Therefore this course will also discuss recent progress on the role nanotechnology in the area of PMI both for fusion and industrial plasmas applications.

The course instructors include leading researchers in the areas of experimental and computational plasma-material interactions. They include: Prof. David N. Ruzic from the University of Illinois at Urbana-Champaign, Prof. Jean Paul Allain from Purdue University, Prof. Brian Wirth from University of Tennessee and Dr. Predrag Krstic from Oak Ridge National Laboratory.

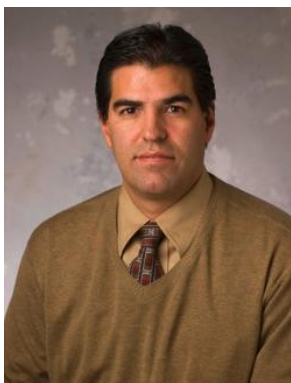
Audience: Students, junior faculty or new faculty entering these fields, industry researcher scientists/ engineers and postdoctoral researchers.

Course Content

The course is divided in two categories: experimental PMI topics and computational PMI. The morning session will cover topics in experimental PMI: 1) *Fundamentals of Plasma-Material Interactions (Ruzic)*, 2) *PMI in Fusion (Allain)* and lastly 3) *PMI in Industrial Plasmas (Ruzic)*. The afternoon session will cover topics in computational PMI: 1) *Introduction to PMI Computational Science (Krstic)*, 2) *Multi-scale Modeling in fusion PMI (Wirth)* and 3) *Computational PMI of industrial plasmas*. The course will conclude with *Progress on PMI Nanotechnology* topic by Allain.

Instructors

Jean Paul Allain completed his Ph.D. degree from the Department of Nuclear, Plasma and Radiological Engineering at the University of Illinois, Urbana-Champaign. He received a M.S. degree in Nuclear Engineering from the same institution. Prof. Allain joined Argonne National Laboratory as a staff scientist in 2003 and joined the faculty in the School of Nuclear Engineering at Purdue University in Fall of 2007 with a courtesy appointment with the School of Materials Engineering. Prof. Allain is an affiliate faculty of the Birck Nanotechnology Center. Prof. Allain is the author of over 50 papers in both experimental and computational modeling work in the area of particle-surface interactions in nuclear magnetic fusion science. His studies include developing in-situ surface structure and composition evolution characterization of heterogeneous surfaces under low-energy irradiation promoting structure and function at the nanoscale. Prof. Allain is also working in coupling post-ionization secondary mass neutral spectrometry techniques with in-situ surface characterization to design ultra-thin active films coupled to directed radiation synthesis with applications in semiconductor, biomaterials and nuclear energy technology areas. He was recipient of numerous awards including the DOE Early Career 2010 Award and the Paul Zmola Young Scholar Award.



Dr Predrag S. Krstić completed his Ph.D. degree from the Department of Physics at the City College of the City University of New York in 1981 on the theory of laser-atom interactions. He received a M.S. degree in Experimental Plasma Physics and B.S. in Technical Physics from the Faculty of Electrical Engineering, University of Belgrade, Yugoslavia. Dr. Krstić joined the scientific staff of the Institute of Physics, Belgrade, in 1976, and joined scientific staff of the Physics Division of Oak Ridge National Laboratory in 1995, holding also adjunct professor position at the Department of Physics and Astronomy of the University of Tennessee. Dr Krstić is the author of over 150 papers on theoretical and computational simulations of slow ion, atom and molecule collisions as well as on the particle-surface interactions in magnetic fusion edge plasma, computational chemistry, molecular electronics, nanofluidics and nanobiotechnology, laser-atom interactions and plasma physics. His classical and quantum molecular dynamics studies on plasma-surface interactions include chemical sputtering, retention, reflection of hydrocarbon and metalized carbon surfaces, and rovibrational analysis of ejected molecules. Dr. Krstić is also working on the construction and functional analysis of various devices for localization and control of bio-molecular ions like are aqueous Paul nanotraps, carbon nanotubes, gold-plated nanopores etc. His theoretical research is closely coupled and validated with the experiments through close collaboration with groups in ORNL, as well as in Purdue, Yale and Arizona State Universities. Dr. Krstić is elected fellow of the American Physical Society.



David N. Ruzic is the Director of the Center for Plasma Material Interactions at the University of Illinois at Urbana-Champaign. He is a professor in the Department of Nuclear, Plasma, and Radiological Engineering and affiliated with the Department of Electrical and Computer Engineering and the Department of Physics, having joined the faculty in 1984. His current research interests center on plasma processing for the microelectronics industry (deposition, etching, EUV lithography and particle removal) and on fusion energy research. Prof. Ruzic is a Fellow of the American Nuclear Society and of the American Vacuum Society (AVS). He is the author of the AVS monograph, *Electric Probes for Low Temperature Plasmas*, numerous book chapters, patents, and over 120 refereed journal articles. He obtained his PhD and MS in Physics from Princeton University, and his BS degree in Physics and Applied Math from Purdue University. He really enjoys teaching and tries to blow something up during every lecture.



Brian Wirth is Professor and Governor's Chair of Computational Nuclear Engineering in the Department of Nuclear Engineering at the University of Tennessee, Knoxville, which he joined in July 2010. Brian received a BS in nuclear engineering from the Georgia Institute of Technology in 1992 and a PhD in mechanical engineering from the University of California, Santa Barbara in 1998, where he was a Department of Energy Nuclear Engineering Graduate Fellow. In 2002 he joined the faculty at the University of California, Berkeley as an Assistant Professor of Nuclear Engineering, following several years in the High Performance Computational Materials Science Group at Lawrence Livermore National Laboratory, and was promoted to Associate Professor in 2006. His research interests involve the combination of multiscale modeling and advanced microstructural characterization to develop improved understanding and models of microstructure - property relationships and microstructural evolution during processing and service in hostile environments, with an emphasis on irradiation effects; and to use this knowledge as a basis for developing advanced materials. He has received a number of awards, including the 2007 Fusion Power Associates David J. Rose Excellence in Fusion Engineering Award and the 2003 Presidential Early Career Award for

Scientists and Engineers (PECASE). He can be reached at (865) 974-2554 and by e-mail at bdwirth@utk.edu.

