APPLICATION FORM FOR THE ORGANIZATION OF AN IUVSTA SHORT COURSE

NATIONAL VACUUM SOCIETY: Japan Society of Vacuum and Surface Science

COURSE TITLES AND LECTURES:

1) Vacuum Gas Dynamics: Theory, Experiments and Applications
   Felix Sharipov, Irina Graur, Oleg B. Malyshev, Roberto Kersevan
2) Properties of small molecules: bridging surface science and vacuum technology
   Katsuyuki Fukutani
3) Plasma Processing; From Fundamentals to Atomic Layer Processes
   Satoshi Hamaguchi
4) Reactive Magnetron Sputter Deposition
   Diederik Depla
5) Introduction to High Power Impulse Magnetron Sputtering (HiPIMS)
   Daniel Lundin
6) Fundamentals of Sputter Deposition; Control of Micro- and Nanostructure
   Ivan G. Petrov
7) X-Ray Photoelectron Spectroscopy (XPS/ESCA)
   John T. Grant
8) Scanning Probe Microscopy
   Franz Giessibl

LOCATION: Sapporo Convention Center, Hokkaido, Japan

DATE OF COURSES: 10th (Sat), 11th (Sun), and 16th (Fri) September 2022

INCLUDED IN WHICH CONFERENCE: IVC-22

OBJECT OF THE COURSES:

The eight short courses aim to guide in fields of vacuum, plasma, thin film, and surface science and to fill the gap between specialized literature and practical needs including theoretical and experimental methods for applications.

LANGUAGE: English

EXPECTED JOB LEVEL OF THE PARTICIPANTS:

PhD students, research engineers, scientists, and R&D staff at companies who like to expand their horizons in new scientific fields and in new scientific methods.

EXPECTED AVERAGE NUMBER OF PARTICIPANTS:

10 participants in each course (80 in total) are expected.

IMPORTANT REMARK:

In these short courses, we will pay attention to meet the recommendations of IUVSTA concerning the organization of short courses, conferences, etc. in the COVID-19 situation. For this purpose, we have foreseen a possible electronic participation for some of the participants. The proportion of online attendants may change according to the health situation.

FINANCES:

18,000 euro is appropriated for organizing a total of eight short courses. 2,000 euro of IUVSTA contribution is requested and will be used for participants and instructors partial funding.

PROVISIONAL BUDGET ATTACHED: Yes

IUVSTA SCIENTIFIC SPONSORING DIVISIONS:

Vacuum Science and Technology Division (VSTD)

UNDERWRITING: Who will underwrite any financial loss?

Japan Society of Vacuum and Surface Science (JVSS)

CHECKLIST FOR APPLICANTS

Organizers must undertake to fulfill the conditions below. Financial contributions from IUVSTA are conditional upon this undertaking.

We agree to

PROVIDE full information of event to the IUVSTA Scientific Secretary

PROVIDE a tentative budget for the event at the STD meeting when asking for approval

PROVIDE Dedicated Website for the event. Give url if known (this information must be passed to the Scientific Secretary before any IUVSTA funds will be released):

Web site of the IVC-22: https://ivc22.org

Name and e-mail address of person who will maintain the site:

Prof. Osamu Takeuchi (JVSS), takeuchi.osamu.ft@u.tsukuba.ac.jp

PROVIDE a report of the event after its completion for the IUVSTA web site:

Name and e-mail address of person who will provide this report:

Yasunori Tanimoto, email: yasunori.tanimoto@kek.jp

AGREE to include IUVSTA name and logo on all event announcements: Yes

I agree to fulfill all the points of above: Yes

Signatures:

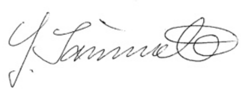
President of the JVSS

Prof. Hidemi Shigekawa

Date: 05/02/2022

IVC-22 Short Course Organizer

Prof. Yasunori Tanimoto



Date: 26/01/2022

Application for IUVSTA support for IVC-22 Satellite Short Courses

Yasunori Tanimoto

Japan Society of Vacuum and Surface Science (JVSS)

ECM-136, 25–27 March 2022

THE 22ND INTERNATIONAL VACUUM CONGRESS

IVC-22

DATE 2022 9.11 SUN – 16 FRI

Sapporo Convention Center, Sapporo, Japan

THE 22ND INTERNATIONAL VACUUM CONGRESS
IVC-22
DATE 2022 9.11 SUN – 16 FRI
Sapporo Convention Center, Sapporo, Japan

JVSS

IUVSTA

Dates

10th (Sat), 11th (Sun), and 16th (Fri) September 2022

Venue

Sapporo Convention Center, Hokkaido, Japan

Participants

PhD students, research engineers, scientists, and R&D staff at companies who like to expand their horizons in new scientific fields and in new scientific methods.

Aims

- to guide in fields of vacuum, plasma, thin film, and surface science.
- to fill the gap between specialized literature and practical needs including theoretical and experimental methods for applications.

IVC-22 Short Course List

	Course Title	Lecturer	Affiliation	Duration and Date	Course Material
1	Vacuum Gas Dynamics: Theory, Experiments and Applications	Felix Sharipov Irina Graur Oleg B. Malyshev* Roberto Kersevan	Federal University of Parana Aix-Marseille University Daresbury Laboratory CERN	2 days (6+6 hours) Saturday & Sunday	- Hard and electronic copies of presentations - Numerical codes to solve basic problems of vacuum gas dynamics
2	Properties of small molecules: bridging surface science and vacuum technology	Katsuyuki Fukutani	University of Tokyo	3-4 hours Friday	
3	Plasma Processing; From Fundamentals to Atomic Layer Processes	Satoshi Hamaguchi	Osaka University	3 hours Friday	Printed and pdf copies of presentation slides
4	Reactive Magnetron Sputter Deposition	Diederik Depla	Ghent University	1 day (7+1 hours) Sunday	*Magnetrons, reactive gases and sputtering (118.41US$)*
5	Introduction to High Power Impulse Magnetron Sputtering (HiPIMS)	Daniel Lundin	Linköping University	3-4 hours Sunday	*High Power Impulse Magnetron Sputtering (Elsevier, 147US$)*
6	Fundamentals of Sputter Deposition; Control of Micro- and Nanostructure	Ivan G. Petrov	University of Illinois	3 hours Friday afternoon	
7	X-Ray Photoelectron Spectroscopy (XPS/ESCA)	John T. Grant	Consultant in Surface Analysis	2 days Saturday & Sunday	Printed copy of all slides
8	Scanning Probe Microscopy	Franz Giessibl*	University of Regensburg	1 day (6 hours) Sunday	Printed copies of key papers, pdf of slides

* IVC-22 Invited Speaker

IVC-22 Short Course Program

Case 1: In person

	Saturday, 10 Sept.		Sunday, 11 Sept.					Friday, 16 Sept.		Paris	NY	LA
Room	1	2	1	2	3	4	5	1	2	-7h	-13h	-16h
9:00		(7-1) XPS Grant		(7-2) XPS Grant						2:00	20:00	17:00
10:00	(1-1) Vacuum Gas Dynamics Sharipov Graur		(1-2) Vacuum Gas Dynamics Malyshev Kersevan		(8) SPM Giessibl	(4) Reactive Magnetron Sputter Depla		(3) Plasma Processing Hamaguchi		3:00	21:00	18:00
11:00										4:00	22:00	19:00
12:00										5:00	23:00	20:00
13:00										6:00	0:00	21:00
14:00							(5) HiPIMS Lundin	(6) Control of Microstructure Petrov	(2) Properties of Small Molecules Fukutani	7:00	1:00	22:00
15:00										8:00	2:00	23:00
16:00										9:00	3:00	0:00
17:00										10:00	4:00	1:00

Case 2: Hybrid

Date	Saturday, 10 Sept.		Sunday, 11 Sept.					Friday, 16 Sept.		Paris	NY	LA
Room	1	2	1	2	3	4	5	1	2	-7h	-13h	-16h
14:00		(7-1) XPS Grant		(7-2) XPS Grant						7:00	1:00	22:00
15:00	(1-1) Vacuum Gas Dynamics Sharipov Graur		(1-2) Vacuum Gas Dynamics Malyshev Kersevan		(8) SPM Giessibl	(4) Reactive Magnetron Sputter Depla		(3) Plasma Processing Hamaguchi		8:00	2:00	23:00
16:00										9:00	3:00	0:00
17:00										10:00	4:00	1:00
18:00										11:00	5:00	2:00
19:00							(5) HiPIMS Lundin	(6) Control of Microstructure Petrov	(2) Properties of Small Molecules Fukutani	12:00	6:00	3:00
20:00										13:00	7:00	4:00
21:00										14:00	8:00	5:00
22:00										15:00	9:00	6:00

Provisional Budget

Income	Unit value (€)	Quantity		Sub-total (€)	Remarks
		Participants			
Registration fee	Fee per person	per course	total	**Fee total**	
		10	80	**13,780**	
2-day course (12h)					2 courses
Standard	**570**	1	2	1,140	48 €/h
IVC participant	**430**	4	8	3,440	36 €/h
Student	**240**	5	10	2,400	20 €/h
1-day course (6h)					2 courses
Standard	**280**	1	2	560	48 €/h
IVC participant	**210**	4	8	1,680	36 €/h
Student	**120**	5	10	1,200	20 €/h
Half-day course (3h)					4 courses
Standard	**140**	1	4	560	48 €/h
IVC participant	**100**	4	16	1,600	36 €/h
Student	**60**	5	20	1,200	20 €/h
IUVSTA funding	**2,000**		**1**	**2,000**	
Total				**15,780**	

Balance				**-3,236**	JPY -404,522

Expenditure	Unit value (€)	Quantity	Sub-total (€)	Remarks
Honorarium for lecture			**4,992**	
2-day course (12h)	**1,248**	2	2,496	2 courses
Basic pay	960			80 €/h
Participant-based raise	288			3 €/h/participant 90 €/h max. (30 participants)
1-day course (6h)	**624**	2	1,248	2 courses
Basic pay	480			80 €/h
Participant-based raise	144			3 €/h/participant 90 €/h max. (30 participants)
Half-day course (3h)	**312**	4	1,248	4 courses
Basic pay	240			80 €/h
Participant-based raise	72			3 €/h/participant 90 €/h max. (30 participants)
Tax for honorarium			**1,019**	Tax rate: 20.42%
Accommodation support	100	11	**1,100**	Stays before IVC
IVC registration support	500	9	**4,500**	11 lecturers (2 IVC invited)
Online connection system	300	5	**1,500**	Max. parallel rooms: 5
Temporary labor	100	8	**800**	per room, per day
Material printing*	4	480	**1,920**	4 €/h/participant
Lunch break*	15	62	**930**	Onsite participants, lecturers and supporters
Coffee break*	7	160	**1,120**	Onsite participants, lecturers and supporters
Total			**17,881**	

*The quantity decreases as the number of online participants increases.

Participants per course: 10

Provisional Budget

Income	Unit value (€)	Quantity		Sub-total (€)	Remarks
Registration fee	Fee per person	Participants		**Fee total**	
		per course	total		
		15	120	**20,020**	
2-day course (12h)					2 courses
Standard	**570**	1	2	1,140	48 €/h
IVC participant	**430**	6	12	5,160	36 €/h
Student	**240**	8	16	3,840	20 €/h
1-day course (6h)					2 courses
Standard	**280**	1	2	560	48 €/h
IVC participant	**210**	6	12	2,520	36 €/h
Student	**120**	8	16	1,920	20 €/h
Half-day course (3h)					4 courses
Standard	**140**	1	4	560	48 €/h
IVC participant	**100**	6	24	2,400	36 €/h
Student	**60**	8	32	1,920	20 €/h
IUVSTA funding	**2,000**		**1**	**2,000**	
Total				**22,020**	

Balance				**167**	JPY 20,850

Participants per course: 15

Expenditure	Unit value (€)	Quantity	Sub-total (€)	Remarks
Honorarium for lecture			**6,000**	
2-day course (12h)	**1,500**	2	3,000	2 courses
Basic pay	960			80 €/h
Participant-based raise	540			3 €/h/participant 90 €/h max. (30 participants)
1-day course (6h)	**750**	2	1,500	2 courses
Basic pay	480			80 €/h
Participant-based raise	270			3 €/h/participant 90 €/h max. (30 participants)
Half-day course (3h)	**375**	4	1,500	4 courses
Basic pay	240			80 €/h
Participant-based raise	135			3 €/h/participant 90 €/h max. (30 participants)
Tax for honorarium			**1,225**	Tax rate: 20.42%
Accommodation support	100	11	**1,100**	Stays before IVC
IVC registration support	500	9	**4,500**	11 lecturers (2 IVC invited)
Online connection system	300	5	**1,500**	Max. parallel rooms: 5
Temporary labor	100	8	**800**	per room, per day
Material printing*	4	816	**3,264**	4 €/h/participant
Lunch break*	15	104	**1,560**	Onsite participants, lecturers and supporters
Coffee break*	7	272	**1,904**	Onsite participants, lecturers and supporters
Total			**21,853**	

*The quantity decreases as the number of online participants increases.

Course Descriptions

(1)

Short Course at

International Vacuum Congress

10-11 September, 2022

THE 22ND INTERNATIONAL VACUUM CONGRESS IVC-22 DATE 2022 9.11 SUN -16 FRI Sapporo Convention Center, Sapporo, Japan

https://ivc22.org

Title: Vacuum Gas Dynamics: Theory, Experiments and Applications

Lecturers: Prof. Felix Sharipov, Federal University of Parana, Brazil
Prof. Irina Graur, Aix-Marseille University, France
Dr. Oleg Malyshev, Daresbury Laboratory, UK
Dr. Roberto Kersevan, CERN, Switzerland

Aims and motivations: The course is addressed to students, scientists and engineers who are not experts in Rarefied Gas Dynamics but who deals with this field in their routine work. The available textbook and handbooks on vacuum technology usually give just fundaments of gas dynamics but not deep enough to understand the modern state of analytical and numerical methods of modelling in this field. The special literature is often too hard for non-experts. This short course targets at basic research training in Vacuum Gas Dynamics and provides a coherent and rigorous introduction into this field including relevant theoretical and experimental methods for practical applications. No preceding knowledge of gas dynamics is assumed.

Structure of the course: The course duration is 12 hours (2 days).

- "Theory and simulations", 6 hours, given by Prof. Felix Sharipov and Prof. Irina Graur
- "Practical Applications", 6 hours, by Dr. Oleg Malyshev and Dr. Roberto Kersevan

Topics:

- **Theory:** Molecular free path, gas rarefaction and flow regimes. Velocity distribution function. Gas-surface interaction. Accommodation coefficients. Free-molecular flows. Analytical solutions in the free-molecular limit. Test particle Monte Carlo method. Velocity slip and temperature jump conditions. Analytical solutions of the Navier-Stokes equations subject to the slip and jump conditions. Intermolecular interaction and kinetic equation. Flows in the transition regime. Discrete velocity method. Direct simulation Monte Carlo method. Main numerical solutions in the transitional regime with examples of their applications: Poiseuille flow, Coutte flow, heat transfer. Transient flows. Numerical models of Holweck and turbo-molecular pumps. Numerical model of Pirani sensor. Rarefied flow calculator. Modelling of gas dynamics processes in vacuum chambers.
- **Applications:** Design of large UHV vacuum systems in free molecular flow regime. Vacuum specification and input parameters. Experimental data: measurements, data analysis, extrapolation and using. Models: overview of different models used with an emphasis on 1D diffusion analytical model and numerical models (test particle Monte Carlo and angular coefficients), pumps and sources of gas in different models. From a model to a mechanical design. Analysis of errors and uncertainties in a final design. Examples of design.

Didactic material: The participants will get hard and electronic copies of presentations and numerical codes to solve basic problems of vacuum gas dynamics.

Information about the lecturers:

Prof. Felix Sharipov graduated from the Moscow University of Physics and Technology, Faculty of Aerophysics and Space Research in 1982. He obtained his Ph.D. in 1987 at the Ural State Technical University. In 1988 he joined the Physics Faculty of the Ural State University where he set up his activity in rarefied gas dynamics. In 1992 he moved to the Federal University of Parana in Brazil where he built up a group on numerical modelling of gas flows in microscale. His research interests are numerical methods of rarefied gas dynamics applied to microfludics, vacuum technology and aerothermodynamics. His group develops both probabilistic and deterministic approaches. He was an organizer of numerous vacuum gas dynamics meetings and schools. F. Sharipov published over a hundred journal articles, several reviews and chapters in handbooks. He is an author of two books and a member of editorial board of "Vacuum" (Elsevier).

Prof. Irina Graur obtained M.Sc. in applied mathematics in 1984 from Moscow Lomonossov State University. She received a PhD also from Moscow State University in 1989 and the Habilitation from Provence University in France in 2008. Irina Graur was associate professor at Keldish Institute of Applied Mathematics between 1984 and 2000. She is currently professor at Aix Marseille University in France. She has made a number of contributions in the field of rarefied gases for the aerospace research. Her current research interests include the experimental and numerical characterization of the gas properties at micro and nano scales. She heads the research group "Non-equilibrium phenomena and microfluidic" in IUSTI Laboratory. She participated in the organization of a number of international conferences, workshops and summer schools. She has co-authored more than one hundred journal articles and conference papers.

Dr. Oleg Malyshev was graduated in the Physics Department at the Novosibirsk State University in1989. He started his carrier as a vacuum scientist at the Budker Institute of Nuclear Physics where he obtained his Ph.D. in 1995. His work includes theoretical studies, experimental research and design of various vacuum systems such as VEPP-5, ANKA, BESSY, SSC. From 1998 to 2001, he worked at CERN designing the LHC beam vacuum system. Since 2001 he works in ASTeC at STFC Daresbury Laboratory, he designed a vacuum system for Diamond Light Source, participated in R&D for International Linear Collider, FAIR, KATRIN, NLS, ALICE, etc. He leads experimental and analytical study in ASTeC Vacuum Science Group. He is an editor of international scientific journal VACUUM (Elsevier), an organizer of international workshops, meetings, an author of more than 160 scientific papers and reports. He is a Charted Physicist and a Fellow of Institute of Physics.

Roberto Kersevan graduated in physics at the University of Trieste, Italy, in 1985. After initial work on the design of the ELETTRA light source from 1988 to 1992, he moved to the SSC Laboratory in Dallas, for the design of the storage rings' cryogenic vacuum system. He then moved to Wilson Lab. of Nuclear Studies, Cornell University, to work on the upgrade of the vacuum system of the e^-e^+ collider CESR. In 1997 he took up the position of head of the vacuum group at the ESRF in Grenoble, France, where he remained until 2009. In 2004 he took a one-year sabbatical leave to work on the installation of the cryomodules of the linac of the SNS, ORNL laboratory, Oak Ridge, USA. Between 2009 and 2011 he worked at the ITER thermonuclear fusion project, Cadarache, France, in the vacuum pumping group. He then joined the Vacuum Surfaces and Coatings group at CERN, where he is now Senior Applied Physicist. He is mostly known for the development of the ray-tracing montecarlo codes Molflow+ and SYNRAD+, the latter being used for synchrotron radiation studies. He was the original developer of non-evaporable getter vacuum chambers on light sources since the year 1999. He has been and still is member of the machine advisory committee of 7 light sources, and reviewer for other accelerator projects.

Course Descriptions

(2)

Properties of small molecules: bridging surface science and vacuum technology

Prof. Katsuyuki Fukutani
(University of Tokyo)

Course description:

Understanding the interaction of molecules with surfaces is of fundamental importance for molecular processes at surfaces and vacuum technology. This course is designed for scientists, engineers, and students who would like to know the basic concepts of molecule interaction with surfaces and the behavior of small molecules at surfaces such as hydrogen, oxygen, water among others.

Duration: half day

(3)

Short Course: Plasma Processing; From Fundamentals to Atomic Layer Processes

Prof. Satoshi Hamaguchi

Lecturer: Prof. Satoshi Hamaguchi has been Professor of Engineering at the Center for Atomic and Molecular Technologies, Graduate School of Engineering, Osaka University since 2004. He has been working on analyses of plasma surface interactions for semiconductor processing, using numerical simulations and beam/plasma experiments. Prior to joining Osaka University, he was Associate Professor of Energy Science at Kyoto University, and Research Staff Member at IBM T. J. Watson Research Center, Yorktown Heights, NY. He received his B. Sc., M. Sci., and D. Sci. degrees from the Department of Physics, University of Tokyo, and M. Sci and Ph.D. degrees in mathematics from Courant Institute of Mathematical Sciences, New York University. He is a Fellow of American Vacuum Society and American Physical Society.

Aims: The course provides basic knowledge of plasma processing of materials, focusing on semiconductor processing, and introduces the forefront of research in atomic layer processes such as atomic layer deposition (ALD) and atomic layer etching (ALE).

Who Should Attend?: Students, scientists, and engineers in industry who are interested in learning the basics of plasma processing and, especially, atomic layer processes.

Contents: (3-hour lecture)

1. Basics of plasmas and plasma processing tools
2. Basics of plasma-surface interaction
3. Reactive ion etching and plasma-enhanced chemical vapor deposition
4. Outline of atomic layer deposition
5. Outline of atomic layer etching

Course Materials: Printed and electronic copies of the presentation slides

Course Descriptions

(4)

Reactive magnetron sputter deposition

Diederik Depla, Professor, Ghent University, Ghent, Belgium

Course Objectives

- Understand the fundamental processes driving (reactive) magnetron sputtering
- Develop strategies for dedicated experiments to unravel the complexity of reactive magnetron sputtering
- To get a good overview of the current literature and modelling techniques.

Course Description

Reactive magnetron sputter deposition is a mature technique often used in laboratories and at industrial level to grow compound thin films. The growth of these films is defined by the deposition conditions, and therefore a good knowledge of the deposition process is essential to tune the growth and as such the film properties.
After a short introduction on the physics of sputtering, the magnetron discharge and the transport of sputtered atoms through the gas phase, the course starts with a few definitions regarding reactive sputtering to show that the processes driving this technique are general applicable. This introduction assists the attendee to the next step : the description of the most common experiment during reactive magnetron sputtering, the hysteresis experiment. The simplicity of this experiment fools initially the scientist because it hides a complex interplay between different processes that define the actual outcome of the experiment. During the course, the details of this experiment are analyzed, and modelling is used to guide the attendee. In this way, the attendee will gain knowledge in a wealth of important process controlling the film growth. A good knowledge of these processes will arm the attendee to analyze and to control the reactive sputtering process.

Course Content

- Sputtering : physics of sputtering, and transport of sputtered atoms
- Magnetron discharges : typical features, electron emission, excitation and ionization
- Hysteresis experiments : what can we learn from this "simple" experiment ?
- Influence of deposition parameters
- Dynamics of reactive sputter deposition
- Arcing
- Discharge voltage behavior
- Process parameters and thin film growth
- Questions and answers

Who should attend?

This course is intended for engineers, scientists, and students
Interested in reactive sputter deposition and its applications.

Course materials

Lecture notes based on the handbook "Magnetrons, reactive gases and sputtering" will be provided.

(5)

Introduction to High Power Impulse Magnetron Sputtering (HiPIMS)

Daniel Lundin
Visiting Professor, Plasma and Coatings Physics Division, Linköping University, Sweden

Course objectives

- Understand the fundamental processes in magnetron sputtering
- Gain a comprehensive description of the HiPIMS process from the fundamental discharge physics to applications
- Show how the HiPIMS process parameters can be adjusted to control film growth and thereby tune film properties, including hardness, homogeneity, and residual stress

Course description

I will give an introductory seminar on thin film deposition using high power impulse magnetron sputtering (HiPIMS), and how this sputtering technique differs from conventional magnetron processes. The seminar includes a brief introduction to the fundamentals of thin film growth using magnetron sputtering with emphasis on the role and characteristics of the plasma. Experimental results and simulations, based on industrially relevant material systems, will be used to illustrate mechanisms controlling nucleation kinetics, column formation, and microstructure evolution.

Furthermore, ionization of sputtered atoms will be discussed in detail for various target materials, since it enables effective surface modification via ion etching and self-ion assistance during film growth, as well as being a key feature in HiPIMS. In addition, the role of self-sputtering, secondary electron emission, and the importance of controlling the process gas dynamics (both inert as well as reactive gases) will be examined in detail with the aim to generate stable HiPIMS processes.

We will also look at how to characterize the HiPIMS discharge to establish general trends on how to optimize any given HiPIMS process. Such process optimization will also allow us to identify what external parameters to adjust for controlling film growth and thereby tune film properties, including hardness, homogeneity, and residual stress.

Who should attend?

This course is mainly intended for students, engineers, and scientists interested in plasma-based thin film deposition and its applications.

Course material

Lecture notes based on the book *High Power Impulse Magnetron Sputtering* (Elsevier, 2020) will be provided.

Course Descriptions

(6)

Course outline:

Control of Micro- and Nanostructure Evolution during Sputter-Deposition

Ivan Petrov

- **Materials Science Department and Materials Research Laboratory, University of Illinois at Urbana Champaign, USA**
- **Department of Physics, Chemistry and Biology, Linköping University, Sweden**
- **Department of Materials Science and Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan**

1) Control of microstructure evolution during sputter-deposition
   a) Film growth processes—nucleation, coalescence, competitive grain growth, recrystallization
   b) Zone diagrams
   c) Epitaxial growth
   d) Effects of reactive species.

2) Use of low-energy ion bombardment to control microstructure during low temperature film growth
   a) Effects of sputtered atoms energy
   b) Effects of gas ion energy
   c) Use of high fluxes of low-energy gas ions
   d) Metal-ion assisted growth – dense, stress-free films; a) Use of synchronized bias in HIPIMS
   e) Kinetic roughing and surface facet formation
   f) Texture inheritance
   g) Metal-ion etch and adhesion control

3) Self-organized nanostructure formation
   a) Thermal segregation and renucleation – random nanocomposites
   b) Ion-assisted segregation – highly-oriented nanocomposites; equiaxed to columnar transition
   c) Resputter yield amplification: HfAlN
   d) Self-organized 3D superlattices via vacancy ordering
   e) SiOx Nanowires by ion-enhanced vapor-liquid –solid (VLS) growth

(8)

Short Course: Scanning Probe Microscopy (6h)

Prof. Franz J. Giessibl

Instructor: The courses are taught by Franz J. Giessibl, who did his PhD studies with Gerd Binnig, Physics Nobel Laureate of 1986, co-inventor of the scanning tunneling microscope (STM) and inventor of the atomic force microscope (AFM) at the IBM Research Division. After his PhD, he moved to Silicon Valley to work at Park Scientific Instruments (now Park Systems) where he succeeded for the first time to image the silicon 7x7 reconstruction by AFM. Franz J. Giessibl is the inventor of the qPlus sensor, a sensor that enables atomic force microscopy with subatomic spatial resolution and uncompromised simultaneous STM/AFM. He has also contributed to the mathematical foundations of noncontact AFM such as force deconvolution algorithms. He holds a chair in experimental and applied physics at the University of Regensburg in Germany.

Who Should Attend? Undergraduate as well as graduate students, but also senior scientists who are interested in exploring the world of high resolution AFM and combined STM/AFM.

Contents:

1. Basics of scanning tunneling microscopy
2. Basics of atomic force microscopy
3. Special challenges faced by AFM
4. Frequency-Modulation AFM
5. Introduction of the qPlus sensor
6. Selection of key experiments :
   - Subatomic spatial resolution
   - Atomic manipulation and driving forces
   - AFM studies of designed atomic quantum structures
   - Measurement of ultraweak forces

Course Materials: Printed copies of key papers, pdf of slides

Course Descriptions

(7)

X-Ray Photoelectron Spectroscopy (XPS/ESCA) - John T. Grant / 2 days

Instructor

The course is being taught by **John T. Grant**, who has over 40 years experience in surface analysis, and who has been teaching such courses for many years. He had been a Distinguished Research Scientist at the University of Dayton for over 30 years. He is now a consultant in surface science. He is co-editor of the book: Surface Analysis by Auger and X-ray Photoelectron Spectroscopy.

Who Should Attend?

Scientists, engineers, technicians, and students, who would like a detailed understanding of the principles and uses of XPS/ESCA for surface analysis and depth profiling.

Description and Objectives

XPS is used to determine the atoms present at a surface and their concentrations, chemistry, and lateral and depth distributions. This course is designed for scientists, engineers, technicians, and students, who would like a detailed understanding of the principles and uses of XPS/ESCA for surface analysis and depth profiling. Topics include the principles of XPS, instrumentation, qualitative analysis, quantitative analysis, artifacts, data acquisition and processing, imaging, and depth profiling.

Course Materials

Printed copy of all slides

Program

Day 1:

- **Introduction -** terminology, surfaces, types of surfaces.
- **The principles of XPS -** production of photoelectrons, peak labeling, electronic configuration of atoms, atoms, molecules, solids, binding energy, spectra, Auger process, valence spectra, handbooks, books, surface sensitivity, information depth, sample handling, spin-orbit splitting, chemical shift, plasmons, multiplet splitting, shake-up.
- **Instrumentation -** dual anode, Bremsstrahlung, monochromatic sources, electron energy analyzers, spectrum acquisition, energy resolution, scattering in analyzers, electron detectors, pulse counting, position sensitive detectors, small area analysis, area location, imaging XPS, methods, equipment and examples, vacuum system, samples, energy scale calibration.

Day 2:

- **Qualitative analysis -** identification of elements, changing x-ray sources, charging, interpretation of chemical shift, relaxation effects, Auger parameter, peak widths, lineshapes.
- **Quantitative analysis -** sensitivity factors, ionization cross section, asymmetry parameter, analyzer transmission, reference spectra, intensities, background subtraction, detection limit, effect of thin overlayers.
- **Artifacts -** x-ray damage, charging, methods for charge control, ghost peaks.
- **Data acquisition and processing -** processing data, background subtraction, satellite subtraction, peak area, lineshapes, curve fitting, deconvolution.
- **Depth profiling -** non-destructive and destructive methods, angle resolved XPS, diffraction, elastic scattering, thickogram, inelastic loss method, sputtering, depth calibration.
- **Applications -** some further examples of applications of XPS.
- **Instrument selection and summary -** factors to consider, general summary.