# NEXT COURSE WILL RUN IN 2011

# SURFACE ANALYSIS:

## AN INTRODUCTION TO XPS, SCANNING AUGER MICROSCOPY AND SECONDARY ION MASS SPECTROMETRY

**20 – 24 April 2009**

### THE COURSE

This is a one week postgraduate level course. The aim is to provide an intensive introduction to the principles of the electron spectroscopic techniques of X-ray photoelectron spectroscopy (XPS or ESCA) and Auger electron spectroscopy (AES), together with scanning Auger microscopy (SAM) and secondary ion mass spectrometry (SIMS). The course will be staffed by lecturers with considerable experience in applied surface analysis, drawn from both the University of Surrey and elsewhere. Each day will comprise lectures, laboratory demonstrations and classes with the course tutors. Attendees with specific problems concerning the applications of electron spectroscopy will have ample opportunity to consult the lecturers. The number of registrants will be limited to ensure maximum benefit from both the practical classes and tutorial sessions.

### WHO SHOULD ATTEND?

The course is for you if you need a thorough grounding in these surface analysis methods, both for "trouble-shooting" investigations and longer term research projects. As the field of surface analysis continues to develop very rapidly, the course provides an ideal opportunity to review the scope and applicability of such methods for specific applications. If the course would be useful for some of your colleagues, please pass the brochure on or contact us for additional copies.

While the course is open to all, a scientific or engineering education to degree level, or a higher education qualification in physics or chemistry is desirable.

### COURSE FORMAT

The course will commence at 09.30 on Monday 20 April 2009 and continue until lunch time on Friday 24 April. Each day there will be three or four lectures, together with demonstrations and laboratory classes on a variety of surface science instruments. There will also be tutorial classes to reinforce the various lecture topics.

Lecture notes will be distributed at registration and will include much of the detailed visual material presented by each lecturer. This will relieve you of some note-taking and will permit greater concentration on the topic. However, these handouts are merely notes, and are intended to **supplement** lectured material. Copies will only be made available to registered attendees.

## ENROLMENT

Each applicant should complete the Registration Form at the back of this prospectus and return it with the appropriate remittance. Additional forms may be photocopied as required.

The basic Course Fee will be £1125 and includes tuition, instrument time, one set of lecture notes and a personal copy of *An Introduction to Surface Analysis by XPS and AES* by Watts & Wolstenhome.

**Companies sending two delegates may send a third delegate for the price of the accommodation and meals only.**

Full joining instructions will be sent to delegates approximately two weeks before the course.

The cost of coffees, lunches and teas from coffee, Monday 20 April until lunch, Friday 24 April will be a further £50. The closing date for applications is Friday, 6 April 2009 although later registrations will be accepted if places are still available. Cheques should be made payable to the "University of Surrey" in £ sterling.

## ACCOMMODATION

When you register you may request a list of local accommodation. A range of hotels is available. There are also guesthouses and the local YMCA offering good accommodation at reasonable rates. We would recommend early reservations as accommodation in Guildford is always at a premium.

## DISCLAIMER

The organisers reserve the right to amend the sequence of lecture topics and to cancel lectures or substitute lecturers if necessitated by circumstances beyond their control.

# LECTURE TOPICS

1. **Introduction to Photoelectron and Auger Spectroscopy I: Basic Principles**
**J E Castle**
Emission of electrons from solids, the photo-electric effect, Auger de-excitation, depth of analysis, nomenclature employed.

2. **Introduction to Photoelectron and Auger Spectroscopy II: Chemical Information**
**J E Castle**
Chemical shift phenomena in XPS, Auger chemical shift and the Auger parameters, the problems of charge referencing with insulators.

3. **Introduction to Secondary Ion Mass Spectrometry** **J F Watts**
Sputtering processes, basic principles of SIMS, static, dynamic and imaging modes. Mass spectral resolution, interpretation, quantification and matrix effects. Comparison of available instrumentation.

4. **Instrumentation for Surface Analysis** **J F Watts**
UHV technology, materials, valves, feedthrough, types of pumps, general spectrometer design.

5. **SIMS Analysis of Inorganic Systems** **J F Watts**
The benefits of SIMS in materials science applications will be illustrated by a series of examples from corrosion, oxidation and allied fields. The use of SIMS in its spectroscopy (point analysis) depth profiling and imaging modes will be described and the additional advantages of high transmission analysers (such as ToF instruments) will be described.

6. **Quantitative XPS of Surface Nanostructures by Analysis of XPS Peak Shape**

7. **Auger and X-Ray Mapping** **M A Baker**
Levels of information to be obtained by combining EPMA and SAM facilities on the same microscope. Optimising experimental conditions.

8. **Sputter Depth Profiling** **J E Castle**
Choice of experimental conditions, depth resolution attainable, preferential sputtering, analytical use of sputter depth profiling in XPS, AES and SIMS.

9. **Non Destructive Depth Profiling** **J F Watts**
The use of angle resolved XPS, and multi-source XPS (AlK$\alpha$, MgK$\alpha$, AgL$\alpha$, CrK$\beta$ and synchrotron radiation) will be discussed.

10. **Applications I: Corrosion Phenomena; Spectra and Images** **J E Castle**
Relationships of XPS and SAM investigations to electrochemistry, studies of corrosion products and formation of passive films. SAM studies of submicron pits, initial stages of pitting corrosion.

11. **XPS at High Spatial Resolution** **J F Watts**
The last decade has seen the size of analysis attainable in XPS reduced from the "standard" condition of XPS (several $mm^2$) through small area XPS (100-250 $\mu$m) to imaging XPS where a spatial resolution of <5 $\mu$m has been demonstrated. This lecture will review the ways in which spatial resolution can be achieved in XPS and describe the commercial instruments currently available that provide an XPS image.

**12. Surface Analysis of Polymers: SIMS** **S J Hinder**

Although XPS can provide invaluable information concerning the chemical environments of the elemental constituents of polymeric materials it is generally unable to provide molecular specificity. This can be achieved by carrying out static SIMS analysis of these materials. This lecture will cover sample preparation, analysis protocol and spectral interpretation of the SIMS spectra acquired from high polymers.

**13. Applications II: Analysis of Hard Coatings** **M A Baker**

AES/XPS for analysis of coatings and relating to other methods such as FTIR, GAXRD, EXAFS and GYPS.

**14. Applications III: Adhesion** **J F Watts**

Difficulties encountered in the surface analysis of polymeric materials, adhesion between organic and inorganic phases, environmental degradation of polymer-to-metal adhesion. The use of XPS in the determination of the acid-base properties of materials.

**15. Recent Advances in Surface Analysis** **J Wolstenholme**

The last decade has seen many instrumental developments in XPS, AES and SIMS. This lecture will review current advances particularly in the provision of analytical information at high spatial resolution.

# THE LECTURERS

## COURSE DIRECTOR AND LECTURER

**Professor John F Watts:** Professor of Materials Science at the University of Surrey, within the Faculty of Engineering & Physical Sciences he is Head of Materials, Surfaces and Structural Systems and is also Director of the UniS Materials Institute. He has extensive experience in the application of surface analysis (XPS, AES, ToF-SIMS and SPM) to applied problems in materials science. His research fields include adhesion between inorganic and organic phases and their subsequent failure, and surface characterisation of polymeric materials, he was awarded a DSc in 1997 for this work (following a PhD in 1981). He has over 270 publications in adhesion and applied electron spectroscopy and has lectured widely in the UK, Europe, the USA and the Far East. He is Editor-in-Chief of the journal Surface and Interface Analysis. He is on the organising committee of SIMSXV and a member of the International Steering Committee of the biennial ECASIA conference series.

## LECTURERS

**Dr Mark Baker:** Dr Baker is a Senior Lecturer in Interface Engineering at the University of Surrey. After obtaining his PhD from the University of Surrey he worked in the electronics industry and spent 6 years running the electron spectroscopy laboratory in the Surface Engineering Unit at the EU Institute of Advanced Materials, Ispra, Italy. His current main research interest is the use of advanced analytical techniques to characterise nanostructured coatings for wear resistant applications. He has over 15 years experience in the application of electron spectroscopic and microscopic techniques to the study of thin films, coatings and corrosion and has published over 60 refereed papers. He is Director of the MicroStructural Studies Unit at Surrey and is a Chartered Scientist.

**Professor James E Castle:** Emeritus Professor in the Faculty of Engineering & Physical Sciences at the University of Surrey. He has published well over 200 papers in the fields of thin film and interface analysis, using all forms of surface analysis, including the scanning probe microscopies. He has served on the Editorial Boards of several major journals in the field. His current interests include studies of electrochromic thin films and the supra-molecular structures of bio-molecules adsorbed on surfaces and the manner in which surface bonding influences their conformation. He is currently co-ordinator of an EU project on intercalation of lithium ions into thin films of vanadium oxide in the context of electrochromic devices. Recent interests, still coming into publication, deal with transport of copper with the working fluids of electrical generation equipment used in the power industry.

**Dr Stephen J Hinder:** Research Fellow and Operations Manager of the Surface Analysis Laboratory at the University of Surrey. He obtained his PhD from the Laboratory of Biophysics and Surface Analysis at the University of Nottingham. He has 10 years experience in the use of SIMS and XPS instrumentation. His current research interests include the use of surface analytical techniques to characterise and enhance the surface and interfacial properties of complex polymeric coating systems. He carries out much of the contract analysis work undertaken by the Surface Analysis Laboratory and thus has extensive experience of applying SIMS and XPS to a wide variety of material systems.

**Dr J Wolstenholme:** Marketing Manager at Thermo VG Scientific. With a background in SIMS, he has been actively involved in XPS and AES for the last twelve years.

# THE SURFACE ANALYSIS LABORATORY

The unit operates all three classes of popular surface analysis instrumentation; XPS, AES/SAM and ToF-SIMS, together with atomic force microscopy. The installed capital value of this instrumentation is of the order of £3M. This includes state-of-the-art instruments for scanning probe microscopy and X-ray photoelectron spectroscopy. This establishes the Surface Analysis Laboratory as the most complete cluster of such instrumentation certainly in Europe, and perhaps in the world.

Our latest XPS system is capable of small area analysis at spot sizes down to 15 microns; this, combined with the high spectral resolution, finds use in research programmes as diverse as polymer surface chemistry through to small corrosion pits in stainless steels. We also operate two scanning Auger microscopes for surface analysis at high spatial resolution (100nm); these instruments are also equipped for both X-ray detection and excitation, making possible the simultaneous acquisition of Auger and X-ray (EDXA) spectra thus giving access to the chemical composition of both the surfaces and the bulk of the material.

All instruments are fitted with sputter ion guns to allow compositional depth profiling to a depth of 1μm. A complete range of in-situ and ex-situ sample preparation stages are available allowing the analysis of the most complex specimens encountered in materials investigations.

SIMS is an extremely surface sensitive technique which has the additional advantage of providing information concerning molecular species and cluster ion formation. ToF-SIMS provides a mass range in excess of 10,000 Da and extremely high mass resolution. The latter capability enables, for example, the $CHO^+$ and $C_2H_5^+$ ions from PMMA at a nominal mass of 29, to be separated quite readily. The Surrey ToF-SIMS instruments have facilities for high spatial resolution imaging of insulators and compositional depth profiling in addition to state-of-the-art spectral resolution.

In recent years the scanning probe techniques of scanning tunnelling microscopy (STM) and atomic force microscopy (AFM) have developed into powerful methods for the characterisation, at an atomic level, of the surface morphology of both conductors and insulators. In conjunction with British Gas plc we are completing a five year programme to study electrochemical processes, occurring in aqueous media at metal surfaces, by STM and AFM. We are the first laboratory in the UK to be equipped with an electrochemical STM/AFM, one in which microscopy and electrochemistry are performed simultaneously in the same instrument.

As well as acting as a focal point for the research projects described in our Research Portfolio the Surface Analysis Laboratory has extensive experience of providing an analysis service to other scientists, both in industry and academia. The latter role was formally recognised in 1985 when the laboratory was designated a SERC Centre for Electron Spectroscopy, with the specific brief of developing and providing surface analysis by electron spectroscopy for the materials community. There is also a strong commitment to the teaching of electron spectroscopy to scientists from outside the University. This is fulfilled by the provision of short courses supported by an introductory text and software package.

For details of our commercial services please contact Professor J F Watts - 01483 689617

# MODULAR MSc PROGRAMME

This short course is offered as a module in our part-time or full-time Modular MSc Programme in Advanced Materials.

The **Advanced Materials Programme** aims to study the structure, processing and properties of a range of advanced materials and associated analytical techniques. The principal objective of the programme is that science and engineering graduates will be equipped with a thorough understanding of several classes of advanced materials and of means by which they can be characterised.

The modules available are set out below. Each module may be taken as an individual short course.

| | |
|---|---|
| ENGM098 | Introduction to Materials Science |
| ENGM099 | Introduction to Physical Metallurgy |
| ENGM117 | Ceramics and Ceramic Matrix Composites |
| ENGM100 | Polymers for Advanced Applications |
| ENGM102 | Introduction to Composite Materials Science |
| ENGM103 | Characterisation of Advanced Materials |
| ENGM124 | Nanomaterials |
| ENGM104 | Surface Analysis: XPS, Auger and SIMS |
| ENGM105 | Scanning Probe Microscopy |
| ENGM003 | Research Methods |
| ENGM106 | Materials under Stress: An Introduction to Fracture Mechanics and Fatigue |
| ENGM107 | Adhesive Bonding Technology |
| ENGM109 | Materials for Biomedical Engineering Applications |
| ENGM111 | Surface Engineering |
| ENGM112 | Numerical Modelling in Materials Engineering |
| ENGM113 | Composite Technology & Smart Systems |
| ENGM114 | Corrosion Engineering |
| ENGM115 | The Science of Adhesion |

Candidates who choose to conduct a project need to complete 7 taught modules.
Candidates who choose to conduct an independent study need to complete 9 taught modules.

If a student wishes to take 'Introduction to Materials Science and Engineering' it must be one of their first three modules. This module is not normally available to students who hold a degree in Materials Science and Engineering.

If a student wishes to take 'Introduction to Composite Materials Science' and 'Composite Technology and Smart Systems' they must take the introductory module first.

Further details of our programme can be found on our web pages

http://www.surrey.ac.uk/eng/pg/mse

# REGISTRATION FORM

## SURFACE ANALYSIS

UNIVERSITY OF SURREY, GUILDFORD, UK
20 – 24 April 2008

Name........................................................................................ Title...............................

Company/Affiliation: ..........................................................................................

Address: ..........................................................................................................

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Tel. No: ........................................email address ..........................................................

Name of Approving Manager: ...........................................................................

| | | | £ |
|---|---|---|---|
| 1. | **STANDARD COURSE FEE** | | 1125.00 |
| | each delegate will receive one set of Lecture Notes | | |
| | 3 delegates may attend for the price of 2 | | |
| | Reduced fee for registered MSc students | | 1100.00 |
| 2. | **MEALS - Coffee, Lunch, Tea** | 5 days | 50.00 |
| 3. | **PARKING** | | ☐ |

**The following should be completed as applicable**

Please charge to the following credit card No.......................................................

3-digit security no. ..............................

Expiry Date..........................................

Name of Cardholder ..........................................................

Type of Card: Visa/ Mastercard / Other: ..........................................

I enclose a cheque for £ ......................................

Please invoice myself/my company for £ ......................................

Order No or Reference/Invoice Address ..........................................................

Company VAT registration number ..........................................................

Special dietary requirements, if any ..........................................................

I AM/AM NOT registered for the MSc in Advanced Materials (URN: _______________ )

**This form should be returned to:**

Lesley Watts
Faculty of Engineering & Physical Sciences (C5)
University of Surrey, Guildford, Surrey, GU2 7XH, U.K.
Tel: 01483 689378 Fax: 01483 686671 Email: advancedmaterialsmsc@surrey.ac.uk

**PLEASE REGISTER BY MONDAY 6 APRIL 2009**
**LATER REGISTRATIONS WILL BE ACCEPTED IF PLACES ARE AVAILABLE**