

Please Note: some of our courses are run every year and some alternate years. This is the most recent brochure available. After November 2005 we are planning to run this course next in December 2007.

**CHARACTERISATION OF ADVANCED MATERIALS
Methods for bulk, surface and structural characterisation**

28 November - 2 December 2005

THE COURSE

The aim of this five-day course is to introduce the principles of the most popular materials characterisation methods based on microscopy, chemical, physical and structural analysis and thermal techniques. Consideration will also be given to the analysis of particulate materials and coatings. The basic principles used for the physical characterisation of materials will be outlined; microscopy by light, electrons and scanned probes will be introduced; and the readily available bulk characterisation methods such as diffraction, X-ray analysis and vibrational spectroscopies will be described. Surface analysis by electron and ion spectroscopies will also form an important part of the course. Particular emphasis will be paid to the use of a variety of methods in multi-technique approaches for the characterisation of advanced materials.

The course will be staffed by lecturers with considerable experience in materials characterisation. The programme will comprise lectures, laboratory demonstrations, computer simulations and exercise classes with the course tutors.

WHO SHOULD ATTEND?

The course is directed at engineers and scientists who require a thorough grounding in the characterisation methods described above. They are applicable to a wide range of industrial scenarios including "trouble-shooting" investigations, quality assurance and longer term research projects. As the field of materials characterisation is developing very rapidly, the course provides an ideal opportunity to review the scope and applicability of the more specialist methods of microscopy and surface analysis. 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 10.15 on Monday 28 November and continue until lunchtime on Friday 2 December. Each day there will be lectures, together with demonstrations and laboratory classes on a variety of materials characterisation methods. There will also be tutorial classes to reinforce the various lecture topics. A textbook will be distributed as part of the course material.

Lecture notes will be distributed at registration and will include much of the detailed visual material presented by each lecturer. This will relieve the student 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.

PLEASE CIRCULATE THIS BROCHURE

For registrations and enquiries please phone Rebecca Jones on 01483 689378

ACCOMMODATION

There is no University accommodation available for this course so when you register you will be sent a list of local accommodation. A range of hotels is available and also guest houses and the YMCA offering good accommodation at reasonable rates. Early reservations are recommended as Guildford accommodation is at a premium.

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 £1020 and includes tuition, instrument hire, one set of lecture notes and a personal copy of "Physical Methods for Materials Characterisation" by P E J Flewitt and R K Wild. The cost of all meals (excluding dinner) from morning coffee on Monday 28 November 2005 until Lunch on Friday 2 December will be a further £50.00.

The closing date for applications is Friday, 11 November 2005. Cheques should be made payable to the "University of Surrey" in £ sterling. **Companies sending two delegates may send a third delegate for the price of their meals only.**

If there are a number of people in your company who would benefit from a course in this field, please contact us to discuss the possibility of an in-house, customised, course to meet your requirements.

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** **J F Watts**
The requirements of materials characterisation and overview of the techniques available to meet these requirements.
- 2. Overview of Physical Property Characterisation** **J A Yeomans**
An introduction to the measurement of density, elastic constants, and other physical properties.
- 3. Thermal Analysis** **I Hamerton**
This lecture will introduce the basic principles of thermogravimetric analysis and differential scanning calorimetry together with associated techniques. The use of these methods for the analysis of inorganic and organic materials will be illustrated.
- 4. X-Ray Diffraction – Basic Concepts** **P R Slater**
A brief review of the crystalline state and the underlying principles of x-ray diffraction including Bragg's Law and the reciprocal lattice.
- 5. X-Ray Diffraction – Examples** **P R Slater**
The use of XRD in materials characterisation and the interpretation of diffraction patterns.
- 6. Infra Red Spectroscopy** **J A Bevis**
Vibrational spectroscopy is a valuable tool for the investigation of chemical bonding in materials, allowing identification of matrix and contaminants. After discussing the basic principles, modifications allowing application to various specimen types will be considered. Case studies to illustrate the use of a range of these applications will be presented.

7. **Light Microscopy** **J A Yeomans**
Preparation of samples for light microscopy; use of reflected light, polarised light and confocal imaging modes.
8. **Image Acquisition Analysis and Processing** **M A Baker**
A common theme in all branches of microscopy is the need to be able to interpret the images quantitatively using image processing packages. This lecture will bring out the synergies present between the different branches of microscopy and emphasise care that must be taken in the acquisition of the primary data to obtain meaningful results.
9. **Electron Interactions** **M J Whiting**
Elastic and inelastic electron scattering by solids; relaxation of ionized atoms by X-ray and Auger electron emission. Electron and X-ray inelastic mean free paths in solids, secondary and backscattered electrons, Monte Carlo calculations.
10. **Scanning Electron Microscopy I** **Y Chen**
This lecture will describe the operational components of a scanning electron microscope and explain the principles behind the formation of a focused electron beam and the rastering of beam to produce a secondary electron image.
11. **Scanning Electron Microscopy II** **M J Whiting**
Although an SEM is routinely used to acquire topographic information there are multitude of other analytical signals that are available. This lecture will provide an overview of the value of such signals in the analysis of materials.
12. **Chemical analysis in the Electron Microscopy** **Y Chen**
The analysis of x-rays in the electron microscope by either energy dispersive (EDX) or wavelength dispersive (WDX) spectrometers is the cornerstone of much work carried out by materials analysts. The operating principles of EDX and WDX will be described together with a critical comparison of the two methods of materials analysis.
13. **Transmission Electron Microscopy** **M J Whiting**
Transmission electron microscopy is widely used for the examination of the microstructure and nanostructure of all classes of materials. The basic working principles of a TEM will be introduced together with the more common analytical options that may be encountered such as x-ray analysis and energy loss spectroscopy.
14. **Scanning Probe Microscopies** **P Zhdan**
Basic principles of scanning tunnelling and atomic force microscopy (STM/AFM). Studies of "real" surface and the immersed electrolyte/electrode interface.
15. **X-Ray Photoelectron Spectroscopy** **J F Watts**
XPS is the most widely used surface analysis method. The principles of photoemission will be introduced together with quantitative aspects of the technique and spectral interpretation. Examples will be given of the use of XPS in adhesion, polymer and corrosion studies.
16. **Auger Electron Spectroscopy and Microscopy** **J F Watts**
AES provides the opportunity to acquire a surface specific analysis at extremely high spatial resolution (< 20 nm). Instrumental aspects of Auger spectroscopy and microscopy will be presented together with examples of its use in materials science investigations.

17. **Secondary Ion Mass Spectrometry** **J F Watts**
Sputtering processes, basic principles of SIMS, and the static, dynamic and imaging modes. Mass spectral resolution, interpretation, quantification and matrix effects. Comparison of available instrumentation. Applications.
18. **Particulate Systems** **J A S Cleaver**
Particulate systems pose their own special problems to the materials analyst. This lecture will review methodologies for the handling of particulates and determination of their size and specific surface area.
19. **Inorganic Thin Films and Coatings** **M A Baker**
Introduction to selected analysis techniques (eg FTIR, GAXRD, EXAFS, GDOS) used to examine the composition, microstructure and bonding in coatings.
- 20 **Organic Coatings** **J L Keddie**
The examination of organic coatings such as paint films is best carried out by adopting a multi technique approach. Popular candidates for this type of research such as ellipsometry, variable angle spectroscopic ellipsometry and SPM will be shown to provide invaluable information on such systems.

THE LECTURERS

JOINT COURSE DIRECTORS AND LECTURERS

Professor John F Watts: Professor of Materials Science at the University of Surrey and Head of the Materials, Surfaces and Structural Systems Research Centre. He has extensive experience in the application of surface analysis 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 is currently Director of the Centre for Advanced Surface, Particle and Interface Engineering in the School of Engineering and Editor-in-Chief of the journal *Surface and Interface Analysis*. He has over 240 publications in adhesion and applied electron spectroscopy and has lectured widely in the UK, Europe, the USA and the Far East.

Dr Julie Yeomans: Director of the EngD Programme in Micro- and NanoMaterials and Technologies (MiNMaT) and Reader in Ceramics in the School of Engineering at the University of Surrey. She joined the University in 1988 from the BP Research Centre. This followed a first degree in Materials Science and Metallurgy and a PhD on microstructure-property relationships in ceramic tool materials, both at the University of Cambridge. Her current research is concerned principally with toughening mechanisms in ceramics and ceramic matrix composites and their effect on wear and thermal shock resistance. She is an Editor of the *Journal of Materials Science*, a member of the Ceramic Science Committee of the Institute of Materials, Minerals and Mining and Chair of the EPSRC Structural Ceramics Network (SCerN).

LECTURERS

Dr Mark Baker: Senior Lecturer in Interface Engineering at the University of Surrey and Director of the MSc Programme in Advanced Materials. After obtaining his PhD from the University of Surrey he has worked in the electronics industry and recently spent 6 years running the electron spectroscopy laboratory in the Surface Engineering Unit at the European Commission Institute of Advanced Materials, Ispra, Italy. Currently researching into the use of analytical techniques to characterise and enhance the properties of coatings for mechanical applications. He has 12 years experience in the application of spectroscopic techniques to the fields of thin film analysis and corrosion.

Mr John Bevis: Principle Chemist at Prysmian Cables And Systems Ltd He has more than twenty years experience in the chemical analysis and the chemical properties of materials used in the manufacture of electric power cables, their joints and terminations. Current interests include the investigation of process materials and their deterioration and behaviour as well as compositional mapping in polymeric insulations.

Dr Yanling Chen: Experimental Officer in Electron Microscopy in the School of Engineering at University of Surrey. He has extensive experience in both scanning electron microscopy and transmission electron microscopy. In the past 10 years he has published more than 40 papers and most of them are based on microstructural studies of materials ranging from metals, ceramics and semiconductors to superalloys.

Dr Jamie Cleaver: Lecturer in Chemical Engineering and a member of the UniS Materials Institute. He has extensive research, teaching and consultancy experience in particle technology. Research interests are based around inter-particle forces, surface mechanical properties and the influence of water sorption by powders. He is currently vice-chairman of the IChemE Particle Technology Subject Group.

Dr Ian Hamerton is Senior Lecturer in Polymer Chemistry in the School of Biomedical and Molecular Sciences, having obtained both Ph.D. and postdoctoral experience with the Royal Aircraft Establishment (now QinetiQ/DSTL). With over 100 peer-reviewed publications, he has been actively researching in the area of high performance polymers for over 17 years. His publications encompass polyimides, cyanate esters and epoxy resins and include three patent applications (two involving novel cyanate esters), an edited book on the same subject, a textbook on the role of polymers in sustainable development, and a RAPRA review report concerning epoxy resins. He is a member of the advisory board for *Polymer International* and was until recently an active member of the Macro Group U.K. committee.

Dr Joe Keddle: Reader in Physics at the University of Surrey. Although currently working in the Department of Physics, he has degrees in ceramic engineering and in materials science. His research interests are reflected in his 65 research papers and book chapters on ceramic thin films, colloidal processing, polymer thin films and coatings, and techniques of characterisation, especially ellipsometry. In recent years he has been awarded two international prizes for his work on organic coatings.

Dr Peter Slater: Lecturer in Chemistry at the University of Surrey. He has been working in the area of inorganic materials for over a decade and has carried out research on solid oxide fuel cells, high temperature superconductors, fast ion conductors and magnetic materials. He has published over 70 papers and has also been commissioned to write a number of reviews. He is an acknowledged expert on structural characterization of inorganic materials by X-ray and neutron powder diffraction.

Dr Mark Whiting: Senior Lecturer in the School of Engineering at the University of Surrey. His two main research interests are phase transformations and the development of new intermetallic materials for high temperature applications. In both these areas transmission electron microscopy is utilised for defect characterisation (bulk and interfacial), crystallographic characterisation and chemical analysis (EELS and image filtering).

Dr Peter Zhdan: Senior Research Fellow in the School of Engineering at the University of Surrey. He received his PhD from the Institute of Catalysis (Novosibirsk) in physical chemistry in 1973. He spent 12 years at the Institute of Catalysis carrying out research in the field of electron spectroscopy and catalysis. In 1986 he joined the Karpov Institute of Physical Chemistry (Moscow) as the Head of the Laboratory of Electron Spectroscopy of Surfaces. He has published over 100 papers in the fields of surface science and

electron spectroscopy and is a member of two of the Research Councils of the CIS Academy of Sciences.

UNIVERSITY OF SURREY

The University of Surrey is one of the UK's leading professional, scientific and technological universities with approximately 12,500 students and a world class reputation for excellence in teaching and research.

Guildford is a thriving business and shopping centre for the surrounding area, easily accessible from London, 35 minutes by fast train and 30 miles by car on a fast road. Both London airports, Heathrow and Gatwick, are just 40 minutes by car; there is a direct rail service from Gatwick and a bus-rail service from Heathrow.

A large Research Park has been established on University land the other side of the A3 from the main campus. This provides facilities for industrial companies to conduct research, and operates in conjunction with the research schools already established at Surrey. Several major research establishments are also within a few miles, and many collaborative research projects with the University have resulted from this proximity.

SURFACE ANALYSIS RESEARCH

Research within this Group, which numbers some 30 academics and researchers, is concerned with the understanding of the manner in which materials surfaces interact with their environments and with each other. Such interactions may be deleterious as in the case of corrosion of metals or environmental degradation of polymers, or they may be beneficial, as we see in the pre-treatment of polymers to enhance their performance and the adhesion phenomena that occur between polymeric materials and metal oxides. Sponsorship for this work is obtained from both government and industrial sources and the current portfolio of research projects is split fairly evenly between fundamental scientific investigations and the study, and hopefully the solution, of problems directly relevant to industry and the community.

The focal point of the research group is The Surface Analysis Laboratory which contains the most complete cluster of surface analysis instrumentation (X-ray photoelectron spectroscopy, time-of-flight secondary ion mass spectrometry, scanning Auger microscopy and scanning probe microscopy) certainly in Europe, and perhaps in the world. The installed capital value of this instrumentation is of the order of £3M and includes state-of-the-art instruments for scanning probe microscopy and X-ray photoelectron spectroscopy. The ethos within the research group is that all student members have virtually unlimited access to this equipment, as required for their research projects. Industrial consultancy work is regularly undertaken using all of the techniques described above. For further details please contact Professor Watts.

Permanent Academic Staff: Professor J F Watts, Dr M A Baker. Professor Emeritus Professor J E Castle

MICROSTRUCTURAL STUDIES UNIT

This Unit was established in 1968, when the University occupied its first buildings at Guildford, in order to provide advanced electron microscopy facilities to every department; biological, physical and materials. Its services were soon in demand by industry and commerce, and it has been undertaking short and medium term industrial contracts ever since. These projects now make up about 15% of the Unit's work, and ensure that its academic research is informed by a real knowledge of the problems encountered by industry.

The Unit has been well supported by the EPSRC and other funding bodies, and represents a unique resource in the UK in terms of its combination of equipment and experienced manpower. Within the MSSU there are currently two transmission microscopes, offering high resolution and analysis with the Philips CM200 (which offers parallel EELS) and 400T three SEMs, one a Variable Pressure Microscope a Hitachi S-3200N, a Field Emission SEM S-4000, also from Hitachi, and a JEOL 8600 microprobe. Both the S-3200N and the 8600 have fully quantitative analysis and mapping.

Details of the MSSU's commercial services are available on request.

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.

- SE3M11 Introduction to Materials Science and Engineering
- SE3M12 Introduction to Physical Metallurgy
- SE3M41 Ceramics and Ceramic Matrix Composites
- SE3M14 Polymers for Advanced Applications
- SE3M15 Introduction to Composite Materials Science
- SE3M16 Characterisation of Advanced Materials
- SE3M56 Nanomaterials
- SE3M18 Surface Analysis: XPS, Auger and SIMS
- SE3M19 Scanning Probe Microscopy
- SE0M20 Research Methods
- SE3M26 Materials under Stress: An Introduction to Fracture Mechanics and Fatigue
- SE3M27 Adhesive Bonding Technology
- SE3M28 Managing Materials Cycles
- SE3M29 Materials for Biomedical Engineering Applications
- SE3M31 Surface Engineering
- SE3M32 Numerical Modelling in Materials Engineering
- SE3M37 Composite Materials Technology
- SE3M38 Corrosion Engineering
- SE3M39 Light Metals and Alloys
- SE3M40 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.

Further details of our programme can be found in our web pages.

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

REGISTRATION FORM

CHARACTERISATION OF ADVANCED MATERIALS

UNIVERSITY OF SURREY, GUILDFORD, UK
28 NOVEMBER – 2 DECEMBER 2005

Name Title.....

Company/Affiliation:

Address:

.....

Tel. No: email address

Name of Approving Manager:

		£
1. STANDARD COURSE FEE		1020.00
each delegate will receive one set of Lecture Notes		
Reduced fee for <u>registered</u> MSc students		995.00
2. MEALS - Coffee, Lunch and Tea		
from Coffee 28 November – Lunch 2 December	5 days	50.00

Please complete the following as applicable:

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

Name of Cardholder

Type of Card: Visa/ Mastercard / American Express / 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 Technology/Materials for Engineering Applications

Cheques should be made payable to the "University of Surrey" in £ sterling.

This form should be returned to:

Miss Rebecca Jones
School of Engineering (D3)
University of Surrey
Guildford Surrey GU2 7XH
Tel: 01483 689378 - FAX: 01483 686671 - email: rf.jones@surrey.ac.uk

**PLEASE REGISTER BY 11 NOVEMBER 2005 ALTHOUGH LATER REGISTRATIONS
WILL BE ACCEPTED IF PLACES ARE AVAILABLE**