

**Please Note: some of our courses are run every year and some alternate years. This is the most recent brochure available. We are planning to run this course next in March 2008.**

## **ADHESIVE BONDING TECHNOLOGY**

**3 - 7 APRIL 2006**

### **THE AIM OF THE COURSE**

The aim of the course is to provide a thorough grounding in the technology of industrial adhesive bonding. This will be achieved through a balance of lectures, tutorials and laboratory demonstrations and experiments.

### **WHO SHOULD ATTEND?**

This course is for you if you have responsibility for the design of systems involving adhesive joints, or for moving such designs through to production. You may be a materials scientist, a design engineer or production engineer or similar. No specific previous qualifications will be assumed but the level is set to appeal to those of graduate or equivalent status with some industrial experience.

Adhesive Bonding Technology is run by the University of Surrey and will feature lecturers from the University and industry. It has been selected by the EPSRC for sponsorship as a stand alone, masters level course.

### **MODULAR MSc PROGRAMMES**

The course may be taken as a credit bearing module in the University of Surrey Modular MSc programme in Advanced Materials. Further information on the programme is given towards the end of this brochure.

### **COURSE FORMAT**

The course will commence at 10.00 am on Monday 3 April 2006 and will run until early afternoon on Friday 7 April. The course will be delivered through illustrated lectures and tutorials; comprehensive lecture notes will be provided. You will have opportunities to discuss specific problems with the lecturers.

### **ENROLMENT**

Please complete the registration form at the back of this brochure and return it with the appropriate fee or request for an invoice. Please photocopy additional forms as required. The Course Fee will be £1020. There will be an additional charge for meals of £50 for the week to provide coffee, lunch, and tea each day. Please send registration forms to:

Rebecca Jones  
School of Engineering (D3)  
University of Surrey,  
Guildford, Surrey, GU2 7XH, U.K.  
Tel: 01483 689378    FAX: 01483 686671    Email: RF.Jones@surrey.ac.uk

## **ACCOMMODATION**

There is a possibility that University accommodation will be available; please contact us nearer the time. Otherwise 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.

The closing date for registration is Friday 17 March 2006. Please make your cheques payable to the "University of Surrey" in £ sterling. **Companies sending two delegates may send a third delegate for the price of their meals only.**

## **COURSE LECTURE NOTES**

You will be provided with a comprehensive set of lecture notes at registration. These notes include all the principal visual material presented during the course. These will supplement the oral presentations. Copies are made available only to those attending the course.

**For registrations and enquiries phone Rebecca Jones on 01483 689378**

## **LECTURE TOPICS**

- 1. The fundamentals of adhesion science** **Professor John Watts**  
A review of the mechanisms of adhesion and the quantitative treatment of the adsorption theory by a surface energy approach. A theoretical approach to durability and the relationship to observed loci of failure.
- 2. Polymer science** **Dr Marie-Laure Abel**  
A gentle introduction to carbon chemistry from methane to macromolecules. Thermoplastic and thermosetting resins, the concepts of chain branching and copolymerization. Structure-property relationships.
- 3. Adhesive formulation and the chemistry of adhesive types** **Dr Bryan Ludbrook**  
The constituents of practical adhesives, resins, extenders, thixotropes, adhesion promoters. A brief introduction to the more popular adhesive types such as epoxy, acrylic, cyanoacrylate and others.
- 4. Pretreatment prior to bonding** **Professor John Watts**  
The need for the pretreatment of metal and polymer surfaces prior to bonding. The development of both the correct chemistry and morphology, examples of anodizing of aluminium and corona treatment of polyolefines.
- 5. Health and safety and environmental aspects** **Dr Martin Fakley**  
Chemical toxicity and other hazards of materials involved in adhesive bonding, hazard assessment, environmental concerns, compliance with current and future legislation, sources of information. These requirements will be illustrated by a series of case histories from industry.
- 6. Mechanical Properties of Structural Adhesives** **Professor Andrew Crocombe**  
This lecture will review mechanical properties of adhesives that contribute to their structural performance. Such properties include constitutive and fracture data that is both linear and non-linear and temperature and rate dependent. Techniques for evaluating and representing such data will be discussed as well as typical values.

- 7. Other adhesive types** **Professor John Comyn**  
 A review of adhesives (other than the more common structural adhesives) which harden by (a) loss of solvent - solvent based neoprene adhesives, aqueous solutions and emulsions, (b) cooling - hot melt adhesives and (c) chemical reaction - silicones, formaldehyde condensates for wood and metals. Polyurethanes. High temperature adhesives. Adhesives which do not harden - pressure-sensitive adhesives.
- 8. Selection of Adhesives** **Dr Martin Fakley**  
 An overview of the types of adhesives available for use in engineering and structural applications. A computer based expert system, dedicated to adhesive selection, will be demonstrated during the course of this lecture.
- 9. Design of Adhesive Joints** **Professor Andrew Crocombe**  
 The role of detail design and stress analysis as well as conceptual evaluation of bonded joints will be established. Design tools will then be presented which facilitate such analyses. Design allowables will then be identified that can be used with these tools to enable a range of service loading conditions to be assessed. Design tools and design allowables for structural adhesive joints, under various service loading conditions, are discussed as well as the relationship of manufacturers specifications to the design process and existing design standards and guidelines.
- 10. Finite Element Analysis and its application to adhesive joints** **Dr Magd Abdel Wahab**  
 The principles of the finite element methods will be introduced. The theory behind the technique will be briefly reviewed and some modelling guidelines will be given. The application of FEA to adhesively bonded joints will be illustrated through examples of several joint types.
- 11. The Bonding Process** **Professor John Watts**  
 A review of practical considerations in making adhesive joints. The sourcing and storing of adhesives, dispensing of adhesives, cure procedures (thermal and other types), automation.
- 12. Modelling the Structural Response of Bonded Structures to Service Loading** **Professor Andrew Crocombe**  
 It will be shown how stress analysis techniques such as the finite element method can be used to simulate the response of complex bonded structures. A range of loading conditions will be considered including quasi-static, creep, fatigue and environmental degradation. Successful modelling of these conditions will lead to greater confidence in bonded products.
- 13. Fracture mechanics applied to adhesive joints** **Dr Magd Abdel Wahab**  
 In this lecture, the theory of Linear Elastic Fracture Mechanics (LEFM) will be reviewed. This includes the energy approach as well as the stress approach. The application of LEFM to bonded joints and brief introduction to Elastic-Plastic Fracture Mechanics (EPFM) will be presented.
- 14. Manufacturing case studies I: The automobile industry** **Mr Jeff Kapp**  
 Adhesive bonding has found a wide variety of applications in the automobile industry but perhaps the most technologically demanding is in the structural bonding area.
- 15. Manufacturing case studies II: The packaging industry** **Dr Mike Cochran**  
 A review of the types and applications of adhesives in the packaging industry will be given. Current developments and changes in practices due to, for example, environmental pressures, will be discussed. Some case studies, illustrating adhesion failure incidents will be described to emphasise the requirement for rapid solutions to

production problems.

**16. Mechanical testing of adhesive joints**

**Professor Allan Hutchinson**

The behaviour of bonded joints under load is reviewed. Various joint geometries are described appropriate to determining adhesive material behaviour and for the assessment of surface pre-treatments.

**17. Durability of adhesive joints**

**Professor Allan Hutchinson**

Exposure of bonded joints to hostile environments can weaken them considerably. The mechanisms of degradation are reviewed. Procedures for assessing joint durability are described. Comparisons between laboratory testing and service experience are made.

**18. Quality assurance in adhesive bonding**

**Mr Terry Twine**

A broad based view of the quality regimes used by world class businesses. The use of statistical and risk based tools to manage processes to achieve the high quality levels required by the users for adhesive systems.

**19. Manufacturing case studies III: The microelectronics industry**

**Mr Terry Twine**

The use of adhesives in electronic packaging (including surface mount technology) and in high precision disk drive assemblies has grown dramatically. To ensure consistent high quality in a high volume manufacturing environment the adhesive bonding processes must be optimised and the necessary ongoing controls established.

**20. Using Structural Adhesives for High Performance, Lightweight Cars**

**Mr Bob Dorney Smith**

A view of the approach required to achieve acceptance for structural adhesives in the manufacture of high performance cars such as Lotus Elise and Aston Martin Vanquish. As with all bonding, this is part culture, part engineering and part chemistry. The aim is to give a broad insight into the progress of both aluminium and adhesives in achieving lightweight products.

## THE LECTURERS

### COURSE DIRECTOR

**Professor John F Watts:** Professor of Materials Science at the University of Surrey, within the School of Engineering he is Head of Materials, Surfaces and Structural Systems and is also Director of the cross School 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 Magd Abdel Wahab:** Senior Lecturer in Mechanics of Materials and Structural Bonding in the School of Engineering, Mechanical, Materials and Aerospace, University of Surrey. He received his BSc, 1988, in Civil Engineering and his MSc, 1991, in Structural Mechanics, both from Cairo University. Dr Wahab completed his PhD in Fracture Mechanics in 1995 at KU Leuven, Belgium, before joining UniS as a lecturer in 1999 and promoted to Senior Lecturer in 2003. He has published more than 100 papers and technical reports in fracture mechanics, finite element, bonded joints and dynamics of structures. His research interests include fracture, creep and fatigue of adhesively bonded joints and vibration of structures.

**Dr Marie-Laure Abel:** Royal Society University Research Fellow in the School of Engineering at the University of Surrey. She gained her MSc and PhD at the University of Paris VII and is at present concentrating on the study of incorporation of silanes in adhesives with the help of the adhesives company Huntsman Advanced Materials Ltd.

**Dr Michael Cochran:** Chemistry graduate and post graduate of Strathclyde University. He has worked for Crown Technology (previously Metal Box and CarnaudMetalbox) for nearly thirty years. He has remained focussed on the materials science aspects of plastic and metal packaging and is now responsible for identifying developments in smart and intelligent materials that may lead to enhanced functionality in consumer packaging.

**Professor John Comyn:** Consultant in adhesion and polymeric materials, and senior visiting fellow at Loughborough University of Technology, chairman of the Society for Adhesion and Adhesives. Studied chemistry at the Universities of Bristol, Leeds and Belfast and spent 22 years teaching and researching at Leicester Polytechnic (now De Montfort University). Joint Editor in Chief of the International Journal of Adhesion and Adhesives. In 1997 he was awarded his DSc by Bristol University.

**Professor Andrew D Crocombe:** Professor in Mechanics of Structural Bonding. Professor Crocombe gained BSc(Eng) and PhD in Mechanical Engineering at the University of Bristol. Principal area of research involves experimental and numerical analyses in structural adhesive bonding, simulating typical service conditions including: creep, fatigue and environmental degradation. Research is also being carried out in soft tissue and skeletal bio-mechanics. Extensive use is made of both in-house and commercial non-linear FEA in all of this work, which has been published widely.

**Mr Bob Dorney-Smith:** Studied Materials Science at University of Sussex, spent nine years teaching both Physics and Chemistry at A level, then a six year period with Ford Motor Co Materials Laboratory at Dunton. A formative eleven years in body-in-white with Mayflower Vehicle Systems in Coventry preceded a move to Hydro Automotive Structures at Worcester in 1997. Currently Ford Account Manager with particular interest in the development of bonded aluminium assys such as Aston Martin Vanquish and the new DB9.

**Dr Martin E Fakley:** Obtained both his BSc and PhD degrees in Chemistry from the University of Sussex before joining ICI Corporate Laboratory in Runcorn. From there he transferred to ICI Agricultural Division R&D and subsequently worked in business development for what became ICI Syntex (now part of Johnson-Matthey) where he was responsible, amongst other things, for starting a business in environmental catalysis. After 3 years as a corporate innovation and technology strategist, in 2000 he transferred to Permabond as Global Development Director responsible for R&D and Quality Assurance (Permabond, the structural adhesives business of National Starch and Chemical, was acquired by ICI from Unilever in 1997). Whilst there, he served on the Research Board of the Welding Institute. When Permabond was part sold and restructured into the Bondmaster business of National Starch in late 2003, Martin left to start his own business as a Technology Strategist. He now operates as an Adviser to the DTI's Knowledge Transfer Partnerships, is a Consultant on sustainable chemical technology for Crystal Faraday, and lectures on Entrepreneurship and Technology Strategy.

**Professor Allan Hutchinson:** Head of the Joining Technology Research Centre in the School of Technology at Oxford Brookes University. His teaching and technical interests include all aspects of design, materials engineering and a variety of joining technologies. Particular research interests include adhesive and sealant materials, adhesion and surface

pretreatment, joint durability, and the performance of large-scale bonded structures. He is the author of over 70 technical publications in adhesive and sealant technology.

**Mr Jeff Kapp:** Currently Body-in-White Adhesives Technical Sales for 3M Automotive, he gained his MEng in Materials Engineering from University of Nottingham in 1997. He has been actively involved with numerous ground-breaking projects, widening the envelope of adhesives application in the automotive industry, including Aston Martin Vanquish, Ford Focus RS Intercooler and adhesive solutions for bonding magnesium. In addition he also represents Ford in cross-industry adhesive forums and has presented to a wide range of audiences, both academic and industry based.

**Dr Bryan D Ludbrook:** As European Technical Manager for H.B Fuller's water based polymers and adhesives, he leads an R&D team based in the UK, Germany and Portugal. He has been active in adhesives R&D and technical service for 34 years and is still learning. His experience over that time has spanned sealants & adhesives for automotive & construction, structural adhesives, plastics compounds, powder coating, PSA for tape and label, converting & packaging adhesives and has involved water based, hot melt, solvent, reactive & plastics compounding and polymerisation technologies.

H.B. Fuller is headquartered in St. Paul, Minnesota, and manufactures and markets specialty chemicals used in thousands of formulations, and hundreds of thousands of applications worldwide. The company has direct operations in 34 countries in North America, Latin America, Europe and Asia Pacific. Global sales totalled \$1.41 billion in 2004. Almost everywhere you look you'll find manufactured goods using adhesives, sealants, or coatings produced by H.B. Fuller.

**Mr Terry Twine:** Fellow of the Royal Statistical Society. He has particular interests in quality and its management through the use of statistical tools. In addition, he is interested in the use of statistical thinking in the management of risk in business. He has many years of experience in applying statistical methods to quality issues in both the motor industry (Austin Rover) and the computer industry (IBM and more recently Xyratex). He is now operating as an independent consultant on risk and statistical applications in business.

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

### UNIVERSITY OF SURREY

The University of Surrey is a Technological University with approximately 9,500 students in Schools of Engineering, Science and Human Studies. The campus is situated on the outskirts of Guildford, below the Cathedral and just 20 minutes walk from the shopping centre and the main railway station. 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.



## **Adhesion and Adhesives Research at the University of Surrey**

There are two focal points for adhesion and adhesives research at the University of Surrey; within the Surface and Interface Reactions Group and within the Solid Mechanics and Design Research Group both in the School of Engineering. The research work in the latter category, led by Professor A D Crocombe, is concerned with bonded structure design analysis methods, the measurement of the mechanical properties and strength prediction for static and cyclically loaded joints and the micro-mechanisms of damage and crack propagation in adhesives. The group has a suite of mechanical testing facilities, together with an excellent range of computer hardware and software, to provide the modelling capabilities necessary to develop a predictive approach to adhesive joint design.

The adhesion science research led by Professor J F Watts is primarily concerned with the interphase chemistry of adhesive joints. From a knowledge of the exact composition of the interfacial region between substrate and adhesive it is often possible to identify those components of an adhesive, or indeed functional groups of a polymer, that segregate to that interface and are thus directly responsible for adhesion. To carry out such work requires sophisticated analytical equipment and the University is fortunate in having one of the best equipped laboratories in the world for this purpose.

### **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. We also have 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 most recent 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 1mm. 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.

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 '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.

It also aims to provide a coverage of aspects of the properties, manufacture, selection, design and economics relating to the use of materials in engineering applications.

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

SE3M11	Introduction to Materials Science
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
SE3M40	The Science of Adhesion

Modules may also be taken from a similar programme 'Advanced Manufacturing Management and Technology'.

Candidates normally complete seven taught modules and a project.

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

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

# REGISTRATION FORM

## ADHESIVE BONDING TECHNOLOGY 3 - 7 APRIL 2006

Name: ..... Title .....

Company/Affiliation: .....

Address .....

.....

Tel .....

Name of Approving Manager: .....

£

- |    |   |                       |
|----|---|-----------------------|
| 1. | <b>COURSE FEE,</b><br>- includes one set of Lecture Notes<br>- reduced fee for students <u>registered</u> on MSc in Advanced<br>Materials including assessment) | 1020.00<br><br>995.00 |
| 2. | <b>MEALS:</b> (Coffee, Lunch, Tea)  | 50.00                 |
| 3. | <b>PARKING</b> @ £2 per day (if required)   | 10.00                 |

### The following should be completed as applicable

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

Expiry Date.....

3 digit security no. ....

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

### This form should be returned to:

Rebecca Jones

School of Engineering (D3)

University of Surrey, Guildford, Surrey, GU2 7XH, U.K.

Tel: 01483 689378 Fax: 01483 686671 Email: RF.Jones@surrey.ac.uk

**LATEST DATE FOR REGISTRATION - 17 MARCH 2006**