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Nuclear expertise intelligently applied

MPC NEWSLETTER

Issue 7 - Summer 2007

The Newsletter of The Materials Performance Centre

Serco Partnership is announced

New northwest nuclear research centre

Residual stress research in the MPC

Nuclear graphite gains new active facilities

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EDF British Energy serco

THE DIRECTOR'S CUT

Welcome to the Summer 2007 edition of the MPC Newsletter. This edition marks the 5-year point in our development and is therefore a good time for reflection on what has been achieved and a look forward to the next phase of the MPC.

Over the last five years we have seen the MPC grow from less than 5 people in Year 1 to over 60 people in Year 5. Over 15 academics at Manchester are now committed to research in the nuclear materials area, including four new academic posts created through core funding provided by BNFL (now provided by the NDA via Nexia Solutions). This growth has been substantially due to the hard work of academics, our strategic partners including Nexia Solutions, EdF, British Energy and Serco (see article in this issue) as well as other nuclear stakeholders including Westinghouse, Rolls-Royce, TWI and Corus. Our strategic partnerships are extremely important to us, and I believe that we can all gain greater benefit as we explore the creation of a consortium model for the MPC. The development of the MPC has also been significantly aided by new investment in underpinning nuclear research by Government through the EPSRC (Keeping the Nuclear Option Open, Materials for Energy and Nuclear Engineering Doctorate programmes) and by the Nuclear Propulsion Critical Technology programme – investment that is critical to help replenish the skills base as the UK explores new civil nuclear build and develop the next generation nuclear propulsion plant. We are delighted that Dr Michael Preuss, in collaboration with academics at Oxford and the Open University, has been awarded a £1.5m grant from the EPSRC to study the oxidation of zirconium alloys. This award is augmented by funding from EDF, Rolls-Royce and Westinghouse. The last five years have seen many of our graduating students commencing careers within the nuclear industry. Industry days at Manchester have provided a successful route for recruitment. Internal investment in facilities at Manchester is ongoing and is strengthening the state-of-the-art base in materials testing, characterisation and materials modelling. Finally, the establishment of the Dalton Nuclear Institute at the University of Manchester is creating a broader vision and support for the development of the University as a world leader in nuclear teaching and research. The creation of a new research facility in West Cumbria through joint investment by the NDA and the University will provide a unique research facility for Radiation Sciences and Nuclear Decommissioning near Sellafield – both including materials elements (see page 3).

Looking forward, the MPC will aim to: (i) develop a consortium model such that our individual partnerships with nuclear stakeholders will be enhanced by additional communication and collaboration between partners and the university, (ii) establish an on-site presence of university researchers in industry (e.g. via the new Nuclear Engineering Doctorate programme) and visiting industrial scientists spending time at Manchester to enhance the relevance and applicability of our research to the end user, and (iii) strengthen research leadership in corrosion and research activity in neutron irradiated materials.

In closing I would like to congratulate Mark and Helena Turski on the birth of their Daughter, Lilya and Sophia Necib who completed the Manchester 10k run in under 60 mins. I hope that you enjoy this issue of the MPC Newsletter.

Andrew Sherry

SERCO PARTNERSHIP

In addition to recent partnerships with EdF and British Energy Generation Ltd, the MPC is delighted that a Memorandum of Understanding has been signed between the University of Manchester and Serco. The collaboration will be in the areas of fracture technology, structural integrity, corrosion, inspection and nuclear graphite and any other areas of mutual interest. This is already providing a fruitful platform for new initiatives between the MPC and Serco and is helping to strengthen the existing links which are in place. We are currently collaborating with Serco in the areas of structural integrity, corrosion and EAC and nuclear graphite. A number of Serco staff have been appointed as visiting scientists at the MPC and Prof. Andrew Sherry and Dr Martin Goldthorpe are providing technical input into a number of industrially based projects. Serco are supporting university research at PhD, Eng D and RA level. The collaboration will be formally launched at an Open Technical Forum meeting to be held on 7th November 2007. The Forum will disseminate key developments in the measurement, modelling and assessment of residual stresses in component design and operation. For further details contact Dr Jane Deakin (jane.deakin@manchester.ac.uk).

NUCLEAR GRAPHITE RESEARCH GROUP GAINS NEW ACTIVE FACILITIES

The Nuclear Graphite Research Group working within the MPC has successfully commissioned a laboratory for the examination of low radioactive nuclear graphite samples, located in The Mill. The facility will be used to examine the treatment of small active graphite samples taken from both UK and European nuclear reactors supporting the work of both PhD and Postdoctoral projects.

Presently under refurbishment, the active graphite laboratory will house state of the art facilities for the analysis and treatment of irradiated graphite samples, which will include a high temperature laboratory tube furnace capable of temperatures up to 1200°C, liquid scintillation counting for β analysis and to calculate decontamination factors, an active glove box, fume hoods and a low temperature oven.

Recently the NGRG has successfully undertaken the first active X-ray tomography experiment at the Materials Science Centre to validate the structural and radiochemical data from French EDF graphite supplied via Serco Assurance at Risley.

The group's focus is to gain understanding of the relationship between graphite microstructure and properties providing new input to support graphite safety and performance in reactors and to assess decommissioning options.

For more information contact:

Professor Barry J Marsden (barry.marsden@manchester.ac.uk) or Dr. Abbie Jones (abbie.Jones@manchester.ac.uk)

FELLOWSHIPS AWARDED

Armourers & Brasiers' Company Fellowship 2007

Dr Dirk Engelberg has been awarded the prestigious Armourers & Brasiers' Company Fellowship 2007 of £2,500. This prize is awarded for top-class post-doctoral research in the field of materials science and technology.

Dirk joined UMIST in 2000 after graduating from The University of Applied Science in Aalen, Germany where he was awarded the 'Best Graduate 2000' prize in the Department of Surface Engineering and Materials Science. Following his MSc in Corrosion Science and Engineering, Dirk commenced a PhD in Metallurgy and Materials Science under the supervision of Dr James Marrow and Prof Roger Newman.

During his PhD he achieved the first "in-situ" 3-D X-ray tomography observations of intergranular stress corrosion cracking in sensitised austenitic stainless steel. These observations build the basis of a newly developed crack propagation model for the improvement in stress corrosion cracking resistance by grain boundary engineering. He is now working with Dr Marrow, developing techniques to assess the effects of grain boundary engineering on microstructure behaviour.

Roberto Rocca Fellowship

Congratulations to PhD student Javier Romero Ospina who has been awarded a Roberto Rocca Fellowship. The Fellowships are awarded on the basis of the student's academic and professional accomplishments, leadership potential and commitment to the economic and industrial advancement of his or her home country. The Fellowships fund studies towards PhD degrees in specific fields of study that include Materials Science, Mechanical, Chemical, Electrical and Petroleum Engineering. Javier is studying 'Texture evolution in zirconium alloys during beta processing' sponsored by Westinghouse and supervised by Dr João Quinta da Fonseca and Dr Michael Preuss.

Dr James Marrow, Dr Dirk Engleberg and Prof Bob Young

£20m NORTHWEST NUCLEAR RESEARCH CENTRE

A major new nuclear research facility is to be established in Cumbria with £20million of initial funding from The University of Manchester's Dalton Nuclear Institute and the Nuclear Decommissioning Authority (NDA). The University and the NDA have signed an initial collaboration agreement, which will see each organisation invest £10million over a seven-year period.

The centre will house specialist research facilities and will drive forward research into radiation sciences and engineering decommissioning. This will include accelerators and experimental equipment to study irradiation damage and effects on materials and chemical systems used in nuclear environments, as well as cutting-edge computational modelling and simulation tools.

The new multi-million pound Centre will provide a base for university research staff and postdoctoral students. It will have close links with the existing British Technology Centre (BTC) at Sellafield, which is managed by Nexia Solutions and will form part of the recently announced National Nuclear Laboratory.

Dr Ian Hudson, Head of Technology and Skills with the Nuclear Decommissioning Authority, says:

"The establishment of new research and development facilities is an important part of the NDA's skills initiative and supports our broader socio-economic responsibilities. The partnership with Manchester will deliver a world class operation of high quality research providing excellence in education and skills for the decommissioning and clean up mission. It will also make an important contribution to the economy of West Cumbria. Alongside other related developments such as the National Nuclear Laboratory and the National Nuclear Skills Academy these new facilities will play an integral part in our aspiration to see the UK and West Cumbria as an internationally recognised centre of excellence for the nuclear industry".

Professor Richard Clegg, Director of the Dalton Nuclear Institute at the University of Manchester, said: "The signing of the agreement with the NDA is an extremely important development in our ambition to make The University of Manchester into one of the world's most prestigious nuclear research and education centres and will act as a magnet for attracting leading scientists and researchers."

NEWS IN BRIEF

PhDs Awarded

Congratulations to Andrew Hodgkins and Fabio Scenini on the award of their PhDs. Andrew's PhD research focused on 'Crack propagation and arrest in nuclear graphite' sponsored by the HSE. Following postdoctoral research with the MPC, Andrew is now employed by Serco Assurance. Fabio Scenini studied 'Stress corrosion mechanisms in Alloys 600 and 690' sponsored by the MPC. Fabio is now a Postdoctoral researcher in the MPC working on 'Improved mechanistic understanding of IGSCC of stainless steels under conditions relevant to NSRP'.

Welcome to New Researchers

Many new researchers have joined the MPC over recent months. Prof Phil Withers is leading a group studying residual stresses, see feature pages 4-5. Research has commenced on projects for a range of sponsors including:

'Microstructure/property relationships in AGR graphite' (BEGL); 'Mechanistic studies of SCC in Alloy 600 in hot water' (EdF); 'Texture evolution in Zirconium alloys during beta processing' (Westinghouse) and 'Full field strain mapping' (EPSRC and Serco Assurance).

Researchers Moving On

Several MPC postdoctoral researchers and PhD students have recently taken up positions in industry. Vicky Allen has moved to Serco Assurance. Mark Joyce has moved to Frazer Nash and Thomas Beale has taken up a position at Durham University although he is based in Daresbury working on the new Diamond synchrotron. Jonathan Duff has taken up a post doctoral research post within the MPC. He is working on the development of an imaging autoclave facility sponsored by Rolls-Royce (MoD).

Collaboration with Idaho National Laboratory

In November 2006 a delegation from the University of Manchester and Nexia Solutions attended a Collaboration Workshop hosted by the Idaho National Laboratory where researchers met with INL scientists and professors from both the University of Idaho and Boise State University, plus representatives from Battelle Memorial Institute and Battelle-Italia. The assembled experts discussed the future of nuclear energy in the U.S. and Europe. Technology meetings focused on graphite, strength of materials, characterization NDA/NDE (nondestructive assay/nondestructive evaluation), damage and corrosion, plus advances in modeling and simulation.

INL scientists are visiting the MPC during the summer to accelerate collaborative working in the materials area.

FEATURE

Residual Stress Research in the

Residual stresses play a significant role in activating degradation mechanisms that are relevant to power plant components, such as environmentally assisted cracking, fatigue and creep. Residual stresses (often referred to as secondary stresses) can also act to exacerbate damage that occurs as a result of direct (or primary) loading. It is therefore important to be able to estimate the residual stresses that are present in power plant components so that they can be incorporated into integrity assessments for plant infrastructure.

Prof Phil Withers has drawn together a group of postdoctoral researchers and PhD candidates within the MPC with a research focus on residual stresses. One of the objectives of the residual stress group is to develop computational tools that will assist in the prediction of residual stresses in welded joints. Welding is known to introduce high levels of residual stress and when account is also taken of the variability in properties that arises across a welded joint, welds are often considered to be performance-limiting regions in a component.

The focus of welding related activities in the MPC is on the estimation of the type I (or macroscopic) residual stresses. Type I stresses can occur over length scales that range from the dimensions of an individual weld bead (i.e. a few millimetres) to the longer range stresses that may be present, for example, across a pipe wall or along the length of a pipe, but they do not include intergranular (type II) stresses or the stress variations that occur within individual grains (type III). Type I stresses occur over scales for which the material can be treated as a continuum and it is these stresses that are most relevant to plant integrity assessments. The welding research activities within the MPC involve making measurements of residual stress distributions in sample welds with a simple configuration. These measurements then provide data for validation of the computational models that are being developed. Other parameters that are measured include the temperature and phase-dependent mechanical properties for the materials of interest.

Although integrity assessments usually focus on type I residual stresses, degradation mechanisms such as environmentally assisted cracking and fatigue may be activated by residual stresses that occur over smaller length scales. As such, a significant component of the residual stress research that takes place within the MPC focuses on the interaction between the development of type I (macroscopic) stresses, and the associated intergranular (type II) and intragranular (type III) stresses. This research also involves making assessments relating to the contribution of each type of stress in activating damage mechanisms.

Having developed an understanding of the development and significance of residual stresses acting over the different length scales, the focus is then to develop techniques and strategies to mitigate the deleterious effects of residual stress on component performance. Mitigation-based research activities include the assessment of the effectiveness of surface treatment processes such as laser peening and ultrasonic impact treatment in introducing beneficial compressive stresses. In addition, the computational tools being developed for the prediction of welding-related residual stresses are to be used with a view to identifying potential improvements to weld designs. Two of the larger projects within the residual stress group are described in this article.

PROJECT 1: University-Based Programme on Welding Residual Stresses

This project is being carried out in conjunction with Rolls-Royce Marine and Serco Assurance. A primary aim is to generate computational tools that enable residual stresses in ferritic and austenitic power-plant welds to be predicted with increased confidence. A second objective is to use the computational tools that are developed to identify potential for improvements in weld design. The project encompasses four work themes:

Residual Stress Measurement: This theme includes a programme of stress measurements in welds using techniques such as neutron diffraction, synchrotron and laboratory X-ray diffraction, the contour method, hole drilling and magnetic methods.

Development of Computational Tools: This embraces finite element models for the prediction of welding residual stresses using software such as ABAQUS and SYSWELD, the development of models for the prediction of phase transformations in ferritic steels, and the potential development of a UMAT for ABAQUS to account for the effects of phase transformations on residual stresses.

Residual Stress Mitigation: This theme assesses the effectiveness of post-weld surface treatments in introducing beneficial compressive residual stresses, as well as the potential for improvements in weld design and post-weld heat treatments.

Material-Property Behaviour: This theme aims to understand the effects of multiple thermal cycles, such as those that occur in multipass welds, on the mechanical behaviour of the material being welded. Different hardening and annealing models will be assessed to determine their suitability in characterising material behaviour.

As part of the university-based programme on welding residual stresses, a series of stress measurements were recently made on bead-on-plate specimens in a ferritic reactor pressure vessel steel. The configuration of the plates is shown schematically in Figure 1:

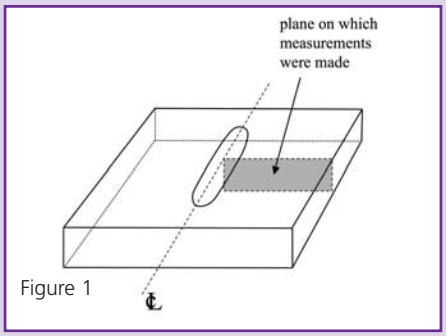


Figure 1

Figure 1: Schematic representation of the bead on plate specimens in ferritic RPV steel. Plate dimensions 180 x 120 x 20 mm; bead length ~ 100 mm.

Figure 3: Measured longitudinal residual stresses on a half plane through the ferritic bead on plate specimens in MPa. The top left-hand corner corresponds to the centre of the weld bead and top surface of the plate. Only half of the plate is shown and all dimensions are in millimetres.

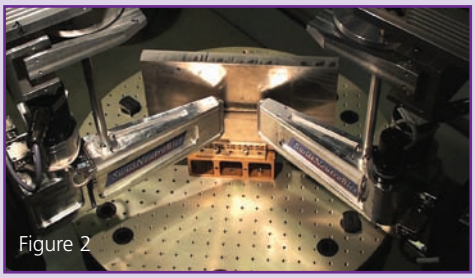


Figure 2

Figure 2 shows stresses in plates being measured by neutron diffraction at the SALSA beamline at the ILL research reactor in Grenoble, France. The image shows a welded plate on its side and the incident and diffracted neutron beams being guided by vertical slits.

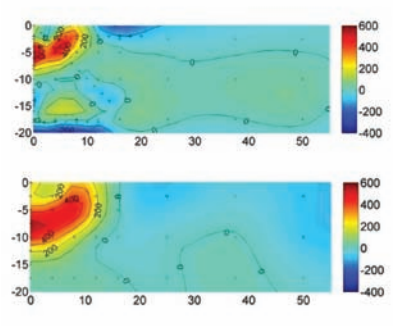


Figure 3

Materials Performance Centre

Members of the MPC residual stress group include:

John Francis (RA – weld stress measurement and prediction of microstructures)

Mark Turski (RA – weld stress measurement, materials testing and analysis)

Hui Dai (RA – prediction of weld microstructures and stresses)

Anthony Bakewell-Smith (PhD – thermomechanical cycling behaviour)

Joe Kelleher (RA – measurement and modelling of stress length scales)

Suzanne Clitheroe (PhD – length scale effects on peened surfaces)

Rashid Bhatti (RA – damage characterisation in PWR materials)

Feizal Yusof (RA – fracture mechanics modelling)

Laura Pocock (RA - weld stress measurement and microstructures)

In parallel with stress measurements, microstructural models are being implemented in order to predict the type of transformation product that will result as a consequence of the welding thermal cycles. The prediction of residual stresses requires knowledge of which transformation will occur, and the temperature-dependent mechanical properties of each phase. These phase-dependent properties can be measured at Manchester with an electro-thermo-mechanical testing (ETMT) rig, as is shown in Figure 4. This system uses resistive heating to reproduce welding thermal cycles on matchstick-sized specimens, and is capable of measuring the elevated temperature properties of microstructural zones that are usually too small to be extracted from welded joints.

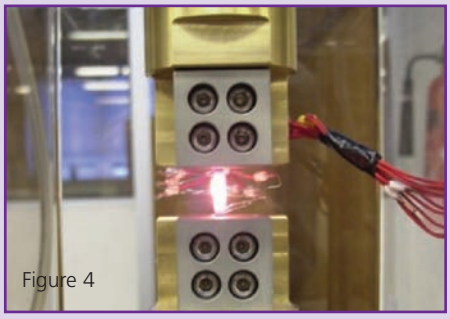


Figure 4: Photograph of the testing of matchstick-sized specimens under welding-like thermal cycles on the electro-thermo-mechanical testing (ETMT) rig at Manchester.

PROJECT 2: Degradation Mechanisms and Residual Stress Length Scales

Degradation mechanisms such as cyclic fatigue or stress corrosion cracking involve the propagation of a crack, which is influenced by the residual stress state in the material. Residual stress in engineering components can be measured and controlled to reduce the susceptibility to these damage mechanisms. However, analysis of the effects of residual stress is complicated by the fact that residual stresses at the microstructural scale and below (type II and III stresses) can be quite different from the macroscopic type I stress. The focus of the present study is to understand the contribution of residual stresses at each length scale to the overall susceptibility to various kinds of damage.

To elucidate this issue, a research programme comprising both computational and experimental approaches has been devised. In particular, the four main research objectives are to:

- Develop computational models that can predict the residual stress at all relevant length scales that arise from plastic deformation or thermal treatments
- Develop and refine experimental techniques to measure residual stress in real components – especially techniques for the smaller length scales as these techniques are less well validated than bulk stress measurement techniques
- Understand how common damage mechanisms are influenced by residual stresses at each length scale, through both laboratory tests on specimens and computer simulation of crack propagation at the microscale
- Identify optimal strategies to minimise susceptibility to damage, including the avoidance of unfavourable stresses from manufacture, surface treatments such as shot peening, and post-weld heat treatments

The relevance of each stress length scale to crack growth will depend on the path of a growing crack through a microstructure. For example, stress corrosion cracking often occurs as intergranular cracks. The propagation of such cracks will be influenced by the stress at the grain boundaries immediately ahead of the crack tip, where the crack would be likely to grow. It is possible to have deleterious tensile stress at some grain boundaries even where the overall bulk stress is compressive. Hence, if only the bulk stress were considered, one would obtain a misleading estimate of the susceptibility to stress corrosion cracking. Similarly, fatigue crack growth often involves plasticity at the crack tip, which, owing to the effect of plasticity on dislocation structures, would be affected by the presence of type III residual stresses around dislocations.

Tests of damage such as fatigue and stress corrosion cracking are relatively simple to perform, but to understand the results one must be able to measure the residual stress in the samples being tested. Although no single residual stress measurement technique is ideal for all applications, several techniques for measuring macroscopic type I stress are reasonably well studied and their limitations understood. However, techniques for measuring the smaller scale type II and type III stresses are less well developed, and there is considerable scope for developing entirely new classes of measurement techniques. One promising approach, which has already been successfully used to measure residual stress in thin films, uses a scanning electron microscope equipped with a focussed ion beam (FIB). The ion beam can perform precision cutting and milling operations at the microscale, and can replicate several stress measurement techniques at this scale that are more commonly used for measuring bulk type I stresses. Figure 5 shows one example using the ion beam to make a cut that releases a bending stress, which causes a deformation that can be viewed with the electron microscope.

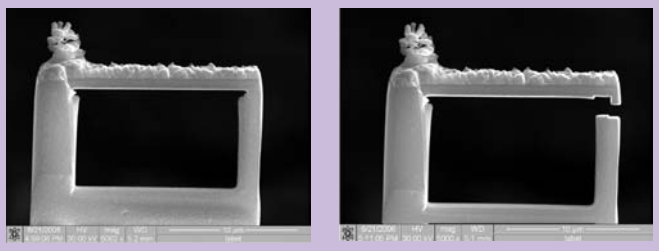


Figure 5: Stress measurement at the microscale using a focussed ion beam (FIB) microscope. The box-shaped structure on the left has been prepared using the ion beam, and incorporates two phases in the top member. When the box is cut open (right), this layer bends upwards slightly because of tensile residual stress in the second phase. By carefully monitoring this deflection, the residual stress can be deduced.

Ultimately this programme will allow engineers to design manufacturing and treatment processes that optimise the residual stresses at all length scales, to provide the best possible resistance to different damage mechanisms. Although this programme concentrates on austenitic stainless steel, many of the approaches will be equally applicable to any material that is heterogeneous at the microscale.

INVITED LECTURE 'STRUCTURE AND PROPERTIES OF NUCLEAR GRAPHITE'

Dr James Marrow gave an invited talk to a joint meeting of the Materials Society of Cumbria (Institute of Materials, Minerals and Mining) and the British Society of Nuclear Engineers on 13th February 2007, with the title of 'Structure and Properties of Nuclear Graphite'. The talk outlined the background to the MPC and Nuclear Graphite Research Group and described the role of nuclear graphite in current and next generation reactors. It emphasised the importance of detailed understanding of the mechanisms of property changes due to neutron irradiation and radiolytic oxidation. He described the new techniques being used at Manchester to study and model microstructure-property relationships, such as X-ray tomography, finite element microstructure models and strain mapping, and underlined the research aim, which is the prediction of component behaviour using mechanistic, microstructure derived models. The talk focussed on two particular topics, which were optical strain mapping methods for the non-contact

measurement of elastic properties and damage nucleation, and the characterisation of strain and damage development at cracks and notches using image correlation and X-ray tomography to map the development of cracks in three-dimensions. New results and observations from this work were presented. The talk concluded that advanced techniques for materials characterisation, including high resolution transmission electron microscopy, X-ray tomography and optical strain mapping are providing new insights into the structure of nuclear graphites, and the mechanisms of damage nucleation. Improved observations of the relationships between microstructure and properties are needed to provide the necessary understanding to predict the long term behaviour of nuclear graphites.

CONFERENCE WATCH

See below for our selection of forthcoming events....

The 3rd International Conference on Recrystallisation grain growth (ReX and GG III)
Juji Island, Korea, 10-15 June 2007.
More details can be found at
www.reg-gg-2007.org

Workshop on Cold Work in Iron-and Nickel-Base Alloys Exposed to High Temperature Water Environments, 3-8 June 2007 Delta Meadowvale Hotel and Resort (Toronto)

International conference on experimental mechanics: experimental analysis of nano and engineering materials and structures (ICEM 13)
Alexandroupolis, Greece, 1-6 July 2007.
More details can be found at http://icem13.gr

KNOO Annual Meeting, 3-5 July 2007, HMS Sultan, Gosport, Hampshire

ASME Pressure Vessels and Piping PVP 2007/CREEP 8
22-26 July 2007 San Antonio, Texas
www.asmeconferences.org

5th BSSM International Conference on Advances in Experimental Mechanics
4-6 September 2007, The University of Manchester, UK

Nulife Meeting 20/21 September 2007, Erlangen, Germany

Symposium on the Scientific Basis for Nuclear Waste Management XXXI
Sheffield, UK, 16 – 21 September 2007

Serco Ltd – The University of Manchester Partnership Launch, location The University of Manchester, UK
7 November 2007

SPOTLIGHT ON.....Professor Colin English

Professor Colin English is a Nexia Solutions Senior Fellow (Materials) and a Visiting Professor at both The University of Manchester and The University of Oxford.

Can you tell us about your background?
I have worked in the field of microstructural characterisation, radiation effects in solids and in-service degradation of structural components for over 30 years. A constant theme of my research has been developing mechanistic insight into complex in-service degradation processes.

What attracted you the role of Senior Fellow?
I believe it is essential for Nexia Solutions to focus on technical quality and to build and maintain a strong interaction with academia. I have strong links with the Materials Performance Centre and also with the Department of Materials at the University of Oxford.

What is your main materials focus?
The two major technical themes that I am involved with are the in-service degradation of materials used in reactor components and materials used in the 'back-end' of the fuel cycle.

What interesting new developments have you been involved with since your appointment as a Senior Fellow.
I am the technical co-ordinator on a research programme 'Zirconium alloys for high burn-up fuel in current and advanced light water-cooled reactors' led by Dr Michael Preuss and funded by the EPSRC Materials for Energy Programme with additional funding from Westinghouse, EdF and Rolls Royce (marine). The research brings together expertise from Manchester, Oxford, OU, Serco Assurance, Rolls-Royce, Westinghouse, EdF and Nexia Solutions.

I am involved in research on the understanding of stress corrosion cracking (SCC) which makes use of advanced microstructural techniques to characterise the crack tip region. Such techniques have real potential to develop new insight into the detailed mechanisms involved in SCC. The research brings together expertise from Nexia Solutions, Oxford and Birmingham Universities.

I am also leading a HSE/NII sponsored research programme

which is using new experimental and numerical methods to understand the influence of loading and geometry effects on the development of Lüders strain in carbon-manganese steels. This work involves experts from both the MPC and Serco Assurance.

Also, I have been involved with the development of a radiation damage science plan for the new Dalton Cumbria Facility (DCF) as part of a project for the NDA that is aimed at developing an overall radiation science plan for DCF.

MPC SOCIAL EVENTS

From nights out in the pubs and clubs to a more sedate session of bowling; MPC socials are wide and varied but always guaranteed to be fun. Work lunches are a regular scene with most of the lunch menus within the city being sampled. As the MPC has grown so have the social events, which range from dinners at restaurants to trips to Dublin.

The last social event was a lunch buffet at an Indian restaurant with an 'all you can eat' policy, which subsequently lead to overindulgence and members of MPC complaining of light headedness from lack of blood reaching the head!!!

The most memorable trip by far was the trip to Dublin. Many a Guinness' were consumed and I remember at some point going back to the youth hostel in a rickshaw and narrowly avoiding death as the guy pulling it weaved in-between cars. Culture and history was also included in the trip in the form of a visit to the Guinness factory.

I hear in the pipeline there will be a visit to Alton Towers for all the lovers of white knuckle rides but also a camping trip to Snowdonia. Until the next instalment of events I leave you with some photos that speak louder than any words I could possibly write.
Lai Mei Li (Final Year PhD Student).

WESTINGHOUSE CENTRE OF EXCELLENCE MEETING

As part of the EPSRC initiative to support materials research related to power generation (Materials for Energy) a multi university research activity led by Dr Michael Preuss from the Materials Performance Centre, which also involves Department of Materials at The University of Oxford and the Materials Engineering Department at the Open University is now underway to study corrosion mechanisms in Zirconium alloys. Zirconium alloys are widely used in light water reactors particularly as cladding material for fuel assemblies. The research grant has an overall value of £1.5M with an additional 10% contribution from EdF, Rolls-Royce and Westinghouse. As a result of this new research activity Westinghouse decided to hold their annual Materials Centre of Excellence workshop in Manchester in April this year. For the first time, Westinghouse also invited EdF and leading researchers from Sweden, France and the US to this workshop to encourage new collaborations and bring together the various research activities on corrosion mechanisms and deformation studies in Zirconium alloys.

NEW RECRUITS INTRODUCED TO THE NUCLEAR INDUSTRY

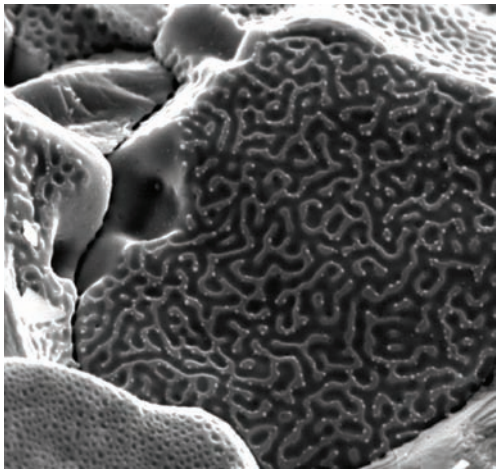
An "Introduction to the Nuclear Industry seminar" has been a regular item on the MPC calendar for the last four years. This set of talks by Scientists and Engineers from Nexia Solutions is aimed at each year's MPC graduate student and research associate intake. This year the lectures were also opened up for the first time to MPC industry partners, resulting in the attendance of over 20 Serco graduate recruits, bringing the total numbers to over 30. The four hours of lectures and demonstrations were delivered by Dr Dave Goddard and Mr Walter Weaver of Nexia Solutions.

Topics covered included:

- The Basics of Radioactivity
- Effects of Radiation on Matter and Human Health
- Risk and Risk Perception
- The UK Nuclear Industry and the Fuel Cycle
- Fission and Fusion
- Nuclear Reactors: Current and Future designs
- Materials in the Fuel Cycle: Reactors, Waste Management and Decommissioning

Feedback from attendees was very positive. Walter Weaver of Nexia Solutions commented afterwards "It's a pleasure to give these talks. Radioactivity and nuclear science are not always covered well in schools and undergraduate courses, so the audience is keen to hear about the industry and to put their research projects into context."

For further information about this seminar and to be notified about future dates please contact Mr Walter Weaver at walter.weaver@nexiasolutions.com.



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