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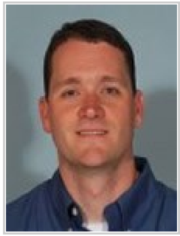

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About

Dr Connolly is currently a Senior Lecturer in the School of Metallurgy and Materials. Dr Connolly's expertise is primarily in the area of corrosion engineering and electrochemical science with specialization in the study of stress-assisted localized corrosion, environmentally-assisted cracking, the transition from localised corrosion to cracking, hydrogen embrittlement, high temperature oxidation and creep rupture in aluminium alloys, nickel based alloys, titanium and steels. He has published over 30 papers in scientific journals as well as reviews and book chapters. He also has over ten years experience in undergraduate and graduate education/instruction with an emphasis on mechanical engineering and materials science.

CV and Research Interests (pdf) (/Documents/college-eps/metallurgy/staff/connolly-CV.pdf)

Qualifications

Senior Lecturer of Localised Corrosion and Environmentally-Assisted Fracture:

- Ph.D. (Materials Science and Engineering) University of Virginia, 2002
- M.S. (Materials Science and Engineering) University of Virginia, 1996
- B.S. (Materials Engineering) Georgia Institute of Technology, 1992

Biography

Dr Connolly was awarded a BS in Materials Engineering from the Georgia Institute of Technology in 1992. He went on to complete his MS and PhD degrees in Materials Science from the University of Virginia before joining the faculty of the US Naval Academy as a Research Professor in 2001.

Dr Connolly was awarded a Royal Society Research Fellowship in 2003 and served as a Visiting Lecturer and Visiting Academic Staff at the University of Birmingham and the University of Manchester (UMIST), respectively, until 2006. Dr Connolly joined the academic staff in the School of Metallurgy and Materials at the University of Birmingham in 2006 as a Lecturer and was subsequently promoted to Senior Lecturer in 2011.

Prior to his academic career, Dr Connolly gained valuable experience working for Mobil Exploration & Producing US as a Corrosion Engineer supporting oil and gas production in the Gulf of Mexico.

Teaching

- Environmental Degradation of Materials
- Fundamentals of Radiation Materials Science
- Physical Metallurgy of Aluminium Alloys
- Organisational Behaviour and Team Skills

Postgraduate supervision

Materials for Energy (Nuclear Power):

- PhD - 'Proton Irradiation Damage in Structural Materials for Generation IV Reactors,' [Nuclear Initiative - internal].
- RF - (1)'Environmental Cracking of Stainless Steels in Nuclear Power Plant as a Function of Platinum Group Alloying (PGM) Additions,' (2) 'Materials for Nuclear Applications' [Ministry of Defence, EPSRC].
- MSc - 'Ion Irradiation Damage in Steels,' [Nuclear Initiative - internal].
- EngD - 'Minimising Corrosion in Nuclear Reactors: mechanisms of corrosion product formation, transport and deposition,' [Rolls-Royce Marine].
- PhD - 'Hydrogen Embrittlement of 304 Stainless Steel as a Function of PGM Alloying Additions,' [Johnson Matthey plc].
- EngD - 'Effect of Dispersions on Localised Corrosion in 316L Stainless Steels in Secondary Side PWR Environments,' [Rolls-Royce Marine].

Materials for Energy (Conventional Fossil-fuelled Power):

- EngD - 'Effects of Microstructure on Steam Oxidation of Austenitic Stainless Steels,' [Doosan-Babcock].
- PhD - 'Steam Oxidation Behaviour of Austenitic Stainless Steels at High Temperature in Supercritical Plant,' [RWE N-Power].

- EngD - ‘Development of Creep and Oxidation Properties for Heat Resistant Alloys,’ [Doncasters-Paralloy].
- MRes - ‘High Temperature Oxidation Behaviour of Austenitic Stainless Steels for Supercritical Plant,’ [RWE N-Power].

Materials for Energy (Oil & Gas):

- RF - ‘Hydrogen Embrittlement/Cracking of Steels in Sour Service’, [EPSRC – KT Secondment - Exova].
- RF – ‘Corrosion Fatigue of in High Temperature. High Pressure Sour Gas Environments,’ [EPSRC – KT Secondment - Exova].
- EngD - ‘Corrosion Test Development for H2S Cracking in Steels,’ [Bodycote plc / Exova].
- MPhil - ‘Stress Corrosion Cracking of 13 Cr Steels in Sour Gas Environments as a Function of Sub-ambient Temperature.’ [Bodycote plc / Exova].
- EngD - ‘Corrosion Fatigue in Corrosive Oil and Gas Well Environments,’ [Bodycote plc / Exova].

Materials for Aerospace:

- EngD - ‘X-ray Tomography studies of Thermal Barrier Coating Failure,’ [Rolls-Royce Aerospace].
- EngD - ‘Optimisation of Mechanical Properties of Aluminium Cast Alloys for High Temperature Pump Body Applications,’ [Goodrich].

Materials for Marine Transport:

- MRes - ‘Corrosion Fatigue Characterisation in 5xxx Aluminium Alloy,’ [ALCOA].

Available Research Opportunities:

- PhD - ‘Proton Irradiation Effects on Corrosion and PWR Water Chemistry’.
- PhD - ‘Corrosion Fatigue Pit-to-Crack transition Observations via X-ray Tomography’.
- EngD – ‘Irradiation Effects on the Mechanical Properties of Advanced Polymers’.
- PhD – ‘Proton Irradiation Damage in Martensitic/Ferritic Steels’.
- PhD – ‘Proton Irradiation Damage in Advanced Ceramic Composites’.

Research

Research Themes

Environmental Degradation of Materials:

- Aqueous Corrosion
- High Temperature Oxidation
- Environmentally-assisted Cracking (including stress corrosion cracking, corrosion fatigue, hydrogen embrittlement, and creep)
- Flow assisted corrosion and deposition in high temperature/high pressure environments
- Irradiation Damage and Effects on Mechanical Properties

Research Activity

Current Research

Environmental degradation has a major impact on many industrial sectors, as it is the major cause of premature, and often catastrophic, failure of engineering structures. It attracts a broad range of industrial collaborators and sponsors, and is particularly appealing to students, who see it as an area with important practical applications. The underlying science is highly interdisciplinary, linking fundamental aspects of electrochemistry and high temperature materials behaviour, physical metallurgy and engineering mechanics.

The goal of my efforts at the University of Birmingham is to establish a major research group in the area of **Environmental Degradation of Materials for Energy and Electric Power Generation**. The focus of the effort has targeted five industry-based themes:

- Materials degradation (including irradiation damage) in Pressurised water Nuclear power plants
- Materials for advanced/low CO2 fossil-fuel burning power plants
- Materials for advanced Oil & Gas recovery
- Material embrittlement issues in the infrastructure for the Hydrogen economy
- Materials degradation in aero and industrial turbines

Each of these industrial-based themes present challenging environmental conditions that could limit the reliability and life of structural components. The scope of environmental degradation issues is quite broad and requires specialised knowledge in the following areas:

- Localised Aqueous Corrosion
- Environmentally assisted cracking (corrosion fatigue, stress corrosion cracking, hydrogen embrittlement)
- High temperature oxidation and spallation
- Creep rupture behaviour

I have been able to develop a substantial research group with appropriate laboratory infrastructure for distinctive work in these areas. The group currently consists of 3 research fellow, 4 PhD students, 7 EngD students, and 3 Mres/MPhil/MSc students, as well as undergraduate research students. Four programmes involve investigation into material issues in nuclear power applications, three programmes involve investigation into material issues in conventional power plant applications, four programmes involve investigation of material issues in advanced oil &gas recovery applications, two programme involves investigation of materials degradation in aerospace/industrial turbines, and one programme involves investigation into hydrogen embrittlement issues of infrastructural materials for use in the hydrogen economy.

The long-term goal of my work is to develop a fundamental understanding of the mechanisms driving stress and corrosion-assisted failures of structural materials, to measure the rates of localised and stress-assisted failure processes, and to use these approaches to develop life-prediction models for critical components. The ecological drivers for improved energy efficiency are placing ever more stringent requirements on the performance of materials. Ever more reliable life prediction is therefore an ongoing challenge that requires a greater understanding of the science underlying the controlling mechanisms of environmentally-assisted failure.

Future Research Strategy

The future strategy or evolution of my research efforts will focus on three additional themes:

- Environmental degradation of advanced materials for Ultra-supercritical conventional power plants
- Environmental degradation of advanced materials for Generation IV Nuclear power plants
- Irradiation effects on mechanical properties of advanced materials for Current and next generation Nuclear power plants.

Production of a dependable energy supply for the 21st century and beyond, while limiting the emission of green house gases, offers many challenges and opportunities for materials science. Future advanced energy systems, such as those mentioned above, will require new materials that operate at dramatically higher levels of performance with respect to stress, strain, temperature, pressure and chemical reactivity.

The efficiency of conventional fossil power plants is a strong function of increased steam parameters (i.e., temperature and pressure). Significant increases in temperature could increase the efficiency of these plants from the current 35% to near 60%. These operating conditions require new materials that can withstand these environments. Advanced stainless steels and nickel-based super alloys are being developed in world-wide activity to accommodate the increased temperatures and pressures that will exist in next-generation ultra-supercritical power plants and it will be imperative to characterise their high temperature degradation behaviour to ensure safety and plant reliability.

To address the issue of sustainability of nuclear energy, fast neutron reactors must be developed, as they can typically multiply by over a factor of 50 the energy production from a given amount of uranium fuel compared to current reactors. New materials as well as fabrication and welding processes need to be developed to achieve higher performance and longer lifetimes, as well as to withstand more extreme conditions. Many challenges for materials will also be experienced in the development of Generation IV nuclear reactors where temperatures may approach 900°C. High temperature reactor technology will need a range of new materials such as advanced nickel-based alloys, refractory alloys, ceramics, advanced composites as well as advanced coatings technology. Mechanical and chemical behaviour of these materials need to be characterised and modelled in the new domains of higher temperatures and higher irradiation levels.

Publications

- D. Saxey, B. Connolly, C. Cooper, J. Knott, Y. Huang, C. Grovenor, G. Smith, S. Lyon, A. Sherry, L. Roswell, A. Pratt, “Understanding Stress Corrosion Cracking of PGM-Doped Stainless Steels Utilising the Latest Generation of Atom Probe,” submitted to **Nature Materials** 2011
- D.A. Horner, B.J. Connolly, S. Zhou, L. Crocker, A. Turnbull, “Novel Images of the Evolution of Stress Corrosion Cracks from Corrosion Pits,” accepted **Corrosion Science**, 2010
- M. Jariyaboon, A.J. Davenport, R. Ambat, B.J. Connolly, S.W. Williams, D.A. Price, “Corrosion behaviour of banded microstructure within nugget of friction stir welds in AA2024-T351,” **Materials Science and Technology**, 27(1), 208-213 (2011)
- M. Jariyaboon, A.J. Davenport, R. Ambat, B.J. Connolly, S.W. Williams, D.A. Price, “Effect of Cryogenic Cooling on Corrosion of Friction Stir Welded AA7010-T7651,” **Anti-Corrosion Methods and Materials**, 57(2), 83-89 (2010)
- M. Jariyaboon, A.J. Davenport, R. Ambat, B.J. Connolly, S.W. Williams, D.A. Price, “The Effect of Cryogenic CO2 Cooling on Corrosion Behaviour of Friction Stir Welded AA2024-T351,” **Corrosion Engineering, Science and Technology**, 44(6), 425-432 (2009)
- R.W. Fonda, P.S. Pao, H.N. Jones, C.R. Feng, B.J. Connolly, A.J. Davenport, “Microstructure, Mechanical Properties, and Corrosion of Friction Stir Welded Al 5456,” **Materials Science & Engineering** A, 519, 1-8 (2009)
- A. Turnbull, D.A. Horner, B.J. Connolly, “Challenges in Modelling the Evolution of Stress Corrosion Cracking from Pits,” **Engineering Fracture Mechanics**, 76, 633-640 (2009)
- P.G. Padovani, A.J. Davenport, B.J. Connolly, S.W. Williams, A. Groso, M. Stampanoni, F. Bellucci, ‘Corrosion and Protection of Friction stir Welds in Aerospace Aluminium Alloys,’ **Metallurgia Italiana**, 10, 29-42 (2008)
- F. Eckermann, T. Suter, P.J. Uggowitzer, A. Afseth, A.J. Davenport, B.J. Connolly, M. Larson, F. de Carlo, P. Schmutz, “In-Situ Monitoring of Corrosion Processes within the bilk of AlMgSi Alloys using X-ray microtomography,” **Corrosion Science**, 50, 3455-3466 (2008)
- T.J. Marrow, L. Babout, B.J. Connolly, D. Engelberg, G. Johnson, J. –Y. Buffiere, P.J. Withers and R.C. Newman, “High Resolution, in-situ, tomographic observations of stress corrosion cracking,” in **Environment-Induced Cracking of Materials: Volume 2 – Prediction, Industrial Developments and Evaluation**, edited by S.A. Shipilov, R.H. Jones, J. –M. Olive, and R.B. Rebak, Elsevier Ltd., Oxford, UK, 439-448 (2008)
- M. Jariyaboon, A.J. Davenport, R. Ambat, B.J. Connolly, S.W. Williams, D.A. Price, “The Effect of Welding Parameters on the Corrosion Behaviour of Friction Stir Welded AA2024-T351,” **Corrosion Science**, 49, 877 (2007)
- D.A. Little, B.J. Connolly, J.R. Scully, “An Electrochemical Framework to Explain the Intergranular Stress Corrosion Behavior in Two Al-Cu-Mg-Ag Alloys as a Function of Aging,” **Corrosion Science**, 49, 347 (2007)
- A.J. Davenport, C. Padovani, B.J. Connolly, N.P.C. Stevens, T.A.W. Beale, A. Groso, M. Stampanoni, “Synchrotron X-ray Microtomography Study of the Role of Y in Corrosion of Magnesium Alloy WE43,” **Electrochemical and Solid State Letters**, 10(2), C5-C8 (2007)
- B.J. Connolly, D.A. Horner, S.J. Fox, A.J. Davenport, C. Padovani, S. Zhou, A. Turnbull, M. Preuss, N.P. Stevens, T.J. Marrow, J.-Y. Buffiére, E. Boller, A. Groso, M. Stampanoni, “X-ray Microtomography Studies of Localised Corrosion and Transitions to Stress Corrosion Cracking,” **Materials Science and Technology**, 22(9), 1076-85 (2006)
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- B.J. Connolly, J.R. Scully, “The Transition from Localized Corrosion to Stress Corrosion Cracking in an Al-Li-Cu-Ag Alloy,“ **Corrosion**, 61(12), 1145-1166 (2005)
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- B.J. Connolly, Q. Meng, A.L. Moran, R.L. McCaw, “Mechanical and Precorroded Fatigue Properties of Coated Aluminum Aircraft Skin System as a Function of Various Thermal Spray Processes,” **Corrosion Engineering, Science and Technology**, 39(2), 137-142 (2004)
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  C.P. Ferrer, M.G. Koul, B.J. Connolly, A.L. Moran, “Improvements in Strength and Stress Cracking Properties in Aluminum Alloy 7075 Via Low Temperature Retrogression and Re-Aging Heat Treatments,” **Corrosion**, 59(6), 520-528 (2003)
- B.J. Connolly, J.R. Scully, “Stress Corrosion Cracking Susceptibility in Al-Li-Cu Alloys 2090 and 2096 as a Function of Isothermal Aging Time,” **Scripta Materialia**, 42, 1039-1045 (2000)
- B.J. Connolly, R.S. Lillard, J.R. Scully, G.E. Stoner, “Water Staining of AA3104-H19 Can Body Stock: A Crevice Corrosion Study Utilizing the Double Crevice Assembly Test Method,” **Corrosion**, 53(8), 644-656 (1997)