

Dr Mark Ward

Research Fellow

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About

Mark Ward is a Research Fellow in the School of Metallurgy and Materials, working at improving materials and processes by applying mathematical modelling, electrical and electronic engineering and more general sensing and control techniques. Research topics include producing titanium, nickel and iron alloys by vacuum arc and electrosag remelting, linear friction and electron-beam welding of aerospace structures, additive manufacturing, and analysis of images and orientation maps.

Mark has had research grants from EPSRC as well as doing purely industrially-funded projects. He teaches engineering mathematics and electronics, and is supervising undergraduate and postgraduate students.

He is currently serving as Undergraduate Admissions Tutor for the School of Metallurgy and Materials. For any questions about the courses available, admissions, and subsequent careers in materials science / metallurgy, please email **met-admissions@bham.ac.uk** (mailto:**met-admissions@bham.ac.uk**)

Qualifications

- PhD, Sensing and Controlling the Plasma Arc Cold Hearth Remelting Process, Birmingham, 1999
- MA, Electrical and Information Sciences Tripos, Cambridge, 1990
- BA, Electrical and Information Sciences Tripos, Cambridge, 1990

Biography

After his A levels Mark took a gap year working for the "Controls" division of British Gas Midlands Research Station : as a teenager it was exciting to do wind-tunnel tests and to help with experiments on what happens when a valve on a high pressure gas pipeline fails. (A very big flame)

Mark studied Engineering at Cambridge from 1987-1990, specialising in electrical engineering and gained a BA (Hons) "Electrical and Information Tripos"

After two more years with British gas in advanced controls, Mark moved to the IRC in Materials Processing at the University of Birmingham in summer 1992 to undertake research on a state-of-the-art facility for making titanium and other alloys. While working on Plasma Arc Furnace, he undertook a part-time PhD "Sensing and controlling the Plasma Arc Cold-Hearth Refining process".

As well as researching and experimenting in the area of atomisation, powder production, and spraying of titanium and nickel alloys, for the past 10 years much of his work has been on improving the quality and cost-effectiveness of aerospace materials produced by Vacuum Arc Remelting. This has included developing tomographic techniques to image the distribution of electric current within the process, and combining the results with those from other sensing techniques and CFD models. This received the Institute of Electrical Engineers "**[Measurement Prize. \(http://conferences.theiet.org/measurementprize/history.htm\)](http://conferences.theiet.org/measurementprize/history.htm)**" in 2003.

Since 2008 Mark has worked on a wider range of topics, including advanced techniques for welding aerospace structures, Durville casting, heat treatment of turbine blades, additive manufacturing, and analysis of images and EBSD orientation maps.

Teaching

Undergraduate:

- "Introduction to Energy Engineering"
- "Modelling Concepts and Tools"
- "Electrical, Electronic and Computer Systems"
- "Design and Professional Skills"

Postgraduate supervision

Open:

- Experimenting in, modelling, understanding and developing the production of high quality titanium aluminide alloys by Plasma melting

Current:

- Measuring the phase proportions in steel by image analysis
- Factors controlling the quality of nickel alloys produced by Durville casting
- Linear friction welding of aerospace alloys

- Segregation and quality during ESR of steels
- Analysis of EBSD orientation maps of rail steel

Research

RESEARCH THEMES

- Electroslag remelting
- Plasma melting;
- Image analysis
- Vacuum arc remelting;
- Process monitoring and control
- Welding
- Atomisation
- Titanium, nickel and iron-based alloys

Other activities

Consultancy in the areas of producing high performance materials by Plasma melting and VAR, and the photographic surveying and temperature measurement of flare tips.

Publications

A Multi-Scale 3D Model of the Vacuum Arc Remelting Process, Koulis Pericleous, Georgi Djambazov, Mark Ward, Lang Yuan, Peter D. Lee , Accepted for publication in Met. Trans. A

S. Abolghasemi, J. Williamson, T. C. Lindley, R. M. Ward and P. D. Lee, 2013, "Thermal imaging and stress analysis for predicting the behaviour and long-term performance of flare tips", The Journal of Strain Analysis for Engineering Design DOI: 10.1177/0309324712464921 sdj.sagepub.com/content/early/2013/01/10/0309324712464921 (<http://sdj.sagepub.com/content/early/2013/01/10/0309324712464921>), Journal of Stress Analysis, Vol 48, (2), 103-111

R. Turner, J.C. Gebelin, R.M. Ward and J. Huang, 2012, "Modelling of the Electron Beam Welding of a Titanium Aeroengine Compressor Disc", Article submitted to Proceedings of 9th Intl. Trends in Welding Research

R. Turner, R.M. Ward, R. March, and R. Reed, 2012, "The Magnitude and Origin of Residual Stress in Ti-6Al-4V Linear Friction Welds; An Investigation by validated numerical modelling", Met Trans B, 43, 1, pp 186-97

R. Turner, J.C. Gebelin, R.M. Ward, and R. Reed, 2011, "Linear Friction Welding of Ti-6Al-4V Modelling and Validation", Acta Mat. 59, pp3792-3803

R.M.Ward, 2010, "3D observations and modelling of the vacuum arc remelting of a nickel superalloy and the motion of Inclusions", INTECO Conference 2010, Shanghai China 29 September -1 October

R. M. Ward, K. A. Pericleous, G. Djambazov, L. Yuan, P. D. Lee , 2010, "Validation of a Multiscale 3D Model of the Vacuum Arc Remelting Process", OPTIMoM: Optimising Performance Through Integrated Modelling of Microstructure, 26 Sep 2010 - 28 Sep 2010, Queens College, Cambridge, UK, IOM3 www.iom3.org/events/optimom (<http://www.iom3.org/events/optimom>)

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K. A. Pericleous, G. Djambazov, V. Bojarevics , R. M. Ward , 2009, "A Unified 3d Model of the VAR Process" Liquid Metal Processing and Casting 2009 Santa Fe 20-23 September 2009, TMS: Warrendale, PA

B.G. Nair, R.M.Ward, 2009, "3-d Analysis of Magnetic Field to Monitor Arc Current during Vacuum Arc Remelting" , Liquid Metal Processing and Casting 2009 Santa Fe 20-23 September 2009, TMS; Warrendale, PA

R.M. Ward, 2008, "Possibilities for monitoring VAR", INTECO 35th anniversary symposium, Austria 3rd-5th September 2008

D. M. Shevchenko, R.M. Ward, 2007, "The Role of side-arcing in the global energy partition during VAR of INCONEL 718", pp.13-18, proc. Int. Symp. Liquid Metal Processing and Casting, Lee, Mitchell, Bellot and Jardy (eds.), Paris : SF2M

D. M. Shevchenko, R.M. Ward, 2007, "Liquid metal pool behaviour during the VAR of INCONEL 718", pp.25-30, proc. Int. Symp. Liquid Metal Processing and Casting, Lee, Mitchell, Bellot and Jardy (eds.), Paris : SF2M

P. Chapelle, R.M. Ward, A. Jardy, V. Weber, J.P. Bellot, M. Minvielle, 2007, "Lateral boundary conditions for heat transfer and electrical current flow during VAR of a zirconium alloy", pp. 7-12, proc. Int. Symp. Liquid Metal Processing and Casting, Lee, Mitchell, Bellot and Jardy (eds.), Paris : SF2M

D Whittaker, B Ginty, W Hopkins, P Unwin, G Penfold, M Ashworth, R M Ward, 2005, "Industrial Opportunities for PM Titanium Products", EuroPM2005, Prague, 2-5 October 2005

R.M. Ward, B. Daniel, R.J. Siddall, 2005, "Ensemble arc motion and solidification during the Vacuum Arc Remelting of a nickel-based superalloy" proc. Int. Symp. Liquid Metal Processing and Casting, Santa Fe, September 18-21

X. Wang, M.D. Barratt, R.M. Ward, M.H. Jacobs, 2004, "The effect of VAR process parameters on white spot formation in INCONEL 718", Journal of Materials Science 39 (2004) 7169-7174

R.M. Ward and M.H. Jacobs, 2004, "Electrical and magnetic techniques for monitoring arc behaviour during VAR of INCONEL 718 : Results from different operating conditions", Journal of Materials Science 39 (2004) 7135-7143

R.M. Ward, M.D. Barratt, M.H. Jacobs, Z. Zhang, A.L. Dowson, "A simple transient numerical model for heat transfer and shape evolution during the production of rings by centrifugal spray deposition", Journal of Materials Science 39 (2004) 7259-7267

M.D. Barratt, Z. Shi, R.M. Ward, P.S. Grant, M.H. Jacobs, J. Mi, 2004, "Microstructure, macrostructure and modelling of the centrifugal spray deposition of large diameter Ni superalloy preforms", Superalloys 2004, Green, Pollock, Harada, Howson, Reed, Schirra and Walston (eds.), TM

