Project title: Micromechanical study of engineering alloys using high resolution digital image correlation

Research Theme: Engineering and Materials

Key words: TRIP; Shape memory; HRDIC; Neutron diffraction;

Supervisory team: Richard Moat, Alex Forsey, Salih Gungor

Project Highlights:
- Novel imaging techniques will be used to quantify micromechanical behaviour of exciting engineering materials
- Data collected at International diffraction facilities will corroborate findings
- Project outcomes will influence new material development and understanding of deformation

Overview:
Recent studies in the OU Materials Engineering group have proven the technique of high resolution digital image correlation (HRDIC) to be extremely useful in developing mechanistic understanding of microscale deformation in engineering materials. Figure 1 shows a strain map created by digital image correlation of SEM images taken during in-situ loading of a simple stainless steel that undergoes a strain induced martensitic phase transformation.

Figure 1. Strain map in simple martensite forming stainless steel after 7% applied strain.

It is clear that some regions of material deform very differently to others, this is particularly apparent in grains that form martensite (see the red/orange stripes in figure 1).

Complex engineering alloys, such as shape memory alloys and TRIP steels rely on martensitic transformation for their special mechanical properties. Variations in mechanical behaviour such as those reported above could have significant impact on the degradation of performance in materials that rely on martensite for their properties. The aim of this project will be to use HRDIC and other complimentary techniques to elucidate the origin of unique properties resulting from martensite and ultimately provide strategies of optimising alloy development to obtain greater benefit from the martensite transformation.

Shape memory alloys are of great interest to space engineers where it is desirable to produce moving parts and actuators from single pieces and TRIP steels are of great interest to the automotive industry, where their exceptional energy absorption is useful for impact and crash resistance.

Methodology:
Miniature tensile test specimens made of shape memory and TRIP alloys will be deformed in the scanning electron microscope while being imaged in-situ. DIC, a pattern recognition and tracking technique, will be used to quantify microscale deformations induced by martensite transformations. Both the shape memory effect and the phenomenal impact resistance of TRIP steels are owed to a martensitic phase transformation and the outputs of this project will be used to better understand the origin of these properties.

Results will be corroborated with measurements made at international diffraction facilities such as those in Oxfordshire, France and Japan. Unlike Neutron and synchrotron x-ray diffraction techniques, HRDIC can be performed using relatively standard lab equipment, meaning wider uptake of the technique could be possible.
Further Reading:

Further details:
Students should have a strong background in materials/metallurgy/physics, an interest in state-of-the-art materials characterisation techniques and a willingness to learn basic programming techniques. Experience of research in metallurgical materials is desirable. The student will join a well-established research group at the Open University, with a world class reputation in strain measurement.

Applicant must be willing to travel occasionally to attended international conferences or to use international research facilities when/if required.

Please contact Richard moat for further information [Richard.Moat@open.ac.uk].

Applications should include:
• A 1,000 word cover letter outlining why the project is of interest to you and how your skills match those required.
• An academic CV containing contact details of three academic references.
• An Open University application form, downloadable from: http://www.open.ac.uk/students/research/sites/www.open.ac.uk.students.research/files/documents/Application%20form.docx
• SETS test scores where English is an additional language (Secure English Language Test).

Applications should be sent to STEM-EI-Research@open.ac.uk by 19 February 2018