NEUTRON DIFFRACTION STUDY OF INTERGRANULAR STRESS DEVELOPMENT IN AUSTENITIC STAINLESS STEEL WELD METAL

S. Sharma[1], M. Turski[2], R. Haigh[1], L. Edwards[1], M. E. Fitzpatrick[1]

[1]Materials Engineering, The Open University, Walton Hall, Milton Keynes MK7 6AA, UK

[2]Materials Performance Centre, A11 The Mill, Sackville St Campus, University of Manchester, Manchester M60 1QD, UK

Austenitic stainless steel is widely used in the nuclear power industry for its excellent resistance to corrosion and its good mechanical performance at high temperature. Many austenitic components are welded, and the properties of the weld metal will have a significant role in determining the overall structural integrity of welded plant. Weld metal can be highly anisotropic due to directional solidification and grain orientation. For structural integrity calculations it is very important to input the appropriate elastic stiffness modulus for weld metal: the elastic modulus can vary considerably between different types of welds material, and even between different directions within the same weld.

We have investigated different austenitic stainless steel samples extracted from welds produced with different techniques and with different welding conditions. The materials investigated were 316 stainless steel using MMA welding, and 304 stainless steel using TIG welding.

In-situ deformation of the samples was performed on the ENGIN-X neutron diffractometer at the ISIS pulsed neutron source, UK. The samples were deformed in tension and compression, and the response of several diffraction peaks was monitored during deformation. A Rietveld analysis of the data was also performed to observe the overall lattice strain response to the applied load. The specimens were compressed up to 2% elastic strain.

There are large differences observed in the elastic response of the samples depending on the direction of applied loading. The macroscopic elastic modulus of the samples varies between 120 GPa and 220 GPa. The internal lattice plane responses vary, as expected, from a high stiffness response of the {111} planes (up to 280 GPa) to a low stiffness response of the {200} planes. There is good correlation between the observed crystallographic texture, the response of the individual planes, and the macroscopic elastic response. The elastic modulus of the weld metal is found to be highly direction-dependent, and is influenced by the grain alignment within the weld.

The TIG weld material is shown to have a lower anisotropy in mechanical properties than the MMA weld, as a result of a less strong texture.