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Micromechanical Study of Heterogenous Deformation of Austenitic Stainless Steel Welded Joints at Different Temperatures

Lifeng Gan[1], Baoyin Zhu[2], Chao Ling[1,*], Esteban P. Busso[1] and Dongfeng Li[1]

[1]School of Science, Harbin Institute of Technology, Shenzhen, 518055, China
[2]Suzhou Nuclear Power Research Institute, CGN, Suzhou, 215004, China
[*]Corresponding Author: Chao Ling. Email: lingchao@hit.edu.cn

ABSTRACT

Heat-resistant austenitic stainless steels are widely used in the final stages of superheater and reheater in in the new generation of fossil fuel power stations, due to their high creep strength. Similar weld joints, fabricated using gas tungsten arc welding, for connecting different components made of the heat resistant austenitic stainless steels usually suffer from premature failures at elevated temperature [1]. Experimental studies showed that cracks may nucleate in the heat affected zone or weld metal of the similar welded joints under service conditions. In order to reveal the physical origin of unexpected failures of the weld joints, a microstructure-based modelling work has been performed. Firstly, the microstructure of the welded joints was experimentally characterised, and then a representative weld microstructure model was digitally reconstructed using Electron-Back-Scattered Diffraction (EBSD) and finite element techniques. The stress-strain behaviour of each weld region at different temperatures was identified using a combination of digital image correlation (DIC) techniques, uniaxial tensile and microindentation tests. Dislocation density-based crystal plasticity models [2] are then formulated and calibrated so as to describe the behaviour of each weld region. Crystal plasticity finite element simulations were carried out based on the generated weld microstructure model to study the heterogenous distribution of stress and strain at the grain level. Local damage initiation mechanisms were systematically analysed for different weld regions.

KEYWORDS

Weld joints; austenitic stainless steel; digital image correlation; crystal plasticity

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