

MODELLING DAMAGE DEVELOPMENT AND CRACK GROWTH IN WELDED COMPONENTS

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Focus Material: Metals

Focus of the Presentation:

(i) Physics-based multi-scale model development;

Abstract

This paper considers the development of empirical and physical based models for damage development and crack growth in rate dependent materials. Two classes of problems are considered which involve the failure of dissimilar metal welds. The first problem concerns the creep failure of ferritic martensitic steels welded to a stainless steel or nickel based alloy. As the stress and temperature are decreased there is a transition from base metal failure to type IV cracking within the Heat Affected Zone of the ferritic steel, and then to interfacial failure. In the second problem we consider the effect of hydrogen on the fracture of a low alloy steel/nickel based alloy weld. At low hydrogen concentration the failure is ductile, but as the concentration is increased there is a transition to a quasi-cleavage mode within a narrow interface region on the Nickel side of the weld, which contains a fine distribution of M_7C_3 carbides. In this second problem rate dependence arises from the diffusion of hydrogen.

In this paper we concentrate on failures at, or close to, an interface. We describe models which take into account the details of the local (evolving) microstructure. For each problem, our models make use of cohesive or interface elements. For the creep problem the rate dependent interface elements contain information about the evolving local precipitates and cavities. We calibrate the models against micro and macro experimental data. In the case of hydrogen embrittlement we place cohesive elements around the fine precipitates, whose properties depend on the local accumulated plastic strain and hydrogen concentration.