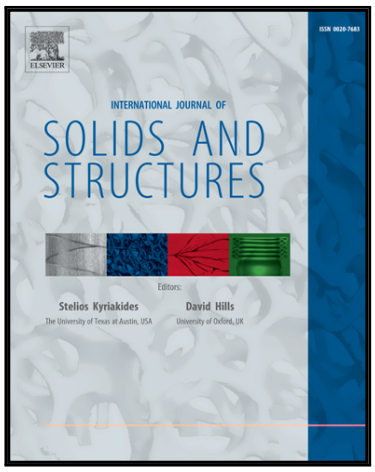

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Initiation and growth of microcracks near a grain boundary precipitation in coarse-grained zones of welded materials

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ABSTRACT

The interfaces between precipitations and the matrix of a welded material and the triple junctions of its grain boundaries (GBs) are two favorable sites for crack initiation. We have developed a theoretical model to describe the initiation and growth of microcracks near a precipitation located at the GB and near one of the triple junctions. Under loading, the stiff precipitation is modeled as a local stress concentrator. GB sliding occurs via the movement of GB dislocations which are accumulated at the triple junction. As such, the GB triple junction acts as an obstacle for GB sliding. The stress fields produced by the interaction between precipitation and GB sliding under uniaxial quasi-static tensile loading are derived using the Muskhelishvili method. By utilizing the energy criterion of crack growth, the initiation and growth of microcracks at the site of the precipitation and at the triple junction are investigated. The obtained results indicate that cracking at the sites of stiff precipitations is the main factor contributing to the cleavage fracture of the coarse-grained zones, which are common for welded materials such as HSLA steel weldments which contain local brittle zones. The majority of microcracks initiates at the boundaries of precipitations and propagates into them.

Keywords: Microcrack; Precipitation; Grain boundary sliding; Triple junction

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