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Combined experimental–numerical investigation of ductile fracture toughness of high purity fine-grained nickel through small-size notched tensile specimens

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ABSTRACT

The available stock of the material is very often insufficient to machine conventional specimens and conduct tests according to ASTM Standards. Specially, it is difficult to meet the specimen size requirements, such as thickness or planar width, and estimate fracture toughness of high strength materials by means of KIc, JIc, or CTOD. A Local Approach to Fracture is an alternative methodology that can estimate macroscopic fracture properties based on the testing of the small-size specimens. In this contribution, an integrated experimental and numerical study was proposed to investigate the mechanical properties of highly ductile and tough nickel consisting of fine grains. The experimental set-up of small-size notched tensile specimens was proposed to obtain different states of triaxial stress and to evaluate the stress state dependence with the failure strain. It was shown that the triaxiality plays a major role on the damage evolution demonstrated on the stress–strain curves by decreasing ductility. The experimental investigation was supplemented by electron microscopy observations of the fractured surfaces. The observed deformation mechanisms leading to the failure, based on the nucleation, growth, and coalescence of microvoids, ware linked with the modified Gurson model proposed for numerical simulations. The simulations provided approximate values of the damage parameters, which were subsequently applied to the crack tip situation. Finally, the evaluated toughness of the material in the mode I crack propagation was compared with experimental data. The proposed model and related damage parameters provided satisfactory predictions of crack formation and propagation.

Note: to be considered as a poster