Effects of void size and spatial distribution on ductile damage

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Abstract

A study of damage due to void growth in 1050 Aluminium is carried out using X-ray Computed Tomography (XCT) conducted in-situ at ID-11 at the European Synchrotron Radiation Facility using the Nanox tensile stress rig. A statistical analysis of the development of void size, void shape, and void volume fraction is carried out through different stages of deformation. The experimental results are compared to predictions from the classical Gurson-Tvergaard-Needleman model, as well as extensions accounting for size effects for micron scale void distributions and statistical variations in spatial void distributions. The effect of size is described by a model based on numerical cell studies of regular void distributions using strain gradient plasticity, where the void size effect is characterized by two extensions to the GTN-model. One is the definition of a size-dependent effective void volume fraction smaller than the physical one, and the other is the introduction of a size-dependent reduction of the influence of the mean stress. The model for statistical variations in the spatial void distribution is based on a recent extension to the classical GTN model, where the microstructural randomness is characterized by a distribution parameter that enters the yield function for the porous material.

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