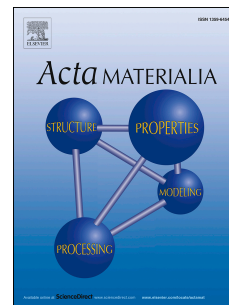


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F. Hannard, A. Simar, E. Maire, T. Pardoen



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Quantitative assessment of the impact of second phase particle arrangement on damage and fracture anisotropy

F. Hannard^a, A. Simar^a, E. Maire^b, T. Pardoen^a

^a*Institute of Mechanics, Materials and Civil Engineering, Université catholique de Louvain, B-1348 Louvain-la-Neuve, Belgium*

^b*MATEIS UMR5510, INSA-Lyon, F-69621 Villeurbanne, France*

Abstract

The fracture anisotropy of the three aluminium alloys Al 6056, Al 6061 and Al 6005A has been characterized in tension. In the three alloys, the onset of yielding and strain hardening behaviour do not significantly depend on the loading direction. However, while the fracture strain is close to isotropic in the alloys Al 6061 and Al 6005A, the alloy Al 6056 exhibits a clear fracture anisotropy. In situ tensile tests in X-ray tomography reveal that there exist two coalescence stages that include intra- and inter-cluster coalescence. A quantitative approach is proposed to relate the propensity to fracture anisotropy to a simple microscopic parameter characterizing the degree of anisotropy in the spatial distribution of second phase particles. The new indicator which quantifies the degree of connectivity or percolation between clusters is successfully assessed for the three Al alloys.

Keywords: X-ray tomography, Ductile damage, Anisotropy, Aluminium alloys

1. Introduction

Ductile fracture results from an overlapping sequence of nucleation, growth and coalescence of small internal cavities leading to macroscopic failure. The current state of understanding of the damage stages from a micromechanical viewpoint is relatively advanced and has allowed the development of predictive models well validated for sufficiently homogeneous materials <1>. Indeed, ductile damage has traditionally been treated as a global process, see for instance the enhanced version of the Gurson model <2; 3; 4; 5>, the material being often treated with "average" microstructural properties assuming a strict progression from nucleation to coalescence. However, there are considerable experimental evidences which indicate that the ductile damage process is often strongly affected by microstructure heterogeneities.

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