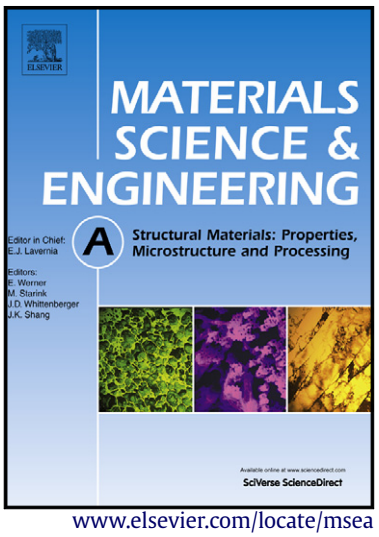

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Geometry and grain size effects on the forming limit of sheet metals in micro scaled plastic deformation

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ABSTRACT

In micro scaled plastic deformation or micro forming process, workpiece usually consists of only a few grains in deformation zone. The so-called size effect thus exists and the material deformation behaviors are quite different from the conventional ones in macro scaled. Size effect affects the deformation capability or the forming limit of sheet metals. To explore this effect, uniaxial tensile tests of different-shaped specimens were conducted to obtain the left-hand-side forming limit diagram of sheet metals from macro to micro scaled. The deformation process was recorded by a digital camera and the limit strains of different deformation conditions were measured using the digital image correlation method. The left-hand-side forming limit diagrams under different thickness-to-grain-size ratio conditions were then constructed. The experimental results show the existence of the significant size effect and the forming limit decreases with the thickness-to-grain-size ratio. However, the scatter of forming limit gets much worse if there are only one or two grains over the thickness of material. To analyze how the size effect affects the ductile fracture in micro forming, Oyane's ductile failure criterion was modified to model the forming limit in micro scaled plastic deformation. Through calculation, the modified criterion is found to be able to model the decrease of forming limit caused by size effect. The revised Oyane criterion can then be used to analyze the forming limit of sheet metals in micro scale.

Keywords: Micro scaled plastic deformation; Size effect; Forming limit; Ductile fracture; Sheet metals.