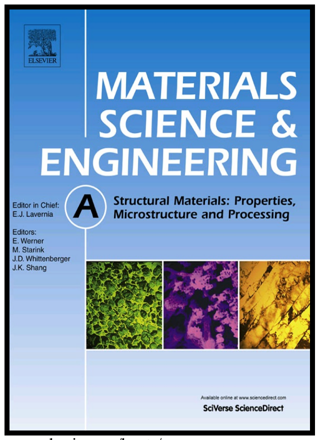

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Prediction of flow stress and surface roughness of stainless steel sheets considering an inhomogeneous microstructure

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Abstract

The aim of this study is to model the mechanical behavior of ultra-thin sheets of stainless steel taking into account the heterogeneous distribution of the mechanical properties of the grains. EBSD analysis and micro-hardness measurements are performed to characterize the grain size and shape as well as the local hardness distribution. A finite element model of a representative volume, based on the grain size distribution and Voronoï polyhedrons, is developed using the dedicated free software Neper and the material inhomogeneity is introduced via a discrete distribution of the flow stress of the grains. Four different flow stress distributions are considered, by changing either the flow stress range or the corresponding volume fractions. A uniaxial tensile test of the representative volume is simulated and compared to experimental data. Then, the influence of the grain heterogeneity on the hysteresis of loading-unloading sequences in tension and on the Bauschinger effect in simple shear is investigated numerically and compared with experiments. In particular, it is shown that the type of the flow stress distribution influences significantly the magnitude of the Bauschinger effect. Finally, the surface roughness is characterized numerically both in tension and simple shear and is shown to reproduce faithfully the experimental values.

Keywords: ultra-thin metallic sheet, surface roughness, grain size, material inhomogeneity, mechanical behavior

1. Introduction

Industrial metallic alloys are polycrystalline materials, that are composed of millions of grains of different sizes, shapes and orientations. Size and orientation are well-known to influence the mechanical properties, e.g. the distribution of crystallographic orientations,

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