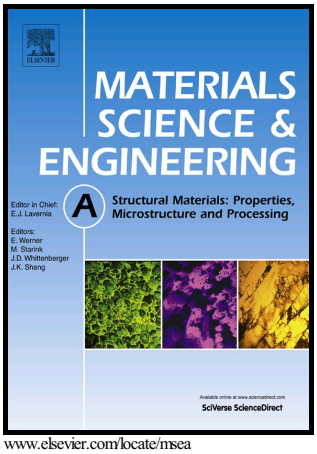
Dislocation versus grain boundary strengthening in SPD processed metals: non-causal relation between grain size and strength of deformed polycrystals

M.J. Starink



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Dislocation versus grain boundary strengthening in SPD processed metals: non-causal relation between grain size and strength of deformed polycrystals

M.J.Starink

Materials Research Group, Faculty of Engineering and the Environment,

University of Southampton, Southampton SO17 1BJ, UK

Abstract:

In metals that are heavily cold deformed, for instance by a severe plastic deformation process, significant strengthening is caused by the high density of defects such as grain boundaries and dislocations. In this work a model for volume-averaged dislocation and grain boundary (GB) creation is used to show that unless significant annihilation of defects post deformation occurs, the dislocation densities and GB densities in the deformed material are closely correlated. The dislocation strengthening effect thus shows a strong correlation with GB strengthening, and correlation of strength or hardness with $d^{1/2}$, where d is the grains size, as in a Hall-Petch type plot, can not be taken as an indication that GB strengthening dominates. Instead, in many SPD processed metals and alloys, dislocation strengthening is the dominant strengthening effect, even though a Hall-Petch type plot shows a good linear correlation.

Key words: Severe Plastic Deformation (SPD), dislocations, recovery, hardness, grain size

1. Introduction

Severe plastic deformation (SPD) has attracted wide attention as a means of improving properties of metals and alloys, and especially improvements in strength have been