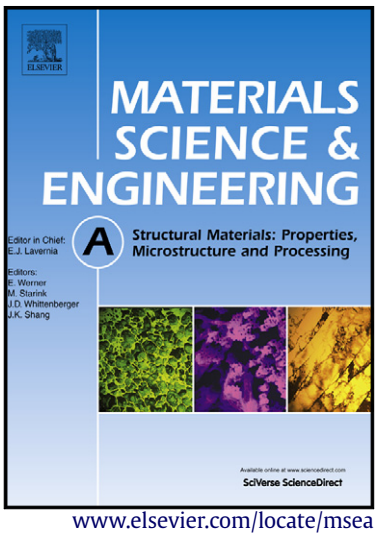

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Strengthening of an Al-Cu-Mg alloy processed by high-pressure torsion due to clusters, defects and defect-cluster complexes

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Abstract

A physically-based model is established to predict the strength of cluster strengthened ultrafine-grained ternary alloys processed by severe plastic deformation. The model incorporates strengthening due to dislocations, grain refinement, co-clusters (due to short range order and modulus strengthening) and solute segregation. The model is applied to predict strengthening in an Al-Cu-Mg alloy processed by high-pressure torsion (HPT). The microstructure was investigated using transmission electron microscopy (TEM), atom probe tomography (APT), and X-ray diffraction (XRD). Analysis of XRD line profile broadening shows that the dislocation density increases significantly due to severe plastic deformation, which contributes to the increase of strength. APT reveals the presence of nanoscale co-clusters and defect-solute clustering. The concepts of the multiple local interaction energies between solutes and dislocations were used to quantitatively explain the strengthening mechanisms. The model shows a good correspondence with measured microstructure data and measured strength.