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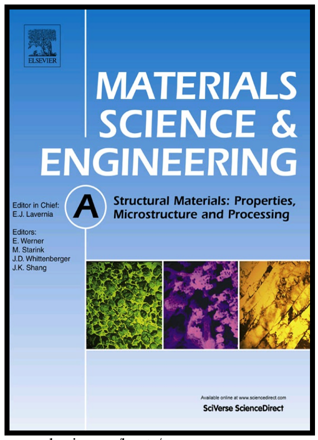

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Revealing the microstructure evolution in Cu-Cr alloys during high pressure torsion

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Abstract

Usually immiscible Cu-Cr compounds in equilibrium condition were mechanically processed via high pressure torsion with large and controllable strains. A systematical investigation on 57 wt.%Cu - 43 wt.%Cr was carried out to get insights into the microstructural evolution of Cu-Cr nanocomposites and their dissolution process, as well as to determine the solid solubility limit of Cu and Cr elements under severe deformation. Microstructure evolution was captured with grain refinement from micron-size down to less than 20 nm as the increase of strains. A strain-saturated state in 57 wt.%Cu - 43 wt.%Cr bulk was achieved after 100 rotations deformation (effective strain 1360), with a stable grain size of 13.7 nm and invariable hardness of 480 – 495 HV. Fine scanning of X-ray diffraction and sub-nanometer scale measurements of energy-dispersive X-ray spectroscopy showed that 32 wt.% Cu could be fully dissolved into Cr matrix , and conversely solubility of Cr in Cu was determined to be about 3 wt.% after an enough amount of deformation. The phase fraction change associated with Cu dissolution into Cr matrix during continuous deformation was captured and accurately calculated, indicating a negative exponential phase change mode. A phenomenological intermixing mechanism based on the kinetic competition between external forcing mixing and thermal-diffusion induced decomposition was proposed, which was well accordant with the phase evolution observed from experimental results.