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PII: S0921-5093(16)30769-9
DOI: <http://dx.doi.org/10.1016/j.msea.2016.07.016>
Reference: MSA33847

To appear in: *Materials Science & Engineering A*

Received date: 20 May 2016
Revised date: 30 June 2016
Accepted date: 5 July 2016

Cite this article as: B. Roy, T. Maity and J. Das, Tuning of nanostructure by the control of twin density, dislocation density, crystallite size, and stacking fault energy in $\text{Cu}_{100-x}\text{Zn}_x$ ($0 \leq x \leq 30\text{wt.}\%$), *Materials Science & Engineering A* <http://dx.doi.org/10.1016/j.msea.2016.07.016>

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Tuning of nanostructure by the control of twin density, dislocation density, crystallite size, and stacking fault energy in $\text{Cu}_{100-x}\text{Zn}_x$ ($0 \leq x \leq 30$ wt.%)

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Abstract

The present study demonstrate the effect of stacking fault energy (SFE) on the evolution of crystallite size, dislocation density, twin density, stacking faults, and their mutual interactions during cryorolling in pure copper (SFE 78 mJ/m²) and copper–zinc alloys with varying Zn content of 10 wt. % (SFE 35 mJ/m²), 20 wt. % (SFE 19 mJ/m²), and 30 wt. % (SFE 14 mJ/m²). The dislocation density, twin density and extrinsic fault probability increases whereas crystallite size decreases upon cryorolling and with the decrease of SFE. Accumulation of dislocations at the twin boundaries causes dynamic recrystallization, promotes grain refinement by forming subgrains inside the twin lamellae. Detail investigation on the activity of structural defects during cryorolling of Cu/Cu-Zn alloys has been done through resistivity measurements. Nanoindentation studies have performed to understand the deformation kinetics of the cryorolled Cu/Cu-Zn alloys with high concentration of structural defects in term of strain rate sensitivity and activation volume. A micromechanical model has been used to demonstrate the effect of SFE and the role of structural defects during nanostructuring at cryogenic temperature.

Keywords: Electron microscopy; X-ray diffraction; Cu-alloy; Nanostructured materials; Grain refinement; Twinning.

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