Coherency Dependent Thermal Stability In Nanotwinned (NT) Cu

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Introduction - All headings format should be Arial, 10 pt., bold, left aligned

Materials such as Cu containing nanoscale growth twins were reported to have high strength and conductivity [1]. This materials of this kind are potential conductors for high field magnets. Thermal stability of nanostructured material often limits their applications. Therefore, an investigation was conducted on twin-boundary coherency-related thermal stability in NT Cu.

Experimental - There should be one blank line Arial, 10 pt. space before each heading.

High purity Cu foils (50×10×0.1~0.2 mm^3 in size) with high density (99%) of coherent twin boundaries (CTBs) were synthesized. The thermal stability was analyzed by differential scanning calorimetry (DSC). The microstructures were characterized on transmission electron microscope (TEM, JOEL-2011) on cross sections. Hardness was done on Tukon 2100 microhardness tester. All facilities were hosted in the National High Magnetic Field Laboratory.

Results and Discussion

TEM images in Figs. 1(a) and (b) show that CTBs are straight and sharp, while incoherent twin boundaries (ITBs) induced by deformation are stepped, and tangled with dislocations, which imply the distortion of atom planes near the incoherent twin boundaries. In NT Cu with CTBs, DSC results in Fig. 1(c) indicate no evident recovery until recrystallization at ~ 308˚C. By contrast, in NT Cu with ITBs the recovery takes place even at ~ 113 ±3˚C, beside the recovery at ~ 212 ±4˚C, and recrystallization at 287 ±5˚C. During 100 ˚C annealing, the hardness in Fig. 1(d) drops rapidly with the deformation stain, i.e. the ITBs content. The degradation of thermals stability is attributed to the mobility and high-energy (498 mJ. m^{-2}) of ITBs, compared with the low-energy (21 mJ.m^{-2}) of CTBs[2, 3].

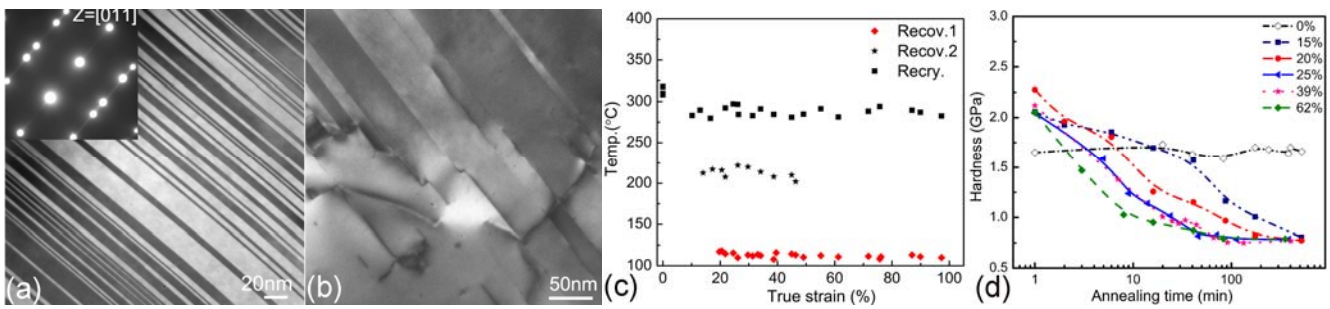

Figure 1. TEM images showing CTBs (a) and ITBs (b) in NT Cu with Z=[011]. (c) Recovery and recrystallization temperature evolution (c) and hardness reduction during 100 ˚C annealing (d) with deformation.[3]

Conclusions

Nanotwinned Cu with high density of coherent TBs possesses high hardness and super stability at 100˚C due to the lack of mobile dislocations at CTBs. The introduction of numerous incoherent TBs by deformation reduces the hardness and stability by migration of Shockley partial dislocations.

Acknowledgements

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References

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[2] Niu, R.M., *et al.* Scripta Materialia **68**, 960-963 (2013).
[3] Niu, R., *et al.* Applied Physics Letters **104**, 011913 (2014).