AN ALMOST UNIFYING THEORY FOR GRAIN BOUNDARY-BASED PLASTICITY

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Revealed in metallic nanocrystals, or thin films (Fig. 1) grain boundary (GB)-based plasticity has been studied for many years under various names: stress-assisted grain growth, grain rotation, grain boundary sliding or shear-coupled grain boundary migration. Based on MD simulations, TEM and in-situ TEM approaches, we will show that a key player in these mechanisms is the disconnection [1, 2]. This defect combines a step and a Burgers vector character, and belongs to GBs, especially real GBs. The motion of these defects can explain most of the above-mentioned mechanisms depending on the amplitude of both its step and dislocation components. But not all of them. Some observations suggest that local atomic shuffling also plays a role as clear non-conservative behaviours are detected, probably postponing the expected happy ending of a complete GB-based plasticity understanding.

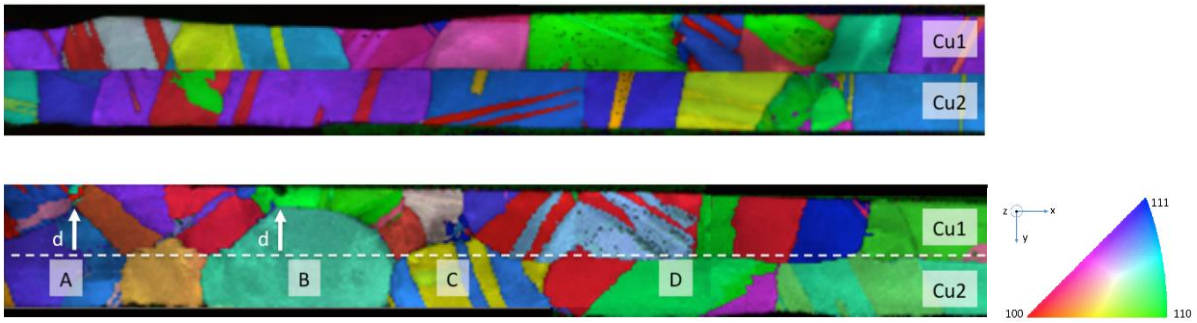

Figure 1 – Copper/copper film bonding experiment where a 3D grain microstructure is re-created after annealing and GB migration (after [3]). TEM cross section, ASTAR-ACOM mapping.

References

[1] Rajabzadeh, et al. Acta Materialia (2014). 77, 223–235.
[2] Rajabzadeh et al. Physical Review Letters, (2012) 110(26), 265507.
[3] Martinez et al. Thin Solid Films (2013), 530, 96–99.