Microstructure and mechanical strength of near- and sub-micrometre grain size copper prepared by spark plasma sintering

Spark plasma sintering (SPS) has been used to prepare fully dense samples of copper in a fully recrystallized condition with grain sizes in the near- and sub-micrometre regime. Two synthesis routes have been investigated to achieve grain size control: (i) SPS at different temperatures from 800 to 1000 °C, and (ii) SPS at 800 °C followed by annealing at temperatures from 950 to 1050 °C. By use of an initial spherical powder with an average particle diameter of ≈ 0.5 μm, samples with average grain sizes in the range from 0.5 to 3 μm have been prepared. Microstructural examination based on both transmission electron microscope, and on electron back-scatter diffraction studies, confirms the samples are in a nearly fully recrystallized condition, with grains that are dislocation-free, and have a random texture, with a high fraction of high angle boundaries. The mechanical strength of the samples has been probed using hardness measurements and tensile testing, revealing an enhanced strength for samples with grain sizes less than ≈ 1 μm.