Acoustic Emission Observations of the Effects of High Temperature fcc Phase Concentration in Pure Polycrystalline Cobalt on its Compressive Behavior

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The compressive behavior of pure polycrystalline cobalt depends on the residual fcc phase content. To assess this dependency, samples are prepared first undergoing isothermal annealing at different temperatures between 600°C and 1100°C. This leads to recrystallization and grain growth dependent on the applied annealing temperature allowing for targeted modification of the microstructure. Annealing at such temperatures leaves ~6-11% of the high temperature fcc phase in the material. Additional thermal cycling around the phase transition temperature was applied to further modify the fcc phase concentration. Increasing the number of thermal cycles leads to grain growth and a significant drop of the fcc phase content and, thus, combined with previous annealing it is possible to closely control the microstructure of the sample. Dependence of the compressive behavior on the microstructure is subsequently examined using deformation testing with constant speed of deformation combined with acoustic emission (AE). It is shown that the yield strength decreases while the fracture strain increases with rising grain size. Subsequently both the yield strength and the fracture strain decrease with smaller concentration of the fcc phase. Further analysis of acquired AE data provides an in-depth look at the deformation mechanisms that take place in the observed material. Observed power law distribution of the AE event parameters confirms the collective nature of the dislocation motion. This further confirms that the dislocation motion does not happen on an individual basis but rather in groups with interactions between the dislocations resulting in scale invariant self-organized avalanche-like motion of dislocation ensembles.

Keywords: cobalt; deformation; acoustic emission; in-situ characterization; collective dislocation motion

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