

APPLICATION OF LINE PROFILE ANALYSIS TO EVALUATION OF MICROSTRUCTURAL RECOVERY ACCOMPANIED WITH PRECIPITATION IN AGED ALLOYS

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Growth behavior of precipitates for precipitate-hardenable alloys is influenced by microstructural recovery in thermal aging treatments. This is due to a close correlation between dislocations and diffusion of solute elements for precipitation. Moreover, the rearrangement of dislocations in the recovery is associated with the composition of the alloys, because interstitial or substitutional solute atoms can restrain dislocation movements. In order to clarify the effect of dislocations on the precipitation phenomena and the correlation between dislocations and solute elements, we need to analyze microstructural recovery of aged alloys quantitatively. Line profile analysis can be a promising method to characterize dislocations in the aged alloys. The recent theory of line profile analysis using several peaks (111, 200, 220, 311, 222, ... for fcc crystal) is a well established and accurate method. However, whereas the multi-peak analysis is based on a homogeneous microstructure, deformed-alloy samples having textured microstructures, especially exhibit inhomogeneous recovery depending on the crystal orientation of grains. Consequently, several line profiles of particular reflections can vary significantly with an aging time, while line profiles of other reflections vary slightly. This inconsistency generates uncertainty in estimating microstructural parameters such as the dislocation density. To address this problem, we measured line profiles of a particular grain group oriented in the same crystal direction, and analyzed them through the classical Warren-Averbach procedure. In the analytical procedure, mean-square strain curves estimated from the line profiles were analyzed by fitting a theoretical strain function to estimate the dislocation density. Figure 1 shows variations in the dislocation density of Cu-Ni-Si alloys as a function of aging time at 720 K. The dislocation density decreased distinctly at an aging time of 20 ks. According to the size distribution of precipitates (Ni_2Si) analyzed by a small angle X-ray scattering method, the growth rate of precipitates rose at this aging time (20 ks). This indicates that coarsening of the precipitates can be accompanied with a massive rearrangement of dislocations. Moreover, with a decrease in the silicon composition of the alloys, the variation in the dislocation density at the aging time of 20 ks became more distinct. This suggests that the interstitial silicon can suppress the coarsening of precipitates at this aging time. The details of the analytical procedure and the correlation between the precipitation and other microstructural features will be presented in the session.

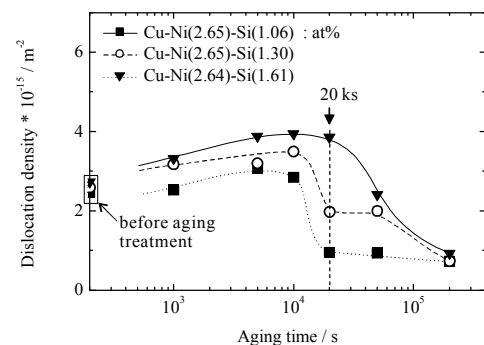


Figure 1. Variations in dislocation density in different copper alloys as a function of aging time at 720 K.