Grain Boundary Properties and Grain Growth: A1 Foils, A1 Films

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Relative grain boundary energy as a function of misorientation angle has been measured in cube-oriented, i.e., ¡100¿ fiber-textured, 120 μm-thick A1 foil using orientation imaging microscopy and a statistical multiscale method. The energies of low-angle boundaries increase with misorientation angle, in good agreement with the Read-Shockley model. The relative energies of high-angle boundaries exhibit little variation with misorientation. Examination of the grain structure of ¡111¿ fiber-textured, 100 nm-thick A1 films annealed at 400 degC for 0.5-10 h shows 5 and 6 sided grains to be the most frequent, and the fraction of four-sided grains to be significant. the mean number of sides is slightly lower than the expected value of 6 for two-dimensional structures. Of lognormal, gamma and Rayleigh distributions, gamma gives the best fit to the grain size data in the films; however, the difference between gamma and lognormal is small. Grain growth is not self-similar and stagnates after one hour of annealing. The evoluion of the grain size distribution with time indicates that the growth stagnation in the films is neither consistent with boundary pinning by grooving nor with conventional treatments of solute drag. Surface, elastic-strain and plastic-strain energy driving forces do not play a significant role int he grain growth and the subsequent stagnation since the films are strongly textured even in the as-depoisted state. The steady-state distributions of reduced grain area for two-dimensional, Monte Carlo and partial differential equation based simulations show excellent agreement with each other, even when anisotropic boundary energies are used. However, comparison with experimental distributions reveals a significantly higher population of small grains in the experiments.