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Excess Vacancies and the Mechanism of the Slow Reaction in Aluminum-4% Copper Alloy*

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Abstract

In order to discuss the mechanism of maintaining an excess concentration of vacancies for a long time during the low-temperature aging of Al-Cu alloys, the activation energy of copper diffusion during the slow reaction is determined from the activation energy of aging with an alloy of Al-4% Cu. The activation energy for copper diffusion is found to increase from that for the fast reaction (0.5 eV) to 1eV with aging time.

Excess concentration of vacancies in equilibrium with small dislocation loops or voids is found to be the most likely mechanism. It is calculated that dislocation loops of about 18 Å in radius exist with a density of $7 \times 10^{16} \text{ cm}^{-3}$. The atomic fraction of vacancies in these loops is $1.3 \times 10^{-4}$. Concentration of vacancies during the slow reaction is estimated from the loop size to be $2 \times 10^{-7}$, which reasonably ensures the diffusion of copper atoms during slow reaction.