A Theory of Internal Friction Peak Due to Thermal Unpinning of Dislocations and Its Application to P_1 Peak in Copper

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M. KOIWA

The Research Institute for Iron, Steel and Othdr Metals, Tohoku University

and

R. R. HASIGUTI

Department of Metallurgy, University of Tokyo

Abstract

A theory of internal frictions due to thermal unpinning of dislocations was developed. The results of quantitative calculations are as follows. (1) An internal friction peak as a function of temperature is formed, of which the shape is different from that of the Debye type single relaxation. (2) The distortion of the peak shape increases linearly with the strain amplitude. (3) The peak height of the internal friction and the magnitude of the associated ΔM effect are related by the equation, $Q^{-1}_{max}=0.126\Delta_M$. (4) The mean pinning distance can be estimated from experimental results.

The predictions of the theory were compared with the experimental characteristics of the P_1 peak in deformed copper, and a satisfactory agreement was found especially as to the distortion of the peak with the strain amplitude. The estimated pinning distance was found to decrease from $200b$ to $20b$ as the deformation increases, where b is the magnitude of Burgers vector, and was found to remain constant or rather slightly increase with the decay (or annealing) of the P_1 peak.

* The **1306th** report of the Research Institute for Iron, Steel and Other Metals. Published in the Acta Metallurgica, **13** (1965), 1219.