Dislocation Emission in Al During Recrystallization (*)

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Summary. — The dislocation structure evolution during isothermal recrystallization of Al has been followed by means of internal friction, modulus defect and X-ray diffraction analyses accompanying the microscopical observations. Many peaks of $Q^{-1}$ and of modulus defect and X-ray diffraction line width have been found, both in nucleation and grain growth, all referable to dislocations. The first of these peaks, at the beginning of recrystallization, presents recovery characteristics different from those shown by the subsequent, secondary peaks. Secondary peaks are interpreted in terms of dislocation emission from grain boundaries, whereas the first peak appears connected with subboundaries, walls present in the initial stages of recrystallization.

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1. — Introduction.

Observations on various metals, as Ag, Au, Cd, Co, Cr, Fe, Ni, Ti, Zr, have shown that recrystallization is accompanied by an internal-friction peak; for the modulus defect, one peak and/or decreases (*) or only one peak (2), in concomitance with the $Q^{-1}$ peak, were observed for Ag.

The relating bibliography can be found in (*)

(*) To speed up publication, the authors of this paper have agreed to not receive the proofs for correction.
A $Q^{-1}$ peak of this kind was observed by us also on Al, during recrystallization by increasing temperature (4) or during isothermal heating at various temperatures (5). In the first case, only modulus defect increases were found; in the second case, during isothermal heating, a maximum of modulus defect in correspondence to the $Q^{-1}$ peak was found.

Such phenomena have been, in general, related to dislocations; Iso et al. (6) refer the $Q^{-1}$ increases characterizing the peak to high degrees of the dislocations in freshly recrystallized domains, i.e. to the occurrence of domains which are freshly recrystallized; Diallo et al. (7) interpret the behaviour on the basis of the relation

$$Q^{-1} \propto \varrho \cdot l.$$  

The $Q^{-1}$ increases of the peak are attributed to increases of the pinning length $l$, the decreases to diminutions of the dislocation density $\varrho$. Dislocation rearrangements, especially in the first increasing part of the peak, are considered essential for the nucleation of new grains.

With the special aim of resolving contributions of nucleation and of grain growth, our previous observations concerning the primary recrystallization stage of Al have been extended to subsequent growth stages. The results reported there refer to isothermal heating at various temperatures.

Recrystallization was followed also by measurements of the modulus defect as well as by analyses of the X-ray diffraction lines, in their dependence on dislocation density and grain size.

2. -- Experimental.

The observations were carried out on sheets of Al 99.9%. The specimens for the various measurements were obtained by cutting from sheets 0.5 mm thick, after cold rolling with reduction of 98%.

From X-ray line broadening the initial grain sizes after rolling and before recrystallization were 0.2 $\mu$m.

The measurements of the internal friction coefficient $Q^{-1}$ and of the modulus defect $D_m$ were carried out with detection of the flexural vibration amplitudes by frequency modulation, in the range of amplitude independence, with amplitudes $< 10^{-6}$; vibration frequencies $\sim 500$ Hz.