



bar at a stress reaching 38.5 kbar



p lines a marking can be observed

On the lateral surfaces of the specimens rectangular indentations, appeared a few μm wide, one side of which being parallel to a (0001) trace. They also included slip lines. These markings, which were also described by Damiano [5], could well result from the differences between the elastic modulus of the precipitates and the matrix which would emit loops gliding to the surface (Fig. 9).

4. Discussion

In the hexagonal metals, the critical resolved shear stresses are a combination of several terms: an internal stress σ_G due to long range interactions with other dislocations, a Peierls force σ_P , an interaction stress with impurities σ_i , and a cross slip stress σ_F .

The Peierls stress σ_P should not change much if its relative variation is to be related to that of the elastic constants $dC_{ij}/C_{ij} dP$ equal to about $3 \times 10^{-3} \text{ kbar}^{-1}$ and to that of the lattice parameters $d(c/a)/dP = 5 \times 10^{-5} \text{ kbar}^{-1}$.

The internal stress $\sigma_G = \alpha \mu b \sqrt{\rho}$, where μ is the shear modulus, would much change only if the total dislocation density ρ would be markedly modified under pressure. This change in the dislocation density which would remain at atmospheric pressure could not be detected. Similarly the interaction stress σ_i must not be much altered by pressure lower than 15 kbar. In fact if iron is taken to be the main impurity in solution, it is known that the solubility is not very much affected by the pressure and the relative variation of the size effect does not reach 3×10^{-2} at 15 kbar. The equilibrium vacancy concentration at 300 °K and at 1 bar is of the order of $2.5 \times 10^{-15}/\text{atom}$ and with a dislocation density of 10^8 cm^{-2} they are unable to saturate all the dislocations. Consequently σ_i should not change much under pressure.

These considerations explain why the critical resolved shear stress on the basal plan σ_{0001} does not change with pressure when it remains lower than 15 kbar.

In the pressure range studied, the parameters μ and b vary little and in opposite ways. Thus the factor $\mu b^2/2$ which controls the line tension is not much modified by the pressure. On the other hand, the dilatation of the order of $3/2 b^2$ per atomic distance, which results from non-linear terms [6, 7], increases the line tension W_1 of the dislocation by ΔW_1 , such as

$$\beta = \frac{\Delta W_1}{W_1} \approx \frac{3 P}{\mu} \quad (1)$$

This becomes appreciable for pressures of the order of 15 kbar.

Under those conditions the model which was developed by Friedel [8] to describe prismatic slip, allows to explain the observed variations. In this model, indeed, the elastic limit is

$$\sigma \sim \left(\frac{\Delta E}{W_1} \right)^{3/2}, \quad (2)$$

where ΔE is the energy which is gained by the dislocation because of the splitting and, neglecting the variation of the stacking fault energy with pressure, it can be verified using formulae (1) and (2) that [9]

$$\sigma(P) \approx \sigma(0) \left(1 - \frac{3}{2\beta} \right) \approx \sigma(0) \left(1 - \frac{9}{2} \frac{P}{\mu} \right).$$