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A T.E.M. IN SITU STUDY OF DISLOCATION GLIDE IN InSb (III-V COMPOUND)

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Tensile microsamples are cut out of samples predeformed up to the lower yield point. They are oriented for single glide, with respective Schmid factors of 0.47 and 0.35 for primary and secondary glide systems.

Several dislocation sources are observed at 180°C, which emit screw and β type 60° dislocations, submitted to a strong Peierls force, and much more rapide α -type 60° dislocations [1] (Fig. 1).

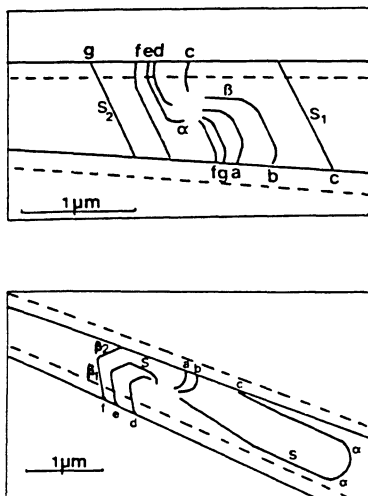


Fig. 1 - Scheme of dislocation sources (1 and 2) observed in situ.

There is no (or almost no) effect of the electron beam on the velocity of dislocations (cathodo plastic effect). The velocity of dislocations, and the corresponding local shear stress, have been measured in the vicinity of sources. The velocity of α dislocations is more than 100 times higher than the velocity of β and screw dislocations, and the velocity of dislocations is proportional to their length (length effect) for a constant local stress, with no indication of a maximum value in the investigated range (Fig. 2).

This means that the probability of nucleating a kink pair is proportional to the dislocation length, and that the time for kink movement along the observed dislocations is shorter than the time for kink nucleation.

No significant difference can be detected between the velocity of screws and β dislocations, for a constant stress (Fig. 2). This tends to confirm that the velocity of "slow" dislocations should be controlled by the mobility of 30° β partial dislocations.

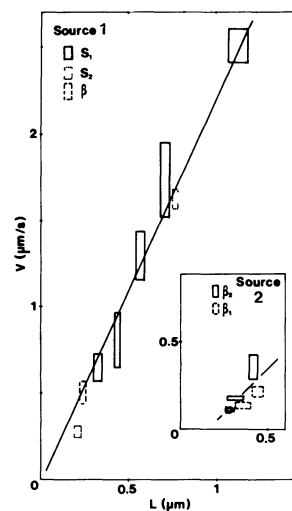


Fig. 2 - Velocity of screw and β dislocation segments as a function of their length.

Using the following expressions for the velocity of dislocations :

$$(1) \quad v = \frac{v_d b^3 L}{kT} \exp - \frac{F_{dk}^* + W_m}{kT}$$

in the length effect range, and

$$(2) \quad v_M = \frac{v_d b^4}{kT} \exp - \frac{\frac{1}{2} F_{dk}^* + W_m}{kT}$$

if the velocity becomes length independent for large lengths (situation not observed here), it is possible to obtain minimum and maximum values for the energy of a double kink of critical size ($F_{dk}^* > .6 \text{ eV}$) and for the kink migration energy ($W_m < .5 \text{ eV}$).

The local stress being estimated as 50 MPa, our measurements are compatible with the results of double etch pit experiments, at similar temperature and lower stresses, provided simple assumptions are made. They are also compared with results obtained by the same technique in II-VI compounds, and the latter appear to behave partly as III-V compounds, and partly as metals.

More recent results obtained in GaAs with N. Clément in collaboration with the University of Lille (Y. Androussi, A. Lefebvre, G. Vanderschave) will be also presented.

Reference :

[1] M. Fnaiech, F. Reynaud, A. Couret, D. Caillard, Phil. Mag. A55, 405 (1987).