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EXTRINSIC-INTRINSIC STACKING FAULT PAIRS
IN EPITAXIAL SILICON

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It has not yet been definitely proved that both extrinsic and intrinsic stacking faults are formed in "epitaxial" silicon. Although in principle it is possible to distinguish between the two types by differences in diffraction contrast,[1,2] in practice there are difficulties that make the interpretation uncertain. Among these are: (1) the difficulty of obtaining an orientation such that only one strong diffracted beam is operating, (2) the uncertainty as to whether a single or multiple fault is being observed.[3]

It is therefore of interest to consider any other evidence for the existence of both types of faults. Previous work[3] has shown that most of the faults in epitaxially grown silicon start at the original surface of the crystal and grow through the deposited material, usually forming closed figures. Because faults always lie on {111} planes, triangular figures are observed for {111} and {110} surface orientations and square figures for {100} surfaces. It was shown that deliberate contamination of the starting surface with oxide greatly increased the number of faults. This suggests that each stacking fault figure results from the inclusion at the original surface of some foreign atoms or particle. If the thickness of such a foreign particle is not equal to an integral multiple of silicon unit cell dimensions then coherence with the particle can only be maintained by a small upward or downward translation relative to the surrounding lattice of the silicon lattice directly above the particle. This may result in the nucleation of stacking faults at the edges of the patch of foreign atoms. When symmetrical closed stacking

fault figures are formed by this mechanism (i.e., three-sided or four-sided pyramids) it can be shown that the faults must all be of the same type, i.e., all extrinsic or all intrinsic. However, if a closed figure of faults is formed, two sides of which lie on parallel planes and the material inside the faults has simply been translated upward or downward relative to the surrounding crystal, then the two parallel faults must be of the opposite type.[3]

Figure 1 shows two parallel faults in a (110) epitaxial layer that are joined at one end by a third fault. This appears to be an example of an extrinsic-intrinsic pair. The fringe contrast on the inclined fault suggests, as is often the case in silicon, that all three of these faults are multiple, consisting of bundles of closely spaced faults of the same type.

References:

1. H. Hashimoto, A. Howie and M. J. Whelan, Proc. Roy. Soc., A, 269, 80 (1962).

2. A. Art, R. Gevers, and S. Amelinckx, Phys. Stat. Soli., 3, 697 (1963).

3. R. H. Finch, H. J. Queisser, G. Thomas and J. Washburn, J. Appl. Phys., 34, 406 (1963).

Figure Caption:

Fig. 1 A probable example of an extrinsic-intrinsic pair of stacking faults. Transmission electron micrograph shows two parallel faults joined by a connecting fault at one end in epitaxially grown (110) silicon.

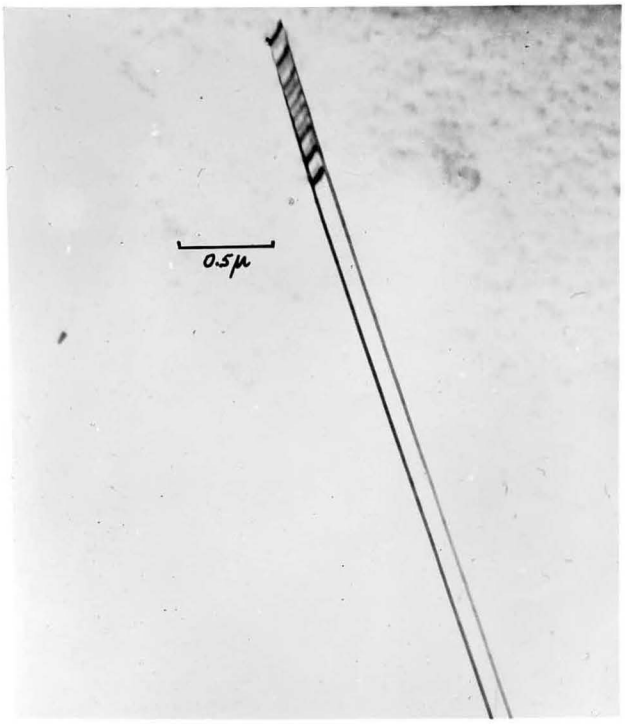

Fig. 1.