structed in the following way. First, static tensile tests were carried out on specimens cut from the same bar as the pellets. The uniaxial stress curve thus obtained was then translated into a uniaxial strain curve by the method discussed by Fowles.[2] The unloading curves were then constructed from elastic–plastic theory which takes into account the work hardening during the compressive cycle. The residual strain is the intercept of the unloading curve with the zero stress axis. The above analysis process is described in detail by Hartman.[4] It was necessary to linearly extrapolate the theoretical curve in Fig. 1 beyond shock pressures of 70 kbars, since the static tensile data did not extend into this strain region.

It is seen that the measured residual strains are close to the values one would expect from rate-independent theory. This indicates that when aluminum unloads from shock strain levels, the initially large reverse flow stresses reported in Ref. 1 later relax to the rate-independent values. The complete unloading curves might, therefore, be expected to look qualitatively like the loading curves reported by Barker *et al.*,[6] i.e., there should exist an initial elastic stress deviation which relaxes toward the static curve as the strain rate decreases.

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Fault Planes in Steam-Oxidized Silicon

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STACKING faults have been observed by Thomas[1] in silicon after annealing mechanically polished single-crystal slices, using transmission electron microscopy. The origin of these faults has been attributed to surface damage from mechanical polishing. Queisser and van Loom[2] have reported the observation of line patterns (visible with an optical microscope) on {100} surfaces of silicon wafers mechanically polished prior to steam-oxidation and then suitably etched. The authors interpret the line as the intersections of stacking faults with the surface. It has been indicated that the presence of water vapor during the oxidation is essential to the growth of the faults.

In this letter, we report the observation of two-dimensional faults in (111) silicon in which the surface damage was removed before steam-oxidation. Silicon slices (25-mil thick) were cut parallel to (111) from a pulled single crystal of high electrical resistivity. They were lapped and chemically polished to a considerable depth (6 mils on each side) to remove the surface damage. Chemical etching showed less than 5×10^2 etch pits/cm^2. Some of these slices were vacuum-annealed at 1000°C for 45 min. Neither Dash etch nor the electron microscope revealed significant defects. The annealed wafers were then steam-oxidized at 1150°C for 45 min. The oxide layer grown was about 0.7 μ thick. After removal of the oxide and after application of Dash etch for about 5 min, etch markings became visible, as shown in Fig. 1. Lines bounded on both sides by etch pits are oriented to maintain 60° angles between each other and delineate the ⟨110⟩ directions, and are of rather uniform length. Often, the lines are arranged in long rows that can be followed over several hundred microns. The rows are often parallel to each other and do not seem to lie in particular low-indexed crystallographic directions. The lines have a limited depth; they disappear after being subjected to the Dash etch for ~8 min, removing ~$1\frac{1}{2}$ μ of silicon. On wafers of 12-mil thickness (which showed etch markings on both sides), no correspondence of row directions or pit densities on the two sides was detected.

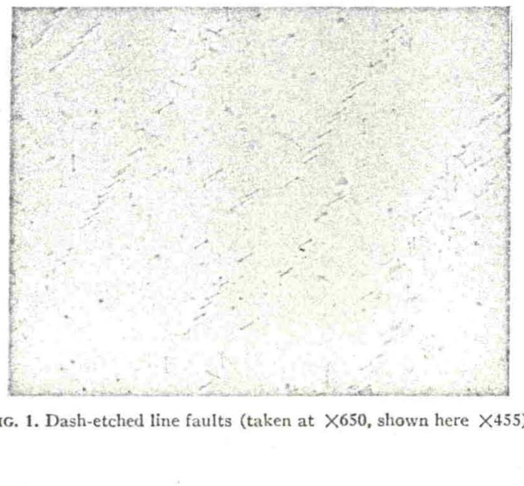

FIG. 1. Dash-etched line faults (taken at ×650, shown here ×455).

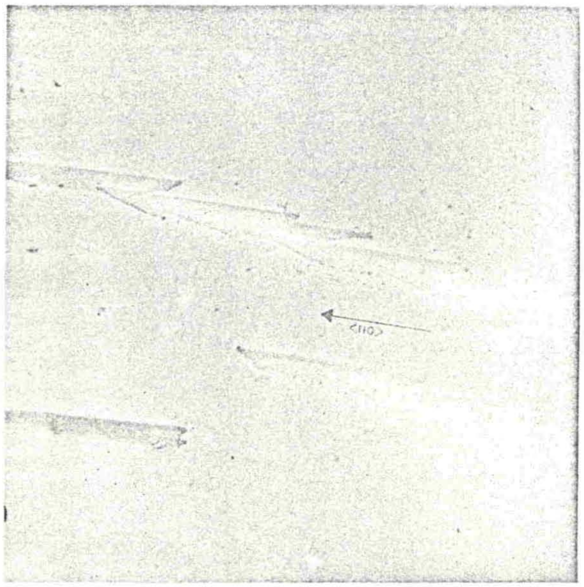

FIG. 2. Electron micrograph of stacking faults; note impurities bounding the faults; taken at ×19 000, shown here ×7600.

FIG. 3. Electron micrograph of ends of stacking faults; taken at ×52 000, shown here ×20 800.