The Structure of Aluminum after Compression

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Since 1925, when the preferred orientations in compressed aluminum were first determined[1,2] the orientations have been described as a fiber texture in which a face diagonal, [110], of the face-centered cubic lattice is parallel to the compression axis. Subsequent experiments have seemed to confirm this texture,[3–5] and a number of theories (recently summarized in references 6 and 7) have been proposed to explain it and to relate it to the behavior of single crystals during compression.[3,8–11]

The experiments reported in this paper prove that the orientations are not adequately described as quoted above—i.e., as a [110] fiber texture—although this is a first approximation to the actual texture. They also show that the texture cannot be thought of as a stable orientation that is reached and maintained after a sufficient amount of deformation. The actual texture, when studied in detail at successive stages of compression, indicates that a hitherto unsuspected range of orientations is present, both in the polycrystalline metal as a whole and in various individual grains in its interior, and that a state of dynamic equilibrium exists within this range. The reasons for the failure of previous theories to predict the actual texture become obvious when the heterogeneous nature of the flow is considered.

In addition to the deformation texture, the manner of its development, and its theory, this paper presents data on the following related subjects: the identity of strain markings in aluminum; the orientation changes in aluminum single crystals during compression and a comparison of these with the conditions in individual grains of a polycrystalline specimen; the origin of asterism in deformed single crystals, which heretofore has been regarded as a distortion localized at the surfaces of slip planes; and the relation of plastic strain in individual grains in an aggregate to the strain of the whole.

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[1] References are at the end of the paper.