A NOTE ON WIDMANSTÄTTEN CRYSTALLOGRAPHY

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The elegant neutron diffraction experiments of Kulka and Olés (1985) are welcome additions to the study of the crystallography of the Widmanstätten structure in octahedrites, and it is to be hoped that their investigations may be extended to other meteorites and that the interpretation of their results could be critically evaluated.

To the latter end it might be useful to review some of the existing observations on Widmanstätten crystallography.

In a couple of classic papers Young (1926, 1939) reported detailed investigations of, (I), the HABIT planes of Kamacite — with respect to the parent taenite — as determined optically by measuring the traces of Kamacite bands on three mutually perpendicular etched surfaces that had been ground on a block of Cañon Diablo meteorite and also of, (II), the LATTICE ORIENTATIONS of Kamacite with respect to its parent taenite, as determined by back-reflection X-ray crystallography.

Young reported (I) in relation to the visually determined habit plane . . . "it is only in an approximate sense that the 4 Widmanstätten planes may be regarded as lying along {111} of the cubic crystal," a situation that was later illustrated by Axon (1962) for the M'bosi meteorite.

Young also reported (II) that in relation to the lattice orientations of the Kamacite and its parent γ there appeared to be a deviation of up to 2° (mean of 15 instances 1.1°) from strictly parallel geometry between the $\{111\}_\gamma$ and $\{110\}_\alpha$ lattice planes. However, if these lattice planes were assumed to be parallel there was still a scatter of 2-6° between the close packed atomic directions $<110>_\gamma$ and $<111>_\alpha$, with a mean deviation of 3.8° for the 15 instances studied. Young considered that his directional deviations were not random and he interpreted the effect in terms of a shearing stress which operated on the parent γ during or soon after the initial exsolution of Kamacite. These measurements were made on the Cañon Diablo iron, in which Kamacite predominates and in which it is not easy to find large continuous volumes of residual γ. Thus his lattice orientation relationships are necessarily of a statistical nature.

More recently, but to a very limited extent, Young's observations have been confirmed by Hasan and Axon (1985) who employed transmission electron microscopy and electron diffraction techniques to examine the lattice orientation of contiguous α and γ in a thin foil specimen of the Gibeon meteorite. They found for their single example a 1½° misorientation of planes and also a misorientation of close packed atomic directions which seemed to vary according as to whether the α-γ relationship was for a high temperature, primary, or for a lower temperature, plessitic, transformation product. These measurements need to be greatly extended before anything can be decided about the pattern, if any, of deviations; and the orientation of the tesseral Kamacite in Gibeon should also be examined. Nevertheless, the electron diffraction results do provide direct information about the crystallographic orientations of contiguous crystals of α and γ; bearing in mind that the measured orientations refer to "good" crystal in "contact" whereas the actual α-γ interface is probably a region of more considerable disorder spread over a few atomic thicknesses of interface material.

It should be mentioned that Young provided a detailed discussion and illustration of the way in which a specific octahedral plane of the parent γ may give rise to a multiplicity of equivalent but slightly misoriented plates of exsolved α, such that on an etched macrosection ostensibly similar and parallel plates of Kamacite may show up with either bright or dark etching character.

Finally it may be noted that the Neumann bands which Kalka and Olés take to be the product of terrestrial impact are very often found to be of preterrestrial origin, as witnessed by their predating the era of ablative surface heating during atmospheric flight.

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