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Technical Note

Cylindrical Carbide Particles

by J. H. Westbrook

IT is always of interest to document the origin of real microstructures which closely approach various idealized morphologies. Such instances constitute excellent bases for experimental studies of the effect of microstructure on properties. Typical examples include the eutectoid steels (lamellae) used by many investigators and the two phase Cu-Cr alloys (spheres) recently employed by Hibbard and Hart.¹ The present note describes a structure with cylindrical particles.

In a study of certain alloys in the Cr-C system, an alloy was arc melted whose composition was very close to the α Cr-Cr₂₃C₆ eutectic (3.2 wt pct C, according to the latest phase diagram published by Bloom and Grant²). The alloy was not analyzed but previous experience with the melting technique employed indicates good correspondence between intended and analyzed compositions with negligible tungsten contamination from the electrode.

The phases present in the alloy were identified by X-ray powder patterns as α chromium and Cr₂₃C₆. Typical micrographs, presented in Fig. 1, show unmistakable evidence of the cylindrical geometry of the carbide phase. The eutectic grains are randomly oriented and, consequently, only a few show the true fibrous nature of the carbide

particles, most being cut so as to show slightly elliptical cross sections. Within any particular grain, remarkable uniformity is to be observed with respect to the size, shape, spacing, and orientation of the carbide particles. Length to diameter ratios have been estimated from the micrographs to be at least 250:1, with diameters of about 1 μ .

This alloy may be of further interest from different viewpoints. On the one hand, it might be used to check the applicability of the equations derived by Fullman³ for computing true particle dimensions of cylindrical particles from opaque random sections. On the other hand, it might be possible to extract the carbide particles from this alloy and repack them in a ductile matrix to form a synthetic structure of the type discussed by Metcalfe et al.⁴ With the large $l:d$ ratio and the small diameter of the carbide fibers, it is likely that the interdefect distance in each fiber is sufficiently great to permit realization of a large fraction of the presumed high strength of the carbide.

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Fig. 1—Typical microstructures of the α Cr-Cr₂₃C₆ eutectic showing the cylindricity of the carbide phase. Both, NaOH electrolytic etch. LEFT: X100. RIGHT: X1000. Reduced approximately 15 pct for reproduction.