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# Imaging of SiC in Metal Matrix Composites

V. Radmilovic, M.A. O'Keefe, and G. Thomas

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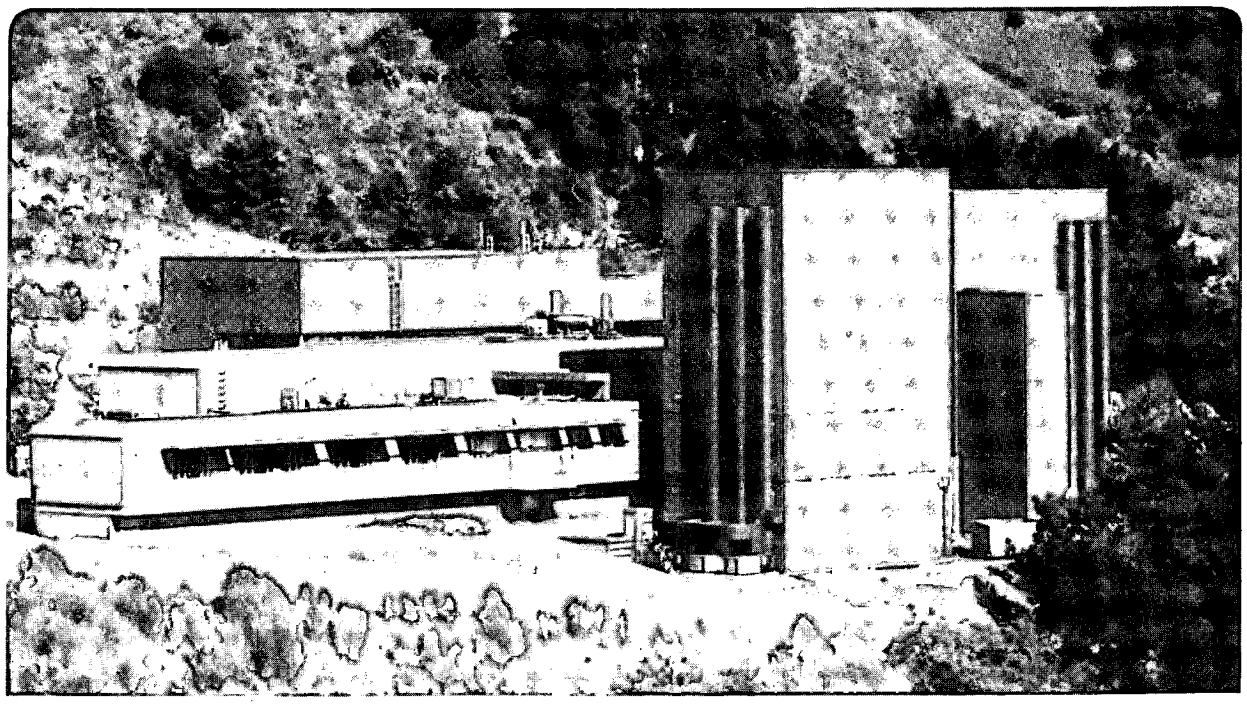

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# Imaging of SiC in Metal Matrix Composites

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Many polytypes of SiC have been reported in investigations by x-ray. However, transmission electron microscopy techniques, under conditions described by Smith and O'Keefe[1] have certain advantages, over the x-ray diffraction in determination of the lattice periodicity[2], especially in resolving fine structural details, e.g. stacking sequences[3], mono-layer twinning, polytypes, etc.[4] The even more complex problem is imaging of SiC in "real-world" materials, as a metal matrix composite (MMC), where SiC is embedded in a metal matrix.

In this paper we believe to be the first attempt in matching simulation to an actual experimental image of SiC in MMC. MMC used in this work was Al-8.5wt.%Fe-1.3wt.%V-1.7wt.%Si alloy containing 15wt.% of SiC particulates, processed by powder metallurgy technique. Figure 1 shows the experimental structural image of $\alpha$-SiC near the edge of the specimen in Al-based/SiC composite. The hexagonal allotrope has predominantly the 6H polytype structure with no visible micro-twins as previously observed by Clarke and Thomas[5]. The 1/3 of the 15R polytype in the same particle is also observed. In fact, this SiC structure represents the 87R polytype, and we believe it is first direct evidence of this polytype observed earlier by Ramsdell[6], based on x-ray intensities distribution. Due to the different thermal expansion coefficient of SiC and aluminum based matrix, internal forces cause local disturbance of SiC structure. This SiC particulate is constrained by the surrounding matrix, causing significant elastic strain to be introduced, and consequently different orientation of adjacent regions in SiC with respect to the incident beam to be present. While high resolution structural images are sensitive to crystal tilt, it is quite clear that the alignment of the incident illumination in "real-world" material, as with SiC in MMC is even more critical than in the case of perfect SiC structure. An extensive multi-slice calculation of images of perfect SiC structure (Figure 2), based only on both thickness and defocus position, assuming exact crystal orientation, does not seem to be enough to allow all structural details in SiC polytype structure to be properly defined.

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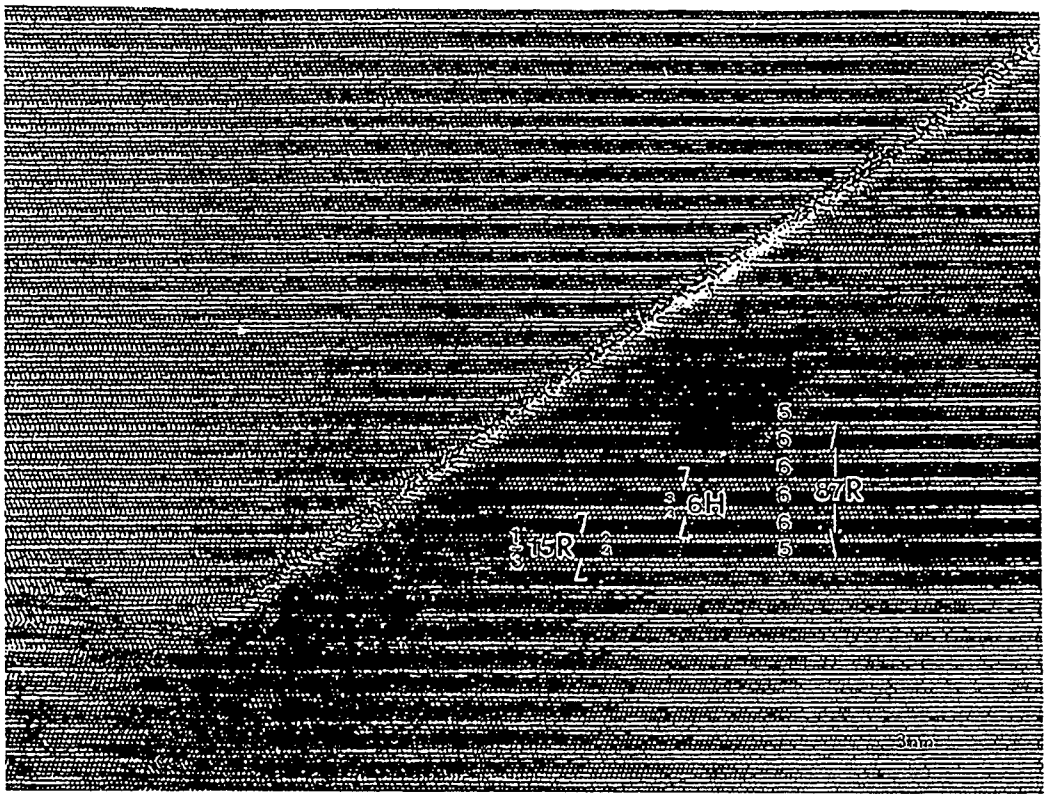


Fig. 1 - High resolution image of SiC 87R polytype structure (6H and 1/3 of 15R polytypes); voltage=1000keV; defocus=-60nm.

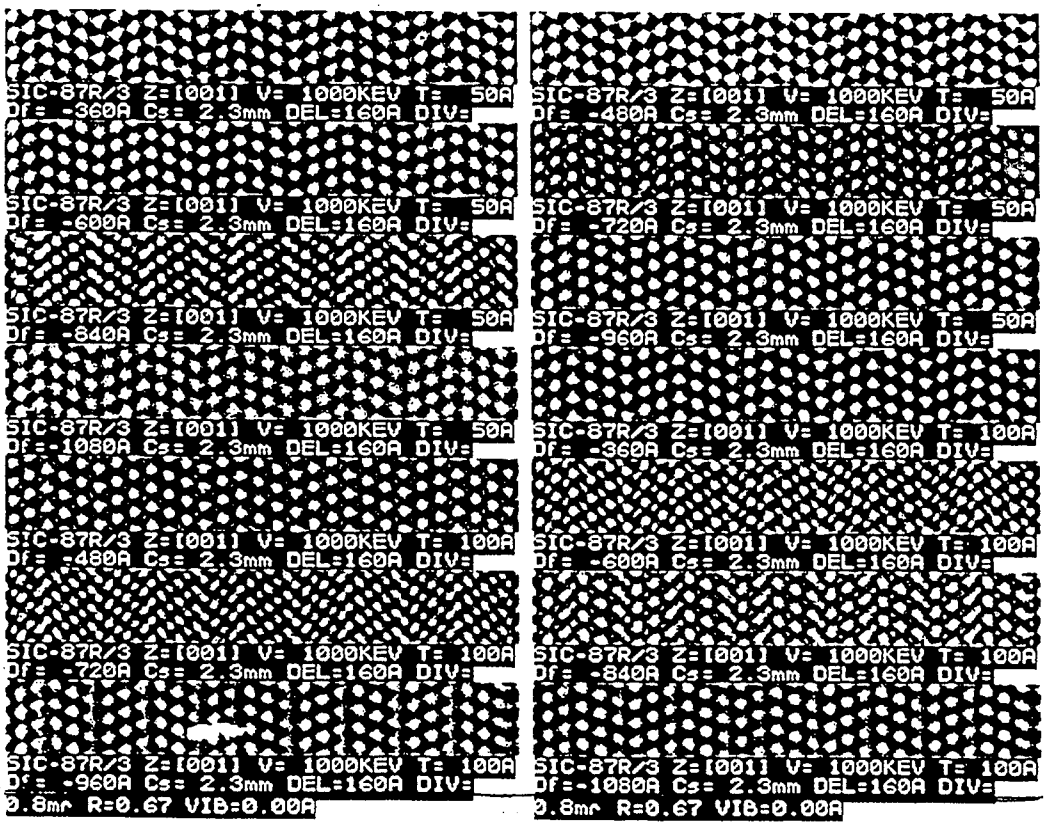


Fig. 2 - Calculated 87R images; voltage=1000keV; $C_s$=2.3mm; $\alpha$=0.8mr; $\Delta$=16nm; t=5 and 10nm.

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