Title
Imaging of SiC in Metal Matrix Composites

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

Publication Date
1992-08-01

LBL-33500
UC-404

Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

Materials Sciences Division

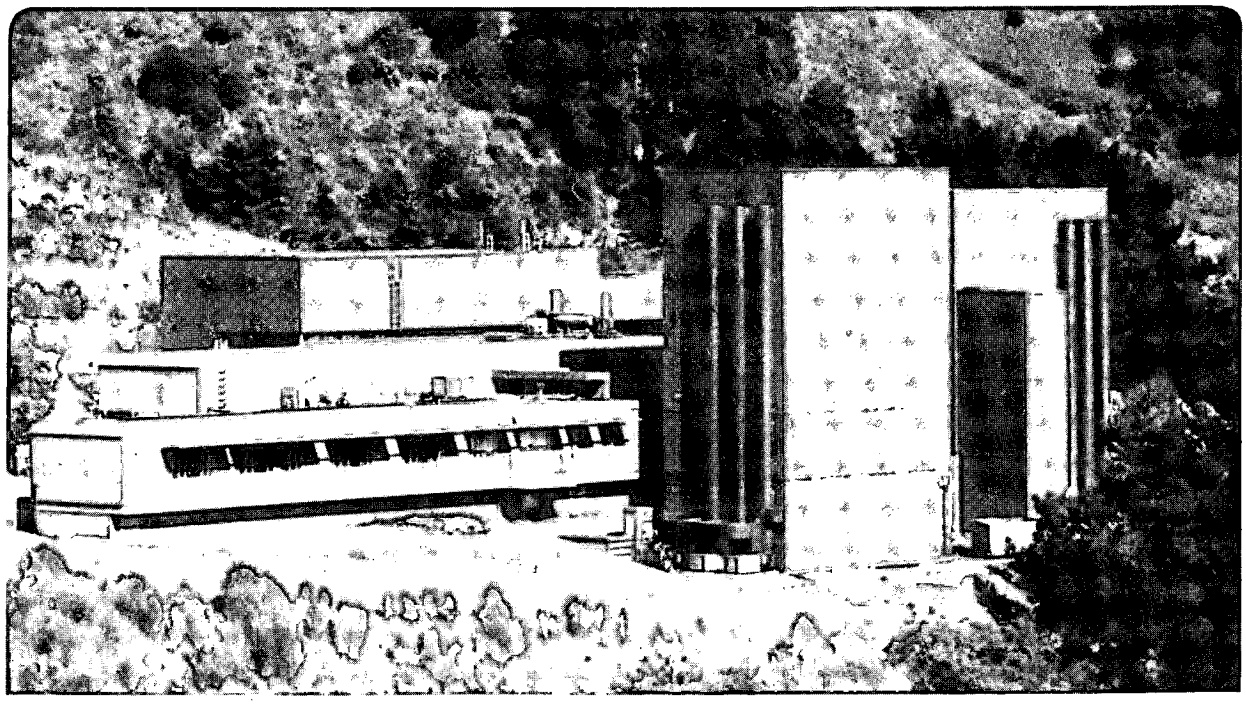
National Center for Electron Microscopy

To be presented at the Tenth European Conference on Electron Microscopy, Granada, Spain, September 7–11, 1992, and to be published in the Proceedings

Imaging of SiC in Metal Matrix Composites

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

August 1992



Prepared for the U.S. Department of Energy under Contract Number DE-AC03-76SF00098

DISCLAIMER

LBL-33500

Imaging of SiC in Metal Matrix Composites

V. Radmilovic[±], M.A. O'Keefe*, and G. Thomas*

[±]University of Belgrade, Dept. of Physical Metallurgy,
Karnegijeva 4, P.O. Box 494, 11000 Belgrade, Yugoslavia

*National Center for Electron Microscopy
Lawrence Berkeley Laboratory, Materials Sciences Division
University of California, Berkeley, CA 94720

Electron Microscopy, Vol. 2, p.449, EUREM 92, Granada, Spain

This work was supported in part by the Director, Office of Energy Research, Office of Basic Energy Sciences, Materials Science Division of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098. Recognition to Allied Signal for supplying the investigated material.

Electron Microscopy, Vol. 2, EUREM 92, Granada, Spain (1992)

Imaging of SiC in Metal Matrix Composites

V. Radmilovic[±], M.A. O'Keefe*, and G. Thomas*

[±]University of Belgrade, Dept. of Physical Metallurgy,
Karnegijeva 4, P.O. Box 494, 11000 Belgrade, Yugoslavia

*National Center for Electron Microscopy
Lawrence Berkeley Laboratory, Materials Sciences Division
University of California, Berkeley, CA 94720

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 α-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.

Acknowledgment

This work was supported by the Director, Office of Energy Research, Office of Basic Energy Sciences, Materials Sciences Division of the U.S. Department of Energy under contract No. DE-AC03-76SF00098. Thanks also to Allied Signal Inc. for supplying the investigated material.

References

1. D.J. Smith and M.A. O'Keefe, *Acta Cryst.* **A39**, 39 (1983).
2. D. Pandey and P. Krishna, *Current Topics in Materials Science* **9**, 414 (1982).
3. N.W. Jeeps, D.J. Smith, and T.F. Page, *Acta Cryst.* **A35**, 916 (1979).
4. G. Thomas, D.R. Clarke, and O. Van der Biest, *Ceramic Microstructure'76.* eds. M. Fulrath and J.A. Pask, Westview Press, Boulder, CO., 29 (1976).
5. D.R. Clarke and G. Thomas, *Proc. 6th UREM,* Jerusalem, 564 (1976).
6. L.S. Ramsdell, *Am. Mineral*, **32**, 64 (1947).

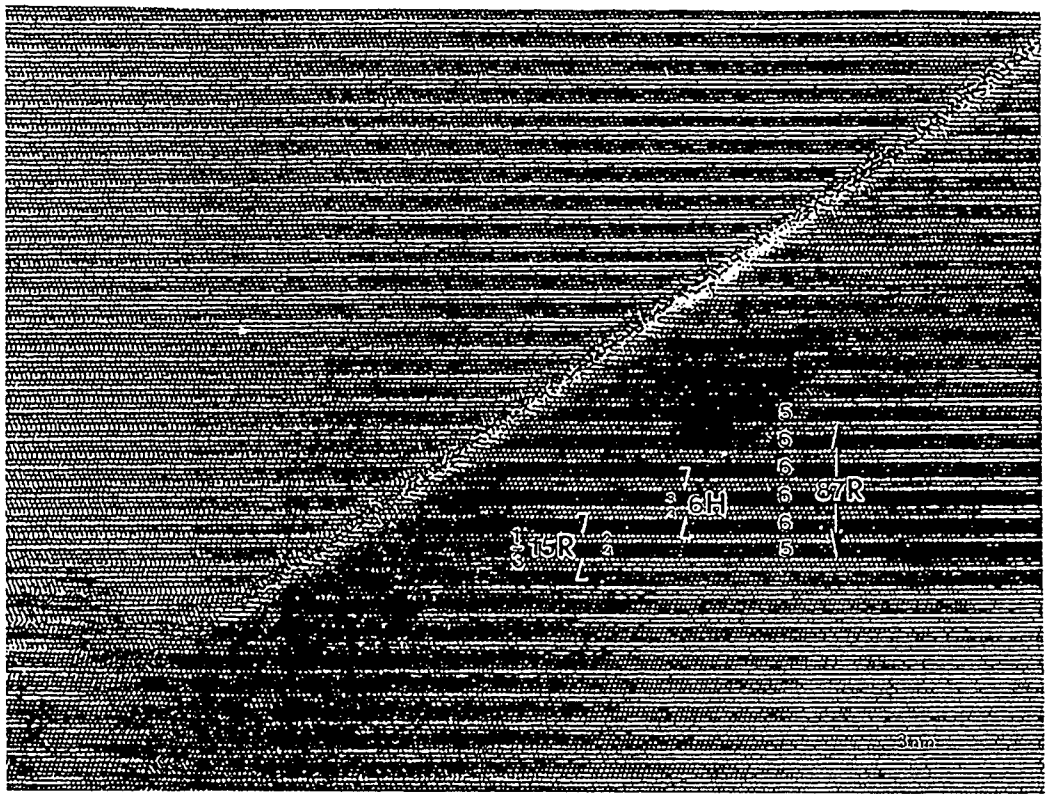


Fig. 1 – High resolution image of SiC 87R polytype structure (6H and 1/3 of 15R polytypes); voltage=1000keV; defocus=-60nm.

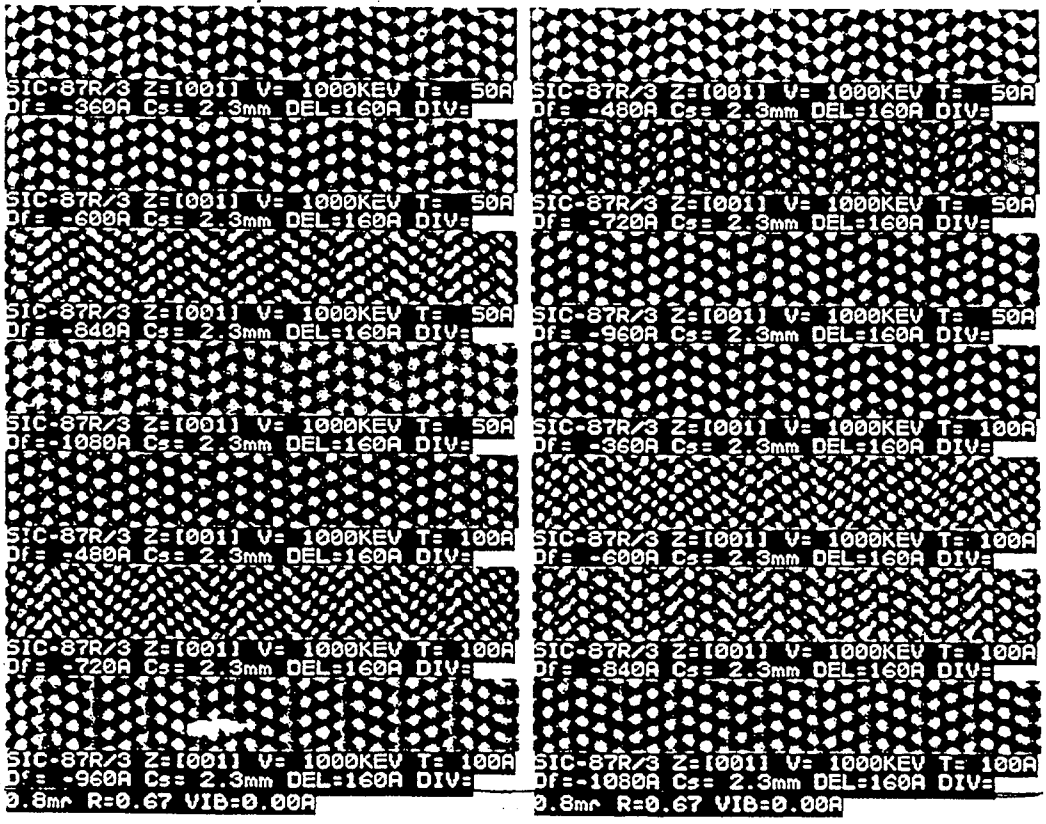


Fig. 2 – Calculated 87R images; voltage=1000keV; C_s=2.3mm; α=0.8mr; Δ=16nm; t=5 and 10nm.

LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
TECHNICAL INFORMATION DEPARTMENT
BERKELEY, CALIFORNIA 94720