NIRT Highlight

Superhard Nanostructured Films

Characterization of material created from focused beams of nanoparticles

Researchers at the University of Minnesota have developed a new method for generating and depositing narrow beams of nanoparticles.[1] These nanoparticle beams are being integrated with microfabrication techniques to fabricate miniature parts for MEMS (microelectromechanical systems). At present a serious limitation of MEMS technology is that many types of MEMS parts quickly wear out. The Minnesota researchers believe that making MEMS parts out of nanoparticles, or coating them with nanoparticles, can make these parts far more resistant to friction and wear, particularly if one uses materials such as hard ceramics.

One challenging aspect of this project is the characterization of these materials over length scales that range from the MEMS scale (microscale) to the nanoscale to the atomic scale. Fig. 1 shows two lines that were produced by directing focused beams of silicon carbide nanoparticles onto a linearly translated silicon substrate. Each line is over 1 cm long, but is composed of 20-nm particles. The line on the left was then prepared for examination under the transmission electron microscope (TEM) by using focused ion beam milling to cut a precise slice from a line cross section, as seen in Fig. 2.[2] (The figure also shows portions of the silicon substrate and the platinum coating that is deposited to aid in sample preparation.) This slice can then be conveniently examined using TEM, which readily images individual nanoparticles, as seen in Fig. 3.

Use of TEM and related diagnostics will allow detailed examination of the nanostructured material. Together with nanoindentation studies, currently underway, this information will allow answers to fundamental questions concerning the structure and properties of material fabricated from nanoparticles.

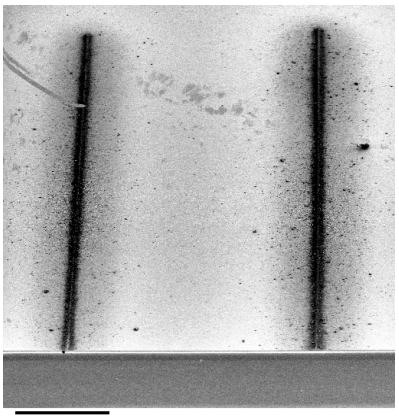

Fig. 1. Lines deposited by focused beams of silicon carbide nanoparti-

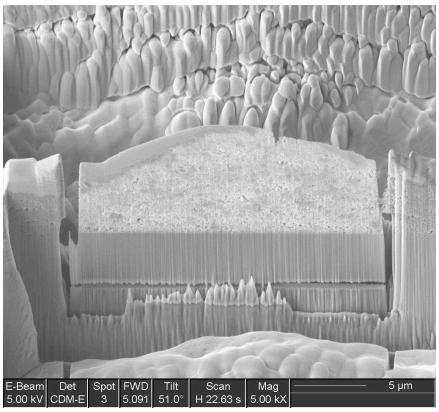

Fig. 2. Slice of cross section cut from line on left of Fig. 1 using focused ion

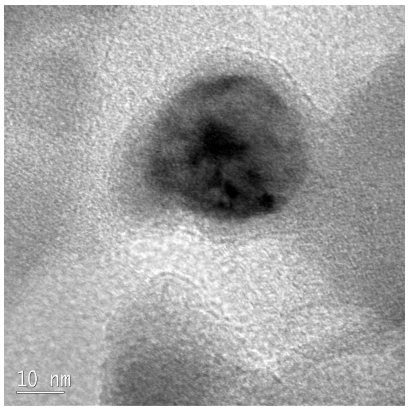

Fig. 3. TEM image of a nanoparticle within the slice shown in Fig. 2.

[1] F. Di Fonzo, A. Gidwani, M. H. Fan, D. Neumann, D. I. Iordanoglou, J. V. R. Heberlein, P. H. McMurry, S. L. Girshick, N. Tymiak, W. W. Gerberich and N. P. Rao, "Focused Nanoparticle-Beam Deposition of Patterned Microstructures," *Applied Physics Letters* **77**, 910–912 (2000).

[2] Assistance in TEM sample preparation from P. G. Kotula and J. Michael at Sandia National Laboratories, Albuquerque, NM, is gratefully acknowledged.

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