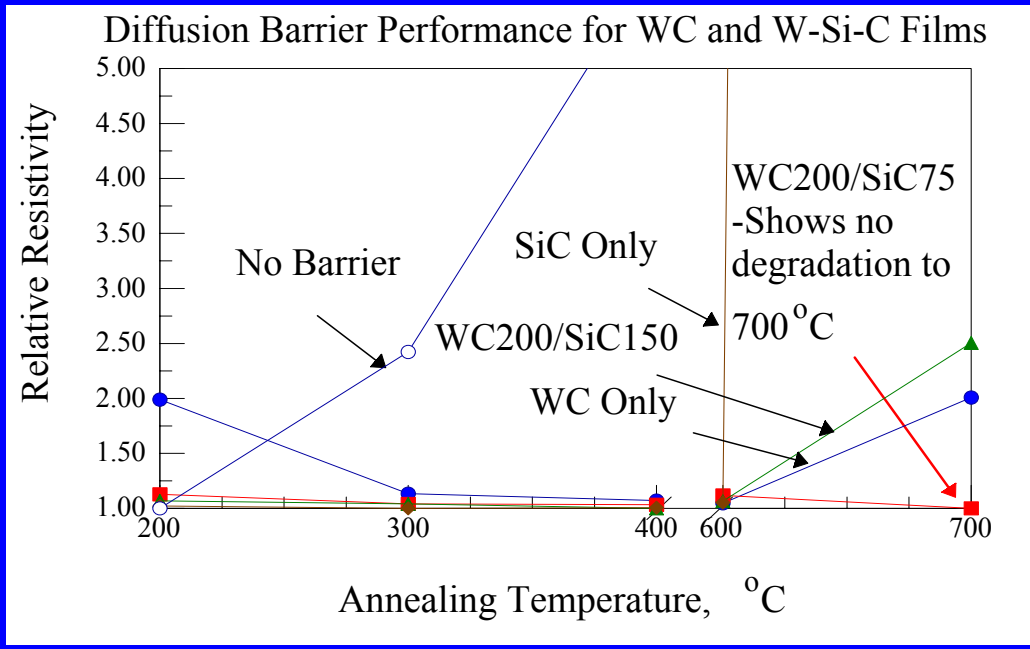
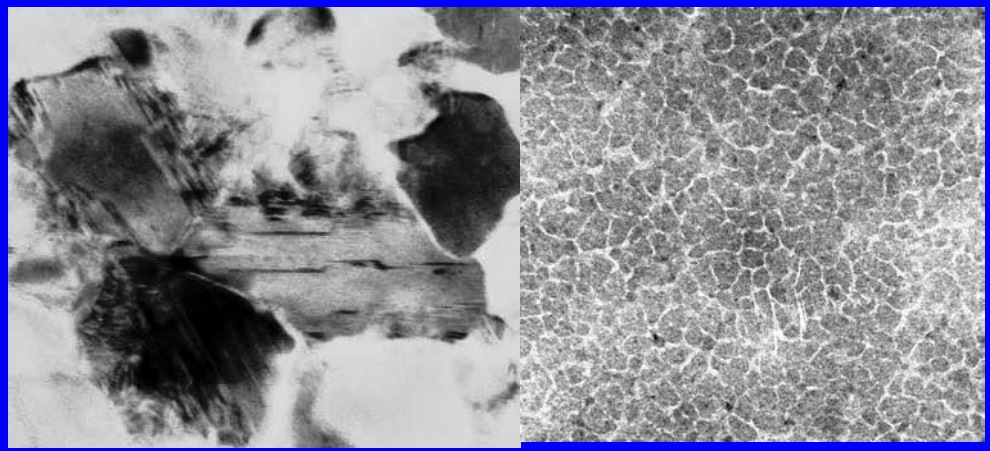
Nanostructured Ceramic Thin Films May Enable Shrinking ICs

James E. Krzanowski, University of New Hampshire, DMR-0207522

The drive to continually shrink integrated circuit (IC) components has placed increased demands on the materials and processes used in their fabrication. The use of copper for thin-film wiring requires diffusion barriers to avoid reaction between Cu and silicon. As dimensions shrink, more effective diffusion barrier materials are needed. We have investigated the diffusion barrier properties of W-Si-C films, and as shown in the graph at upper right, we have succeeded in developing a material stable to 700°C, as indicated by the low resistivity. At the heart of this innovation is the modification of the microstructure, near the atomic level, of the WC films by Si additions.

Similar microstructural effects have been observed in Mo-Si-C films. The pair of images at right show a Mo_2C film on the left, and a Mo-Si-C film on the right. The latter demonstrates that Si additions promote dramatic grain refinement and densification.





Multilevel Educational and Research Experiences

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Our program has involved students from the high-school through graduate school levels. One undergraduate and one graduate student are currently working on projects related to this research. The undergraduate student has gained valuable research experience by studying the oxidation properties of metal-silicon carbide thin films. The picture at right shows this student setting up an experiment using our two-dimensional area detector x-ray diffraction system. The image below shows x-ray data obtained using this system. The graduate student is conducting thesis research on the property enhancements (including diffusion barrier properties) and structural disordering in transition metal carbide/silicon carbide thin films. We also provide research experiences for students who excel high school science programs. This past year, we had four students involved in this program.