2-7-2008

CEAS e-news 02.07.2008

College of Engineering and Applied Sciences

College of Engineering and Applied Sciences **Western Michigan University**

…CEAS e-News … a Parkview Campus e-publication

Engagement – Leadership – Globalization – Innovation

Thursday, February 7, 2008

Volume 03, Issue 19 **Jerrie Fiala, Editor**: jerrie.fiala@wmich.edu

Silicon carbide research examines nano-behavior of ceramics

Researching silicon carbide (SiC) is tedious, expensive, and important in the study of ceramics, which are used in optical and laser devices. **Deepak Ravindra**, a mechanical engineering master's candidate, spends days completing research tests that involve ductile machining of silicon carbide. One test takes up to a week to set up and then requires 12 to 15 hours of micro-machining to finish the ceramic material into a smooth reflective surface.

"It's a process that can't be rushed," said **Dr. John Patten**, the manufacturing engineering department sponsor and the advisor to the silicon carbide project. "When you rush, you make mistakes."

Using a $60,000 National Science Foundation (NSF) funds and working with Mound Laser & Photonics Center in Dayton, Ravindra is presently wrapping up the first stage of a project that has shown that it is possible to use single-point diamond turning to micro-machine SiC ceramics, a difficult task because they are very hard materials with almost no fracture tolerance. This means they are extremely susceptible to chipping and cracking.

The researchers have discovered that SiC is not as brittle as what others believe. They machined a six-inch SiC disk at the nano/micro level to make it smooth and shiny without breaking it. "In general no one has been able to accomplish this work with silicon carbide using single-point diamond turning," Ravindra said.

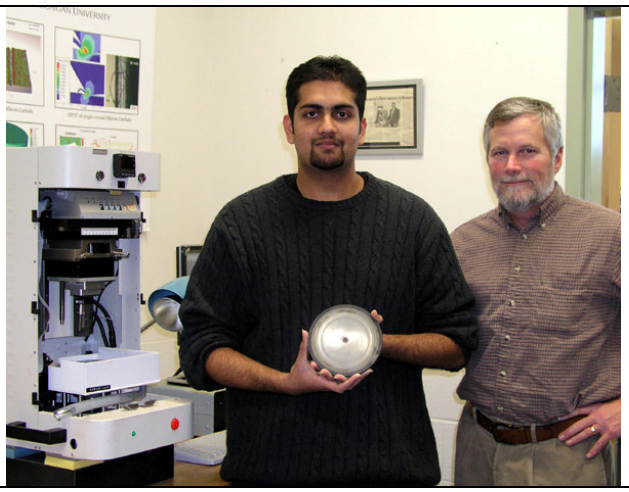
Using a single-point diamond tool for the turning operation, Ravindra said the key to his success is the small size scale being used. "We cannot remove very much material at a time," he said.

Now that they know the material can be micro-machined, Ravindra and Patten will study the structure of the SiC to understand it at the atomic level. The new $24,000 grant is "The Effects of Crystal Orientation in Single Point Diamond Turning (SPDT) Operation of CVD [chemical vapor deposition] of Silicon Carbide (SiC)" from Taiho Kogyo Tribology Research Foundation in Japan.

From ongoing work, the researchers examined single crystals of SiC; for the new project, they will examine and try to improve the technique for use on poly crystals.

Patten said they're trying to understand whether these CVD materials have some preferred orientation that affects the way the material behaves. "Obviously we have some idea, but we don't know for sure," he said. "Studying the poly crystals at the atomic level could lead to understanding the 'why' of the structural orientation."

The SiC research is being done in conjunction with several other projects including one with Third Wave Systems using a $163,000 grant from the Department of Defense. In addition to these grants, the research group recently received $50,000 in additional funding from MUCI, for a laser enhanced machining system to augment their current work.



Deepak Ravindra (left) and **Dr. John Patten** are researching silicon carbide. Ravindra is holding a six-inch ceramic disk that he has micro machined with the universal micro-tribometer on the left to make it reflective and useful for optical mirrors

Last spring Ravindra submitted his first research proposal to the Tribology Foundation. He recently presented a paper on the project - "Ductile-To-Brittle Transition (DBT) of a Single-Crystal for a SiC Wafer" by Ravindra, Patten, and **Makoto Tano** - at the Advances in Abrasive Technologies Grinding Conference of the International Symposium on Advances in Abrasive Technology (ISAAT) of the Society of Manufacturing Engineers (SME). Ravindra's attendance and participation at this conference was partially funded with a grant from the WMU Graduate School (Travel Grant Program).

The paper was published in the conference proceedings Tano is a Japanese Ph.D. student who helped Ravindra and Patten set up a device that they used for their initial research.

Results of the research should prove useful in saving time and cost and improving accuracy in the manufacturing processes related to laser mirror applications.

Ravindra came to WMU in 2002 from Malaysia and earned a BS in mechanical engineering (ME). During his senior year, he was inspired by Patten's work on SiC and decided to continue his education and his research. He defends his master's thesis next semester, and he plans to seek a Ph.D.

More information on this is available at their Web site: http://www.wmich.edu/engineer/mrc/ or by contacting them directly at deepak.ravindra@wmich.edu or john.patten@wmich.edu

Send your thoughts or suggestions for future topics to the editor at jerrie.fiala@wmich.edu Thank you.