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Impurities Enhance Powerful Semiconductor, Basic Research Wins Top Award from UDRI

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BASIC RESEARCH WINS TOP AWARD FROM UDRI

DAYTON, Ohio — Tracking impurities in a powerful semiconductor has won Steven R. Smith the year's top award from the University of Dayton Research Institute.

Smith received the 1998-99 Wohlleben-Hochwalt Award for outstanding professional research on Wednesday, April 21. Smith, a research physicist in the metals and ceramics division of UDRI, was recognized for basic research in silicon carbide, a crystalline material used in high-power, high-temperature and high-frequency electronic applications.

"Silicon carbide is important in certain electronic uses because of its natural characteristics," Smith said. "It conducts heat very readily, better than some metals, and it can operate at large voltages. You can run a lot of current through it and increase the amount of power a particular device can handle."

Applications can include all-electric aircraft that are less mechanically complicated and more reliable than conventional aircraft; high-density devices that can generate greater computing power; blue-light emitting diodes (LEDs) that allow for a full range of colors in LED displays; and advantages in communication and data storage.

Using tests, including one he invented, Smith pioneered basic research into the electronic properties of silicon carbide by detecting and measuring small amounts of impurities in the material.

The presence and quantity of nitrogen, boron, aluminum, vanadium and titanium will enhance or hinder the electrical properties of silicon carbide. Smith uses three established techniques to characterize the impurities — deep-level transient spectroscopy to detect deep-level impurities, thermal admittance spectroscopy to detect shallow-level impurities and capacitance-voltage to determine the amount of the shallow impurities. To complete the

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analysis, Smith uses a process he invented — optical admittance spectroscopy — to detect all electrically active levels of impurities. His technique has been adopted by Northwestern University of Magdeburg and the University of Erlangen, both in Germany, as well as NASA Lewis Research Labs.

The four techniques record the electrical "fingerprints" of impurities in the semiconductor.

Smith's research is part of a continuing five-year research program, which is seventh in a series of contracts at the U.S. Air Force Materials Laboratory. His evaluative tests detect amounts ranging from one part in 100 million to 50 parts per million, and all of the measurements are based on characteristics of metal-semiconductor contact, which is fabricated in Smith's capacitance lab at Wright-Patterson Air Force Base.

He works side-by-side with Air Force silicon carbide suppliers — growers, as they're called, since the material is not naturally found on Earth — evaluating the material as it develops. "We use the information we find to change the growth to produce the characteristics of silicon carbide they're growing," Smith said. "We help to determine what must be done to produce the product the Air Force wants."

Also receiving awards April 21 were:

- Endel V. Iarve, research engineer in the nonmetallic materials division, who received the 1998-99 Wohlleben-Hochwalt certificate of merit for professional research for his work in developing spline approximation techniques for analyzing composite bolted joints;

- V. Charlene Dunson, executive technical secretary for the electrical and computer engineering division, who won the 1998 award for outstanding support person; and

- Fred L. Davis, senior electrical technician in the electrical and computer engineering division, who was presented the 1998 award for outstanding technician.

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For media interviews, call **Steven Smith** at (937) 255-4474, extension 3221.