



Nanomaterials Research Corporation

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Hazardous Solvent-Free Manufacturing of Electroceramic Powders

DESCRIPTION OF THE TECHNOLOGY

With support from the Environmental Protection Agency's (EPA) Small Business Innovation Research (SBIR) Program, Nanomaterials Research Corporation (NRC) has developed and commercialized an innovative manufacturing technology for performance ceramics. NRC's process improves device quality while preventing pollution by reducing the amounts of raw materials, solvents, and binders required for production of these ceramics in comparison to conventional manufacturing techniques.

NRC's manufacturing method for performance ceramics offers the following advantages over conventional techniques in that it: (1) eliminates the formation of secondary gaseous, liquid, or solid wastes; (2) reduces the processing, containment, and treatment of solvents and resulting vapors by more than 10-fold; (3) reduces energy requirements by recovering mass and heat through process integration; and (4) produces performance ceramics of significantly improved quality (i.e., monodisperse, nanosize particles with extraordinary properties).

SIGNIFICANCE OF THE TECHNOLOGY

The performance ceramics industry produces and sells more than \$18 billion of ceramic products annually and

is one of the fastest growing segments of all industries listed by the North American Industry Classification System. The performance ceramics industry is enabling growth within the electronics, utilities, medical devices, optics, and telecommunications industries, and the market for such ceramics is expanding in conjunction with this growth. More than 1 billion ceramic devices (e.g., capacitors, thermostats, varistors, inductors, resistors, and IC substrates) are produced and sold each week. Anticipated growth in the market for ceramic devices will further extend the role of performance ceramics.

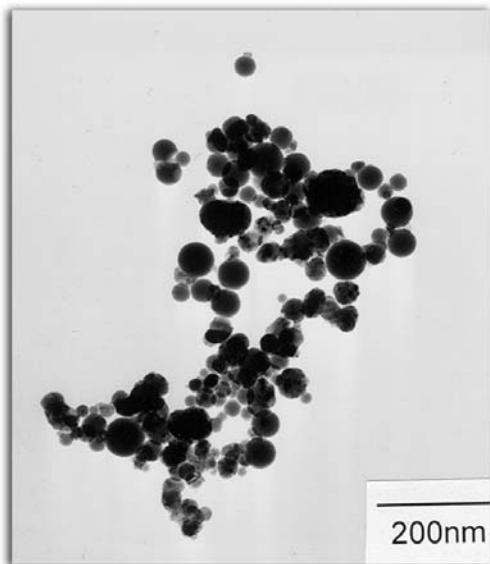
Performance ceramics typically are produced by solvent-based techniques that inadvertently lead to processing, containment, and treatment of hazardous solvents and byproducts. Given the commercial importance of the electroceramic industry, it is imperative that environmentally benign manufacturing techniques are developed to prevent pollution at its source while providing performance improvements to customers.

COMMERCIALIZATION SUCCESS

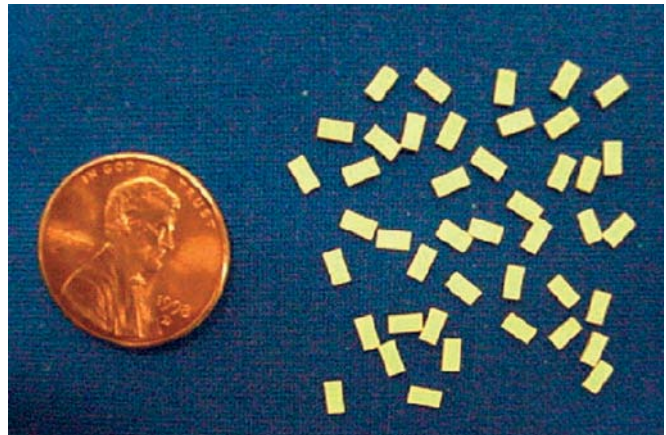
NRC has demonstrated that devices produced from nanosized electroceramics are nanostructured and meet the needs of high-performance components that will be

SBIR Impact

- ◆ NRC has developed and commercialized a manufacturing technology for performance ceramics that improves device quality while preventing pollution at its source by reducing the amounts of raw materials, solvents, and binders required for processing.
- ◆ This technology enables the manufacture of nanoscale electronic grade powders needed in next generation miniature electronics. The market for nanostructured components is expected to exceed \$100 million/year in less than 5 years.
- ◆ NRC is scaling up the manufacturing process to produce 100,000 nanostructured components per week from electroceramic nanoscale powders.



Nanopowders of performance ceramics produced by NRC.



Nanotechnology electronic devices from nanopowders of performance ceramics manufactured using NRC's innovative manufacturing technology.

essential for the anticipated era of nanodevices and molecular electronic components. Manufacturing of these devices is being scaled up by NRC to serve surface-mount electronics, cellular telecommunications, power components for utilities, laptop computers, and biomedical products. The market for nanostructured components should exceed \$100 million/year in less than 5 years.

COMPANY HISTORY

Since the company was founded in 1994, NRC has experienced an average annual growth of more than 100 percent. NRC currently has more than 60 employees. In 2000, the company began a scale up of its manu-

facturing process, which was successfully completed in 2001. In March of that year, NRC was reorganized into two companies: (1) Nanomaterials Research LLC, which focuses on nano-engineered device development and manufacture; and (2) NanoProducts Corporation, which focuses on the development and manufacture of nanoscale powders and emerging powder-based energy technology products. In February 2002, NanoProducts Corporation and Hosokawa Micron Corporation announced a strategic partnership and signed a letter of intent for a joint venture in Japan to develop, manufacture, and market nanoscale powders and related nanotechnology.

What is the SBIR Program?

EPA's Small Business Innovation Research (SBIR) Program was created to assist small businesses in transforming innovative ideas into commercial products. The SBIR Program has two phases—Phase I is the feasibility study to determine the validity of the proposed concept and Phase II is the development of the technology or product proven feasible in Phase I. EPA also offers Phase II Options to accelerate the commercialization of SBIR technologies and to complete EPA's Environmental Technology Verification (ETV) Program. For more information about EPA's SBIR Program and the National Center for Environmental Research, visit <http://www.epa.gov/ncer/sbir>.