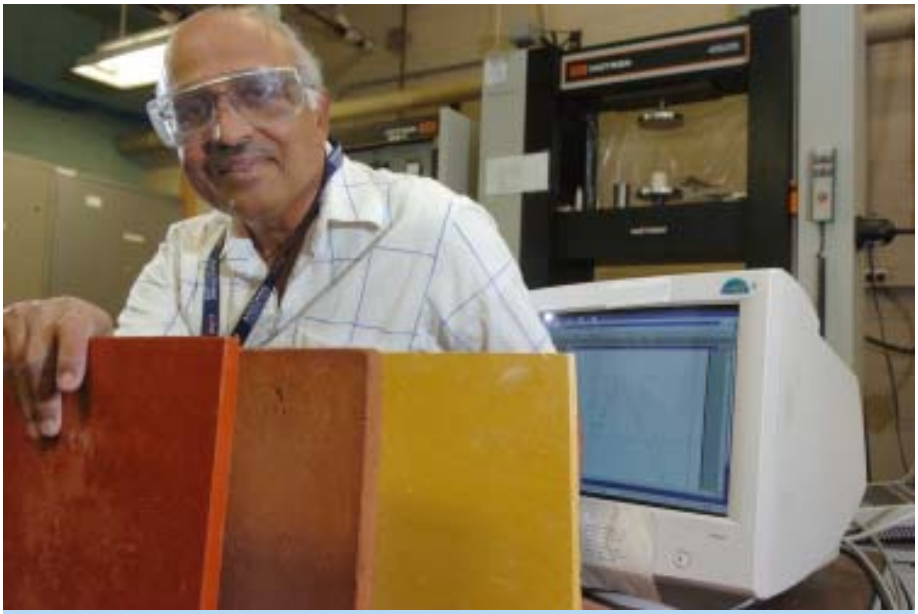
Innovative cement helps DOE safeguard nuclear facilities

When Argonne materials scientists Arun Wagh and Dileep Singh initially developed Ceramicrete®, a novel phosphate cement that stabilizes radioactive waste streams, they did not immediately recognize that with one or two extra ingredients, the cement could solve another problem in the nuclear complex.

In the course of the development of the Ceramicrete technology, Wagh and Singh formed a multilayered collaboration among Argonne, the Russian Federal Nuclear Center (VNIIEF) in Sarov, Russia, and Ceradyne Boron Products LLC. This international scientific partnership created an unusually efficient nuclear shield that blocks the neutrons and gamma rays emitted by nuclear materials, enabling safer nuclear storage.

Singh, Wagh and their collaborators modified the original Ceramicrete by adding boron to block neutrons and iron-containing materials to block gamma rays, making it one of the few materials that provides a shield against both forms of radiation. Other materials, such as stainless steel, provide a viable shield from gamma rays but fail to insulate neutrons.

Poor neutron shielding can lead to disastrous consequences: when neutron-irradiating nuclear materials are stored in large quantities in a small area, the emitted neutrons can interact with nearby stored fuel, causing a nuclear chain reaction. If the material is stored in a large area or in a pool of water that absorbs neutrons, on the other hand, the site can be vulnerable to terrorists or espionage.



Argonne materials scientist Arun Wagh displays three plates made of Ceramicrete, the same composite that is now used as the basis for casks that can safely store nuclear material.

The Ceramicrete technology has earned two coveted R&D 100 awards, commonly referred to as the “Oscars of invention,” one in 1996 and another in 2004, and the Intellectual Property Lawyers Association of Chicago named Wagh the “Inventor of the Year” in 2006.

Casks with the new boron-containing Ceramicrete-based composite provide a better answer to the nuclear storage problem, according to Wagh. “If we can shield neutrons, we can put containers of nuclear material closer to each other, and thereby monitor the site better. Compact sites are safer,” he said.

The initial modeling of the casks and testing of the boron-containing Ceramicrete took place in Russian laboratories as part of the Initiatives for Proliferation Prevention (IPP) program, an international nonproliferation program administered by the Department of Energy and National Nuclear Security Administration. IPP especially seeks to employ former Soviet nuclear weapons researchers in projects devoted to peacetime uses of nuclear energy.

“We’re interested in high-volume products based on Ceramicrete, since it’s a product with a diverse range of applications,” said Vladimir Arkhangelsky, a scientist at VNIIEF and one of Wagh’s Russian

colleagues. “And I’d also like to continue the valuable collaboration with Argonne.”

After the VNIIEF scientists determined that the cement successfully absorbed neutron radiation, Ceradyne built and tested prototype shields, then marketed the material under the name BoroBond®. Working with Department of Energy (DOE) contractors, Ceradyne has introduced the BoroBond shields for storage of nuclear materials in Oak Ridge, Tenn. These contractors have built several hundred BoroBond-based casks that now house nuclear material.

“Ceradyne Boron Products has established a high-volume production facility based on the Ceramicrete technology,” said Jim Waugh, Ceradyne General Manager. “We look forward to customizing BoroBond to meet upcoming nuclear storage requirements worldwide.”

The development of BoroBond not only solves a significant problem facing the nuclear energy industry and scientists, but also highlights the value that Argonne’s research and development provides to industry and DOE, according to Wagh. “We thought of a totally new cement, and with funding from the Department of Energy we have been able to bring together expertise from Russia and American industry to develop products that have solved at least one big problem within the DOE complex. The BoroBond shield showcases a successful investment of DOE funds, as DOE scientists, U.S. for-profit industry and Russian nuclear scientists together have completed a project that makes the world a little safer.”

“The beauty of the story is that DOE paid to develop this technology, we commercialized it through Ceradyne, and Ceradyne helped DOE in its mission of safeguarding nuclear facilities,” added Terry Maynard, who manages Argonne’s technology transfer efforts for Ceramicrete.

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