Energy Technology researchers solve energy and medical problems

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Argonne's Energy Technology Division (ET) provides **innovative materials and engineering solutions** to national energy challenges that range from energy production and conservation to transportation. Researchers also find creative ways to re-use and extend the value of their discoveries.

The division's innovation has been recognized in the past two years by three R&D 100 Awards, given annually by R&D Magazine to the world's "100 most technologically significant new products."

Hydrogen transport membrane

ET's hydrogen transport membrane, one of the 2004 R&D 100 winners, is expected to advance the hydrogen economy by providing hydrogen for fuel cells to power vehicles and computers and even supply electricity to the nation's power grid.

The membrane may provide an economical and environmentally friendly way to produce hydrogen from carbon-based feedstocks.

Argonne's ceramic membrane provides pure hydrogen gas by selectively separating hydrogen from gas mixtures generated by fossil fuel-based processes. The membrane can withstand the high temperatures and pressures that occur during coal gasification and methane reforming.

The hydrogen transport membrane was developed by Argonne scientist Balu Balachandran and colleagues Stephen Dorris and Tae Lee, in collaboration with Gary J. Steigel, Richard Dunst and John Winslow at the National Energy Technology Laboratory in Pittsburgh. The membrane was patented in 2003, and technology development is underway with industrial partners Eltron Research, Inc., and ITN Energy Systems, Inc.

Argonne's ceramic membrane was developed as part of the U.S. Department of Energy's Office of Fossil Energy through the National Energy Technology Laboratory's Gasification Technologies Program.

Spray-on structural cement

ET's other 2004 R&D 100 award was for Grancrete, a spray-on structural phosphate ceramic cement that may provide safe, inexpensive housing. Grancrete was developed by ET scientist Arun Wagh in collaboration with Jim Paul of Casa Grande International of Mechanicsville, Va.

The two have been working together since 1996, when Wagh and a colleague developed Ceramicrete, another R&D 100-award winning cement product for stabilizing radioactive and hazardous waste for long-term.

Grancrete is a magnesium-phosphate cement binder that hardens within hours when mixed with water. For low-cost housing, the powder can be mixed at a construction site with water and sand and sprayed onto polystyrene foam sheets in frames. Within two to four hours, Grancrete forms a rigid, long-lasting structural wall or ceiling that is permanently bonded to the panels.

These structures could provide long-lasting, easily maintained housing to a large segment of the world's population that could not previously afford adequate shelter. A Grancrete structure of approximately 800 square feet, for example, is estimated to cost $6,000 in labor and materials to build.

Nanocoatings can save energy, costs

In 2003, nanostructured carbide-derived carbon (CDC) technology for sliding and rotating equipment received an R&D 100 award. CDC is grown with graphite, diamond, amorphous carbon and carbon “nano-onions” -- small carbon structures with concentric rings, resembling an onion. These components vary from 2 to 10 nanometers in thickness (one nanometer is one-billionth of a meter).

Industrial partners are interested in using the coating to seal water pumps in automotive engines to prevent dry-run failure and extend the engine's lifetime. This coating may save billions of dollars and reduce energy consumption.

Because it is created with nano-layers, the coating bonds strongly to its substrates under severe loading or sliding conditions. CDC has exceptional friction and wear resistance in wet, dry and high-temperature environments.

The CDC technology was developed by ET's Ali Erdemir along with colleagues Michael J. McNallan of the University of Illinois at Chicago, Yury Gogotsi of the A. J. Drexel Nanotechnology Institute, and students Sascha Weiz and Daniel Ersoy of the University of Illinois at Chicago.

Their research was funded by the Department of Energy Office of Energy Efficiency and Renewable Energy, Office of Industrial Technologies, Industrial Materials of the Future Program.

Saving lives instead of cooling buildings

ET engineers have joined with the University of Chicago's Emergency Resuscitation Center doctors to develop a technique to use ice slurry to save the lives of cardiac arrest victims by rapidly cooling their brains. The technique is intended to be used by paramedics on people having cardiac arrests away from a hospital where they have a less than 5 percent survival rate.

Not the type to let good ideas go to waste, ET engineers adapted a process originally designed to cool buildings efficiently to save the lives of cardiac arrest victims.

ET engineers developed a process to replace the chilled-water cooling systems in building complexes with ice slurry. The slurry was engineered at the microscale level using patented methods to dramatically improve its characteristics – specifically its fluidity and storability. They planned to store ice particles in water overnight in a central plant and then pump the mixture from the plant to the surrounding buildings the next day. “The ice slurry provides at least five times as much cooling as the same amount of water,” explained developer Ken Kasza.

Since the only industrial interest was a small-scale demonstration in Japan, researchers sought a new use for the ice slurry technology. Argonne engineers working with doctors at the Emergency Resuscitation Center decided to cool human bodies instead of buildings and to save human lives instead of energy costs.

Brain cells start dying rapidly 10 to 12 minutes after cardiac arrest because blood stops flowing to the brain and delivering fresh oxygen. Cooling the body internally with ice slurry is much faster than external cooling. Researchers are now fine-tuning the procedure. Ice slurry would be inserted into the lungs, cooling the surrounding blood, then medics would perform chest compressions to circulate the cooled blood to the brain. The cool blood slows cell activity and preserves brain cells while the patient is en route to the hospital.

This would give doctors at the hospital more time to revive normal heart, blood flow and brain activity. The slurry would be suctioned out after it melts.

This research is a collaboration between Argonne and the University of Chicago, and is funded by the National Institutes of Health.

Source: Argonne