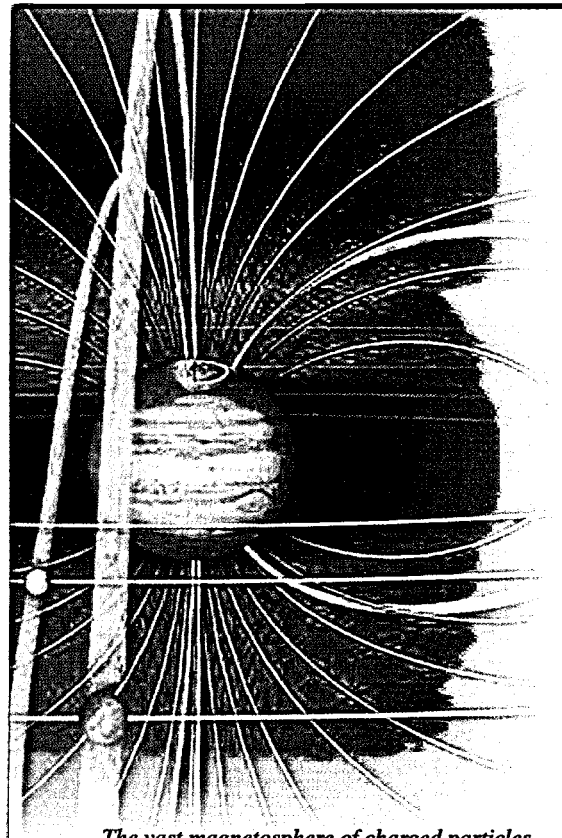


The vast magnetosphere of charged particles whirling around Jupiter, normally invisible, can be seen here, thanks to a new type of imaging instrument aboard NASA's Cassini spacecraft (which has ORNL materials aboard).

SPACE EXPLORATION

Science for the Final Frontier

On August 20, 2002, the National Aeronautics and Space Administration celebrated the 25th anniversary of the Voyager 2 space probe's odyssey through our solar system—perhaps humanity's greatest feat of space exploration. Voyager 2 sent to Earth spectacular photographs of the planetary terrains, rings, and moons of Jupiter, Saturn, Uranus, and Neptune. Voyager 2, now well over 6 billion miles away from the sun, is carrying materials made at ORNL.

In 1975, ORNL researchers led by C. T. Liu developed an iridium alloy needed to clad spheres of plutonium-238 oxide fuel in the Voyager 1 and 2 spacecraft, which were launched in 1977. The radioactive fuel is used to supply electrical power to the space probes' experiments and communication equipment. The iridium-alloy cladding would prevent the fuel from escaping into the environment in the unlikely event that the spacecraft would accidentally re-enter Earth's atmosphere, undergo its searing heat, and strike Earth's surface.

Pure iridium has a high melting point and excellent resistance to oxidation at elevated temperatures but is too weak and brittle to withstand maximum impact. ORNL researchers discovered that adding just the right levels of alloying agents (e.g., thorium) imparted the extra ductility that would enable the iridium alloy to withstand the impact forces of maximum credible accidents.

Another ORNL material aboard Voyagers 1 and 2 is thermal insulation composed of bonded mattes of carbon fiber, needed to maintain the fuel cladding in a preferred temperature range. The two ORNL materials, which are still being produced, also are aboard NASA's Galileo, in orbit around Jupiter, and Cassini, a spacecraft headed for orbit around Saturn in July 2004.

ORNL researchers also helped design radiation shielding for moon-bound astronauts, scoops for collecting moon rocks, and boxes to hold them on Earth. The next project is to design a power conversion system for a possible nuclear reactor on a Mars-bound spacecraft.

GRAPHITE AND CARBON PRODUCTS

From Missiles to NASCAR

The name Graphite Reactor acknowledges graphite's desirable properties. This form of crystallized carbon was chosen as the moderator for both Oak Ridge's first reactor and the Hanford plutonium-production reactors. Graphite not only slows neutrons from uranium fission enough for plutonium to form but also grows stronger at high temperatures and resists radiation damage.

In the 1940s Eugene Wigner correctly predicted that neutron irradiation of graphite would cause it to swell. Concern about "Wigner disease" helped spur the growth of ORNL materials research.

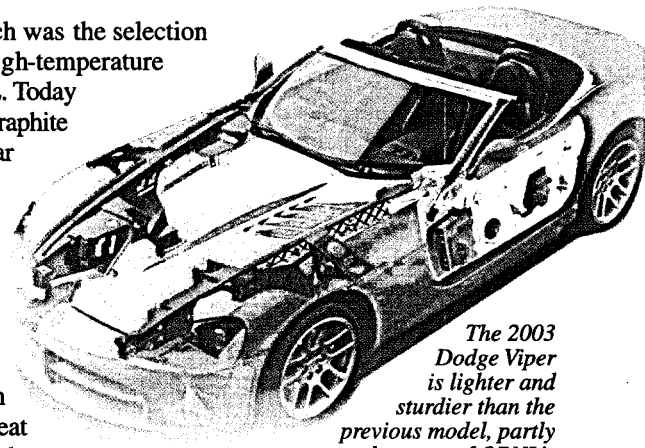
By controlling the orientation of graphite's crystalline grains, ORNL's Walt Eatherly, Ray Kennedy, and Fred Jeffers developed the award-winning GraphNOL, which was commercialized in the 1980s. This graphite, which resists radiation damage and withstands extreme thermal shock and stress, has been used in missile nose cones.

One motivation for this research was the selection of graphite as the moderator for high-temperature gas-cooled reactors designed at ORNL. Today Laboratory researchers are assessing graphite properties and standards for the Nuclear Regulatory Commission as part of the advanced gas-cooled-reactor program.

In the 1960s, Oak Ridge researchers led by John Googin developed the first method to produce carbon foams, which have been used as high-temperature furnace insulation. Carbon-bonded carbon-fiber insulation was developed at ORNL for use in heat sources aboard satellites and space probes.

In the 1990s Ted Besmann and others developed carbon-composite bipolar plates to make lighter, longer lasting auto fuel cells. The technology was licensed to Porvair, Inc., which is installing a pilot unit to produce plates for a major fuel-cell developer.

Tim Burchell and James Klett developed a process that was commercialized for making carbon-carbon brake discs that give airplanes better stopping power. In 1998 Klett produced graphite foam that transfers heat unusually well. This licensed technology has uses for vehicles, electronics, and homeland security.



The 2003 Dodge Viper is lighter and sturdier than the previous model, partly because of ORNL's carbon-fiber-composite research. (Courtesy of the Chrysler Group)

1967

KENO Monte Carlo code developed for assessments of nuclear criticality safety

Walker Branch Watershed research facility opens for ecosystem studies

ORNL selected to lead U.S. ecosystem research under International Biological Program

Viruses separated in high-speed ORNL centrifuges

Simulation code developed for assessments of protective ability of radiation shields

1968

Second MSR operated using uranium-233 (first reactor to use this fuel)