Magnetic Resonance Imaging for Advanced Ceramics

The steps in processing high-performance, high-temperature structural ceramics planned for use in advanced heat engines require much more understanding than has been achieved to date. Part of processing science is the development of practical nondestructive evaluation methods to identify problems at the earliest possible stages. One such method that has the potential to affect processing science is magnetic resonance imaging (MRI), a chemically sensitive, noncontacting, and nondestructive technique. DOE funded a project to study the potential of MRI to directly map the distribution of: (1) organic binders and plasticizers used in injection molding processes; and (2) porosity after the binder/plasticizer has been removed (i.e., dewaxed). Because the polymeric organic binder/plasticizer used contains a high concentration of protons, it was an excellent candidate for MRI. It was shown that MRI can be used to directly image distributions of organic binders/plasticizers as used in injection molding, and image porosity distribution if a carefully selected filler fluid is used with a proper infiltration procedure. Follow-on work with the technique is currently being undertaken by the DOE Ceramic Technology for Advanced Heat Engine Project.

Recycling of Post-Consumer Plastic Scrap

It is projected that the energy embodied in plastics to be saved through recycling of post-consumer scrap can be as much as one percent of U.S. annual energy consumption. These savings would be in premium fuels, oil, and natural gas used as feedstock and fuels in plastics production. In addition, a major disposal problem would be alleviated by recovering and recycling plastics, since over 40 billion pounds of plastics are produced annually in the U.S. alone. The capability to recycle plastics from scrapped automobiles may make the use of plastics for major structural parts such as fenders and hoods more acceptable to automobile manufacturers and environmentalists. Under DOE funding, the Plastics Institute of America (PIA) at the Stevens Institute of Technology in a coordinated effort with Lowell University, Lehigh University, and the Polytechnic Institute of New York successfully showed the technical feasibility of recycling plastic scrap from shredded automobiles. These research studies were complemented by an industrial scale-up effort coordinated by the PIA and funded by the DOE Office of Industrial Programs. In June 1986, the Plastics Institute of America (PIA) held a technology exchange workshop on "Plastics Recycling as a Future Business Opportunity." This workshop, which was financially supported entirely by the PIA, was primarily aimed at entrepreneurs, representatives of local governments, and Congressional staffers. It was concluded that there is a potential constituency for plastics recycling in the private and local government sectors.

Ductile Ordered Alloys

The development of advanced energy conserving technologies is constrained by the lack of materials capable of withstanding high temperatures, high pressures and highly corrosive environments. Development of metallic materials of ordered crystal structure with high-temperature capabilities has provided an alternative to ceramics in overcoming material limitations. Intermetallic compounds offer potential advantages such as excellent high-temperature strength; good response to work hardening; superior creep properties; excellent oxidation and corrosion resistance for certain intermetallics (e.g., aluminides); and potential for reduced need for strategic materials. However, poor ductility and fabricality have been major problems with using aluminides as structural materials. Developed at Oak Ridge National Laboratory through research supported by the ECUT program, nickel aluminide is the first truly ductile ordered intermetallic alloy for withstanding high temperatures. The new high-temperature alloy is moving rapidly toward commercialization, with five