

Producing Strong, Lightweight Ceramics and Composites for Cars

Lightweight structural ceramics and composites capable of withstanding high temperatures will help automakers develop low-emission, fuel-efficient engines and heat-recovery systems. These new components reduce vehicle weight, friction, and energy loss. Argonne National Laboratory is developing and improving fabrication techniques for ceramics and composites to ensure consistently high quality.

In-Situ Evaluation of Ceramic Composites

A simple, low-cost technique developed by Argonne researchers evaluates in-situ strength and damage to fibers during ceramic composite processing and in service. The strength of the ceramic composite components is directly related to the degree of fiber damage. This technique provides a unique tool for predicting composite performance. Argonne's goal is to evaluate the performance of these composites in real-life components for automotive applications.

For more information, see www.transportation.anl.gov/ttrdc/materials/ceramic_test.html or contact J.P. Singh, phone: (630)252-5123.

In-Situ Strength and Damage to Fibers			
Strength	As-fabricated Condition	Exposed Condition	Relative Strength Degradation
In-situ Fiber Strength (GPa)	1.7	0.8	53%
Component Strength (MPa)	19.5±2.1	7.7±1.1	60%

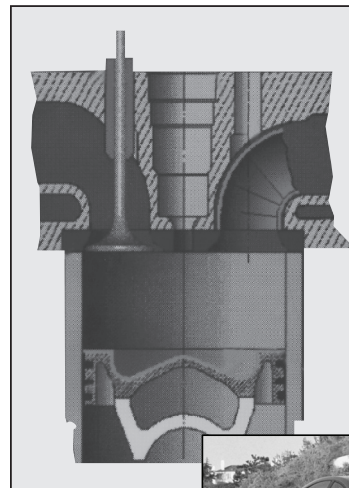
Strength degradation of fiber-composite component after exposure to service conditions directly correlates with fiber damage.

Nondestructive Characterization of Ceramic Materials

Argonne maintains an active program to develop nondestructive characterization (NDC) techniques and methodology for advanced ceramic materials. Researchers are studying structural ceramics (e.g., monolithics and continuous-fiber-reinforced composites), high-temperature protective ceramic coatings, high-temperature gas separation membranes for H₂ and O₂ production for transportation fuel cells and electronic ceramics (e.g., superconductors and solid-oxide fuel cells). Sophisticated research capabilities used for analyzing the materials include high spatial resolution x-ray tomographic imaging facilities,

laboratories dedicated to laser scattering, infrared imaging, nuclear magnetic resonance, ultrasonics, acoustic emissions, and image-processing ability (workstation-based). Recently, a six-axis articulated robot arm controlled by a computer was added to allow contour following of complex shapes. By correlating the NDC data with destructive analysis, verification of the NDC data is being established. Current efforts are focusing on ways to couple NDC data with analytical models to allow estimates of a component's remaining life.

For more information, see www.transportation.anl.gov/ttrdc/materials/ceramic_ndc.html or contact Bill Ellingson, phone: (630)252-5068.



Argonne is working to improve the reliability of ceramic engine components such as valves by using low-power lasers to detect subsurface damage.



Lightweight ceramics and composites will help reduce vehicle weight, friction, and energy loss. Concept car photo courtesy of DaimlerChrysler.