High Temperature Materials Laboratory User Program

Solving a Materials Failure Problem

Background

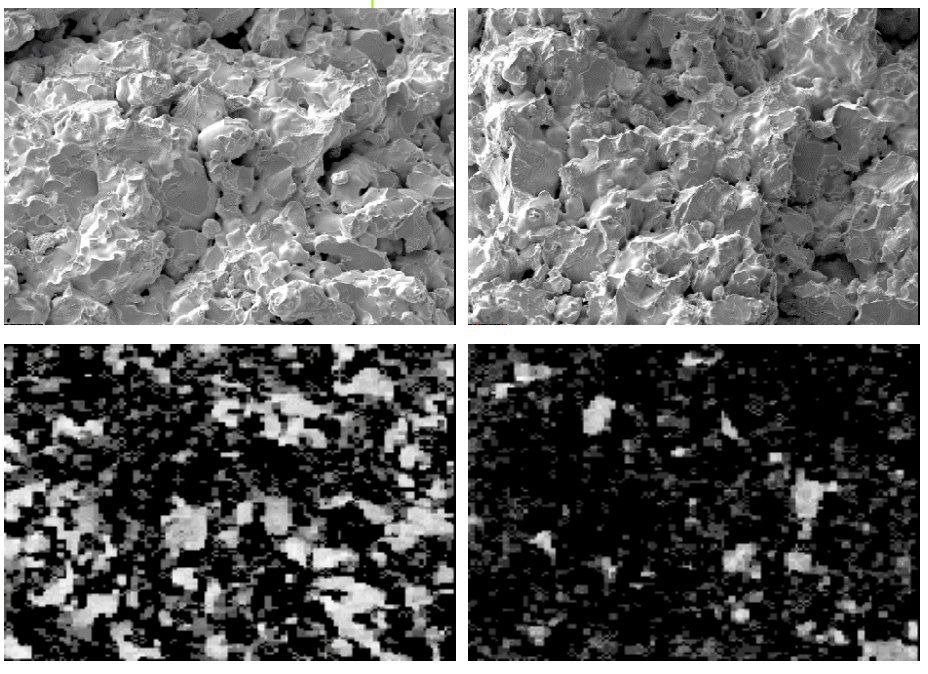
DaimlerChrysler Corporation (DCC) uses a variety of powder-metal-derived parts in its automobiles. DCC found that a significant number of powder metal rings, made from combined iron and ferro-phosphorous powders, were fracturing in use because of embrittlement. Ultimately the embrittlement was eliminated by the addition of graphite, but the root cause of the embrittlement remained unknown.

The Technology

A DCC staff member visited the High Temperature Materials Laboratory (HTML) under the User Program and worked with Dr. Harry Meyer to solve the problem.

DCC utilized HTML's special characterization equipment— a scanning electron microscope (SEM) and scanning Auger nanoprobe (SAN)—for analysis. The SEM showed that fracture occurred primarily as a result of omnipresent voids in these powder metal parts, and that "good" material and "poor" material looked similar. However, the SAN clearly showed that the "poor" material had an uneven distribution of phosphorous atoms, which were particularly heavily concentrated on boundaries between the metal alloy grains. This type of grain boundary contamination is known to cause brittle failure and thus is strongly suspected to be the cause of failure in the "poor" materials.

Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle



SEM images (top) and SAN scans for phosphorous (bottom) show similar fracture behavior but P enrichment on the grain boundaries of "poor" material (left).

Future Direction

The data presented here are preliminary. A final description of the mechanism that leads to embrittlement in ferro-phosphorous powder metal parts is still being discussed. Additional work by DCC, HMTL, and the part supplier is expected to define the mechanism and determine a means to prevent "poor" parts from being produced.

Benefits

DaimlerChrysler has taken advantage of the HTML's User Program and its sophisticated materials characterization equipment to help solve an important materials failure problem. The knowledge gained will improve the quality of their vehicles.

Where Can I Find More Information?

Dr. Arvid Pasto

Oak Ridge National Laboratory

865-574-5123

pastoae@ornl.gov

DOE Technology Manager

Dr. James Eberhardt

Department of Energy

202-586-9837

james.eberhardt@ee.doe.gov

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