Heavy Vehicle Propulsion Materials

Low-Cost, High-Toughness Cermets

Background

The reliability of structural ceramics for advanced diesel engine applications could be improved significantly if the critical fracture toughness (K_{Ic}) were increased without strength degradation. At the same time, cost is a major factor in determining the applicability of new materials in engine components. Thus, research is under way at Oak Ridge National Laboratory to develop high-toughness materials that are also low in cost. Titanium carbide/nickel aluminide (TiC/Ni_3Al) composites have shown a combination of superior physical properties and mechanical behavior using conventional powder processing methods. Previously, the general property envelope has been studied and the compositions refined. The project activities will be in close association with CoorsTek, Inc., a parts supplier, for scale-up of the processing, and Cummins, Inc., for rig-testing of fabricated parts.

The Technology

TiC/Ni_3Al composites under development for application in diesel engines contain Ni_3Al volume contents on the order of 30 to 50 vol % in order to match the thermal expansion of steel. Typically, flexural strengths greater than 1000 MPa and fracture toughnesses higher than 15 MPa/m are obtained for these composites. In addition, these properties are retained up to temperatures of 800°C.

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

As-sintered rods

Commercialization

The research project has made following advances toward commercialization:

- We have gone from laboratory scale (less than 200 g/batch) to more than 3 kg/batch of milled powders.
- We have supplied more than 20 kg of blended powders to CoorsTek for forming into "green" rods.
- We have sintered "green" rods to greater than 98% of theoretical density and supplied the dense rods to Cummins for machining into components and subsequent engine testing.

Benefits

The use of high-toughness cermets in diesel engines has the potential to improve fuel economy and reduce emissions by allowing use of higher injection pressures. Because the fabrication techniques and the equipment employed in production are very similar to those used in the fabrication of WC-Co hard metals, the processing costs are well established and known to be cost-effective.

Where Can I Find More Information?

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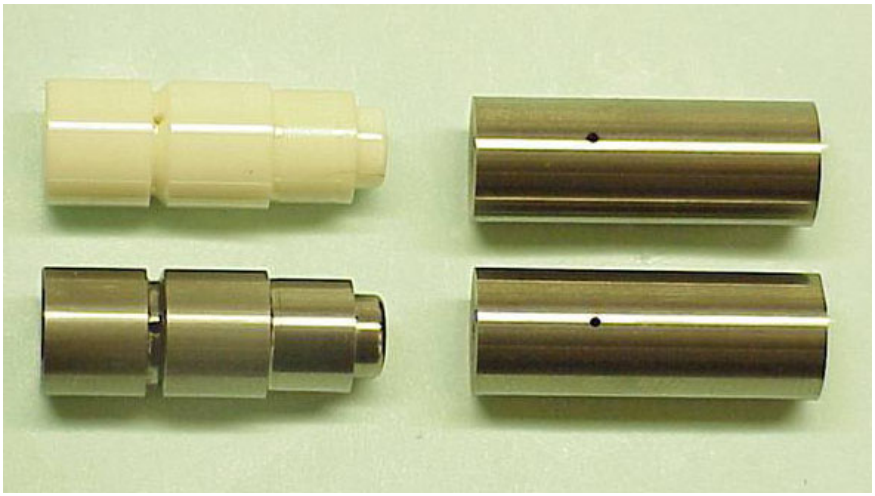

Zirconia (top) and cermet (bottom) after machining into test parts

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