High Strength Weight Reduction Materials

Lightweight Truck Brakes

Background

Improvements in the energy efficiency of heavy vehicles are possible by reducing aerodynamic drag, lowering engine and drive-train friction, and lowering the rolling resistance of tires. One of the consequences of this new technology is an increasing demand on the brakes. Therefore, research has been undertaken on new brake materials, especially those offering weight advantages over traditional gray cast iron.

Future U.S. Department of Transportation safety regulations will require shorter stopping distances for trucks, and that will stimulate a transition from drum- and shoe-type brakes to disc-type brakes. New materials technology must be ready to provide lightweight, effective brakes for the next generation of fuel-efficient, safer trucks. Several projects at Oak Ridge National Laboratory (ORNL) address this need.

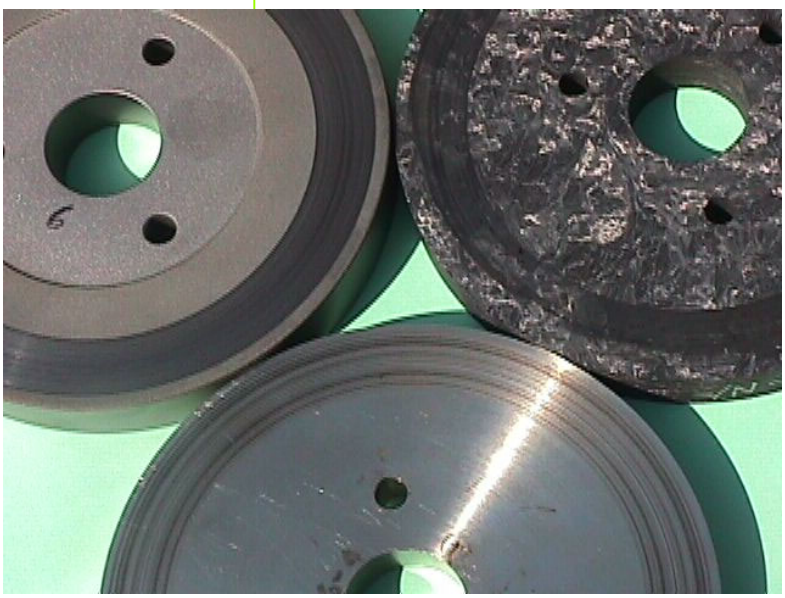
The Technology

Truck brakes typically consist of two types of materials: a metal (such as cast iron) for the disc or drum and a multi-component composite material for the lining (called "friction material").

Of these two, most of the weight is in the drum or rotor, so the primary thrust is to develop lightweight materials to replace cast iron. Finding a suitable friction material to pair with new lightweight discs is also an important consideration.

To enable cost-effective screening of a variety of candidate brake materials, ORNL designed and built a sub-scale brake testing (SSBT) apparatus. It measures friction, temperature, wear, and vibration. Tests can be run in both wet and dry conditions to simulate highway environments.

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



Candidate brake disc materials after friction testing on the SSBT: commercially coated titanium (upper left); experimental ceramic composite (upper right); uncoated titanium alloy (bottom).

Experimental rotor materials and coatings, like the following, have been compared with traditional brake materials using the SSBT:

- Aluminum matrix composites
- Intermetallic alloy (Fe_3Al)
- Ceramic composites (C/SiC)
- Titanium alloys
- Coated titanium alloy

Titanium alloys offer both light weight and resistance to corrosion by road salt, but surface treatments or coatings are needed to control friction and wear. Research to identify the best coatings and friction materials for use with titanium uses thermal imaging, friction testing, detailed characterization of the thin surface layers formed by friction, and analysis of wear particles.

Commercialization

ORNL is working with a major titanium alloy supplier and a manufacturer of racing-grade, coated titanium rotors. Other methods of achieving the needed performance using novel surface treatments are also under study. Future plans are to evaluate titanium discs on full-sized truck brakes.

Benefits

- Compensates for the lower running resistance of more fuel-efficient trucks
- Saves weight that can be added to the truck's payload
- Resists aggressive road deicers that rust cast iron brakes
- Makes use of new technology for lower-cost titanium processing

Where Can I Find More Information?

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