Argonne's near-frictionless carbon coatings find new use

June 10 2005

A research collaboration between the U.S. Department of Energy's Argonne National Laboratory and the Kurt J. Lesker Company will study the durability of nearly frictionless carbon surface coatings in high-performance, vacuum environments.
The coating has a lower coefficient of friction than any other known material. It was developed at Argonne and received an R&D 100 Award for being one of the 100 most important technology advancements in 1998.

The nine-month Argonne-Lesker collaboration will examine nearly frictionless carbon coatings as a possible replacement for traditional chemical lubricants, such as greases and oils, used in specialized devices called neutron choppers.

Neutron choppers play an important role in neutron beam experiments like those conducted at Argonne's Intense Pulsed Neutron Source. Neutron beams are useful probes for studying the arrangement of atoms in materials such as glasses and superconductors.

A neutron chopper is essentially a disk rotated at high speeds with an aperture through which a neutron beam may pass during certain periods of the disk's rotation. Because of the demand for neutron beam experimental facilities, choppers must operate continuously for long periods of time, and their components must endure high vacuum conditions and neutron bombardment.

Ali Erdemir, a materials scientist at Argonne, explained that chemical lubricants degrade more rapidly in the chopper's vacuum environment. As a result, they limit the operating speed of the neutron choppers and can even reduce the accuracy of neutron beam measurements. Furthermore, because they are made radioactive by neutron bombardment, chemical lubricants must undergo a “cool-down” period before routine maintenance can be carried out.

The substitution of the nearly frictionless carbon coatings for chemical lubricants is “a great opportunity to solve these problems,” Erdemir said. “There is a lot of potential for improving chopper performance.”

The carbon coating has not yet seen widespread commercial use because of difficulties in cheaply manufacturing carbon-coated materials. However, Erdemir said two unnamed companies are working to bring the coating process to an industrial scale.

“The cost is the major issue,” he said. “In order to meet the cost requirements, you have to coat many thousands [of machinery parts] in one run.”

However, neutron choppers are not a large-volume application, and the additional cost of the specially coated components is acceptable given the potential improvements to the accuracy of neutron beam studies, Erdemir said. Furthermore, if the carbon coating proves durable in harsh vacuums, the technology could find broader applications, such as in vacuum pumps and spacecraft components.

The cooperative research program between Argonne and the Lesker Company will first test and optimize the carbon coating in vacuum conditions. Then researchers will devise a method to deposit the coating on critical moving parts of the neutron chopper device.

The cooperative research and development agreement is funded by a Phase I grant of the DOE Small Business Technology Transfer Program. Phase I funding, designated for preliminary studies, does not include plans to fabricate an actual device. If results from Phase I are promising, Phase II and III funding could be approved to develop and commercialize a product.

The Kurt J. Lesker Company is an international manufacturer and distributor of vacuum components and vacuum systems for research and industrial applications.

Source: Argonne National Laboratory