Materials Engineering Branch

TIP*

No. 120 High Friction and Wear Rate of Graphite in Vacuum

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For terrestrial applications, graphite (an allotrope of carbon) is frequently used for sliding electrical contacts, motor brushes, and lubrication because of its low friction, low wear rate and high electrical conductivity. Graphite has a laminar planar hexagonal crystal structure with very anisotropic properties. This anisotropy is a direct consequence of the covalent bonding within the plane of the hexagonal structure and the much weaker van der Waals bonding between layers.

The absorbed water, that produces the low friction and wear rate in air, makes graphite an excellent lubricant (see Ref. 1 and 2). When graphite is exposed to vacuum, the absorbed interlaminar water evaporates from the graphite. As a result, in vacuum, the coefficient of friction can increase by a factor of five and the wear rate increases very rapidly as well.

When motor brushes with high graphite content were used in a space application, the high friction often stalled the motors or the high wear rates abraded and shorted the commutators. When graphite is inadvertently used as a lubricant in high vacuum, the five-fold increase in the coefficient of friction always causes failure. Graphite sliding electrical contacts, motor brushes, and lubricants should not be used for space applications.

References:

1. Surface Effects in Adhesion, Friction, Wear, and Lubrication by Donald H. Buckley, 1981, Elsevier North-Holland Inc., 52 Vanderbilt Avenue, New York, NY 10017, p. 573

2. Graphite Lubrication by Robert H. Savage, Journal of Applied Physics, Volume 19, No. 1, January 1948, p. 1