NASA TECH BRIEF

High Temperature Rare Earth Solid Lubricants

Results from a study of the rare earth fluorides (CeF_3 and LaF_3), conducted at temperatures ranging from 1800°F or higher, have indicated that they have good potential for use as solid lubricants. Other characteristics of the rare earth fluorides, such as moderately high friction coefficient, combined with good antiwear properties, suggest possible use in power transmission devices such as clutch plates and brakes, and as fillers in mechanical carbons. Tests also showed that these fluorides exhibited fairly low hardness (4.5 on the Moh scale); hexagonal crystal structure; thermal expansion coefficients which match those of substrate metals such as nickel base super alloys and stainless steels; and water insolubility. In addition, they have good chemical stability and melting points above 2200°F (1200°C).

Friction experiments with powdered rare earth fluorides were conducted in argon and air atmospheres from room temperature to 1800°F. The specimen configuration consisted of Inconel 600 riders sliding on a stationary Inconel 750 disc, lubricated with a thin layer of powdered CeF_3 or LaF_3. The data showed that, in general, the rare earth trifluorides were effective in reducing metallic wear. In both atmospheres and over a large temperature span (500° to 1800°F), the friction coefficients were within the range of 0.1 to 0.4, which is typical of the friction coefficients obtained with many grades of mechanical carbons in commercial use as sliding contact bearing and seal materials. This suggests that rare earth fluorides such as LaF_3 may be useful as lubricating fillers for mechanical carbons, especially for high temperature applications.

Fused-fluoride coatings were then prepared and evaluated. The compositions were: LaF_3 with 25 weight percent of a CaF_2-BaF_2 eutectic and CeF_3 with 12 weight percent LiF eutectic. These compositions were readily fused on metal substrates at 1600°F in a hydrogen atmosphere and, upon cooling, formed adherent coatings. Friction experiments with both compositions showed that the CeF_3 composition had lower friction coefficients than the LaF_3 coating. The CeF_3-LiF coating was relatively insensitive to temperature in the range from room temperature to 1200°F. The friction coefficient was 0.4 at room temperature and gradually decreased to 0.3 at 1200°F.

Notes:

1. The following documentation may be obtained from:

   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference:
   NASA-TN-D-5301 (N69-29568), Rare Earth Fluorides and Oxides—An Exploratory Study of Their Use As Solid Lubricants at Temperatures to 1800°F (1000°C)

2. Technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B70-10175

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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