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NASA TECH BRIEF

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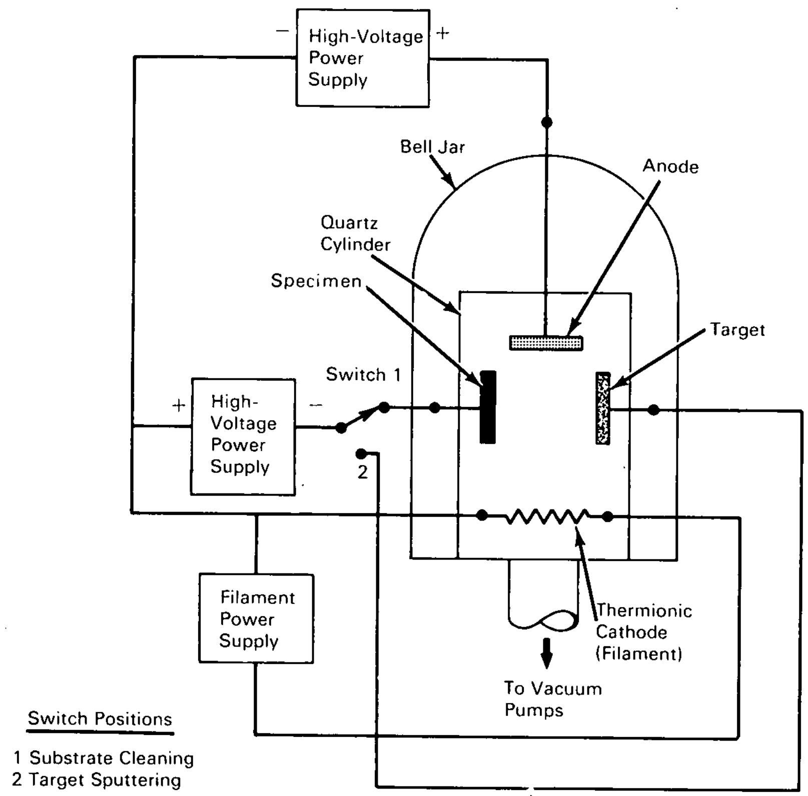
Application of the Solid Lubricant Molybdenum Disulfide by Sputtering



The problem:

Molybdenum disulfide (MoS_2) is frequently used as a solid lubricant in conventional and in high-temperature and high-vacuum environments. To be durable and effective, lubricant films of MoS_2 must be firmly bonded to the surface of the material requiring lubrication. Obtaining uniform, strongly bonded films has been a limiting problem.

Previously, MoS_2 films have been obtained either by using binders or by burnishing the substrate material with MoS_2 powder. There are applications where a bonding agent is undesirable, as for example, environments producing chemical interactions that affect film adherence through decomposition of the binder. Burnished MoS_2 films have relatively poor bonding and usually have a higher coefficient of friction and poor coating thickness uniformity.

(continued overleaf)

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The solution:

A molybdenum disulfide lubricant film was deposited under controlled experimental conditions on two substrates, niobium (Nb) and nickel-chromium (Ni-Cr) alloys, by means of physical direct-current sputtering.

How it's done:

The sputtering system uses a three-electrode (triode) geometry: a thermionic cathode, an anode, and the target, all enclosed in a vacuum chamber.

The thermionic cathode is a spiraled filament of 1 millimeter-thick tungsten wire which, when heated, acts as a thermionic electron source. The anode is a flat stainless steel disk to which a positive electrical potential of about 500 volts is applied to establish a flow discharge between it and the thermionic cathode. The target (the material to be deposited) is a cylindrically shaped binder-free compact of MoS_2, 1.3 cm in diameter and about 5 cm long, held in a water cooled holder. A negative electrical potential is applied to this target.

The substrate material (Nb and a Ni-Cr alloy disk) is placed close to the target material and the atoms ejected from the target are deposited on the substrate to form a continuous film which is both uniform and strongly adherent. Thicknesses of the films were measured during and after sputtering and were in the range of 2000- to 3000-angstroms.

Notes:

1. Measured coefficients of friction of the sputtered MoS_2 film (0.06 to 0.09) are in agreement with the values (0.03 to 0.08) reported in the literature for resin-bonded films.
2. The sputtered MoS_2 lubricant film on the niobium substrate was friction tested for more than five hours without failure in ultrahigh vacuum at loads of 250 grams and a speed of 5 ft/min. This lubricating film durability gives a qualitative test of the strong bonding adherence between film and substrate. The film thickness was uniform, and film thickness repeatability was maintained.
3. The MoS_2 cylindrical compact was made without a binder by using compacting pressures of 50,000 to 100,000 psi.
4. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B68-10340

Patent status:

No patent action is contemplated by NASA.

Source: T. Spalvins and J. Przybyszewski
(LEW-10544)