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# NASA TECH BRIEF



## A New Solid Lubricant

COMPARISON OF FRICTION COEFFICIENT AND WEAR LIFE OF BURNISHED FILMS OF GRAPHITE FLUORIDE, GRAPHITE, AND MOLYBDENUM DISULFIDE IN THREE DIFFERENT ATMOSPHERES AT 25°C

[Moisture content: moist air, 10,000 ppm; dry air, 20 ppm; dry argon, 20 ppm; linear sliding speed, 1.6 m/sec; load, 500 g; riders, 440-C stainless steel.]

| Powder | Disk substrate (stainless steel) | Minimum friction coefficient | | | Wear life, min | | |
|---|---|---|---|---|---|---|---|
| | | Atmosphere | | | | | |
| | | Moist air | Dry air | Dry argon | Moist air | Dry air | Dry argon |
| $(CF_{1.12})_n$ | 301 | 0.05 | 0.02 | 0.025 | 700+ | 250 | 50 |
| Graphite | 301 | .09 | Immediate failure[a] | Immediate failure | 350 | 0 | 0 |
| $MoS_2$ | 301 | * | Immediate failure | Immediate failure | ----- | 0 | 0 |
| $(CF_{1.12})_n$ | 440-C | .06 | .15 | ----- | 1200 | 450 | -- |
| $MoS_2$ | 440-C | .15 | .02 | ----- | 30 | 70 | -- |

[a]Criterion for failure was a frictional force equal to that of unlubricated metal combination.

*Since $MoS_2$ does not work as well in moist air as it does in either dry air or dry argon, no tests were run in moist air.

Friction and wear life studies on burnished films of the compound graphite fluoride ($CF_x$) have demonstrated its potential as a new solid lubricant material.

Graphite fluoride powders were burnished onto roughened stainless steel disks and the ensuing films were evaluated using a pin-on-disk sliding friction apparatus. For comparison, similar tests were performed using burnished films of graphite and of $MoS_2$.

The results show that graphite fluoride is an effective lubricant in moist air, in dry air, or in dry argon at temperatures up to approximately 400°C. The friction coefficient which varies with the temperature and the type of stainless steel disk used, ranges from 0.02 to 0.15. See the figure. These values are comparable or superior to the friction coefficients measured for comparable $MoS_2$ or graphite films. However, the measured wear lives of the graphite fluoride films are up to six times greater than either $MoS_2$ or graphite

(continued overleaf)

films. For example, at room temperature in dry air, the average wear life of a $(CF_x)_n$ film was 450 minutes, while that of a $MoS_2$ film was only 70 minutes.

## Notes:

1. Graphite fluoride is a lamellar compound of carbon formed by the controlled chemical reaction of graphite with gaseous fluorine. Its crystal structure is similar to graphite except that the distance between lamellar planes has been expanded.
2. Graphite fluoride is white in color and quite clean to work with. It is hydrophobic, and has high electrical resistance.
3. Mr. Marco Petronio and his associates of the U.S. Army's Frankford Arsenal suggested graphite fluoride as a possible solid lubricant. The graphite fluoride powders used in this investigation were formulated at Rice University for the Frankford Arsenal.
4. Documentation is available from:
   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10250
5. Technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
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   Cleveland, Ohio 44135
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## Patent status:

No patent action is contemplated by NASA.

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