Wear/Friction Studies of Steel vs. Steel Using Graphene as a Lubricant

Study of Lubricity Using Nanoscale Materials

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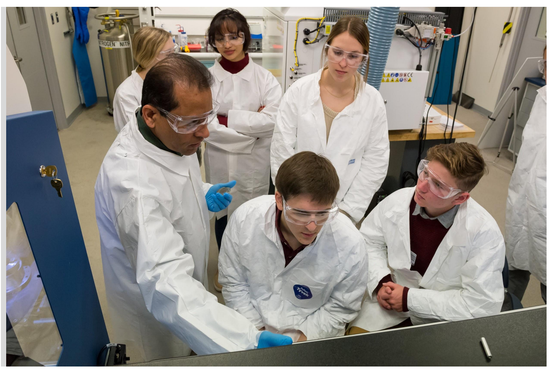
ABSTRACT

The purpose of this research is to find how the 2D form of graphite (Graphene) helps to reduce friction and wear on sliding steel surfaces that will eventually help to develop longer-lasting solid lubricant. This research is important because it will help to replace conventional oil-based lubricants that need to be spent or dumped after their use, creating danger to the environment. The graphene based solid lubricants can be easily spray coated on steel surfaces and due to high surface area, bonded nicely to the steel surface. The lubricant's compact crystal structure does not allow even water vapors to interact with the underlying steel surface, thus it helps the tribo-corrosion. Tribo-Corrosion is the material degradation process due to the combined effects of corrosion and wear. We studied the effect of graphene lubrication on wear and friction of steel surfaces and will compare its results with that of steel vs steel without any lubricant.

This research was made possible through the *Exemplary Student Research Program*. Tests were performed using a Ball-on-disc type tribo testing using standard test parameters and results were studied using a Raman spectroscopy and optical microscopy. All trials were performed at the Center for Nanoscale Materials (CNM) at Argonne National Laboratory.

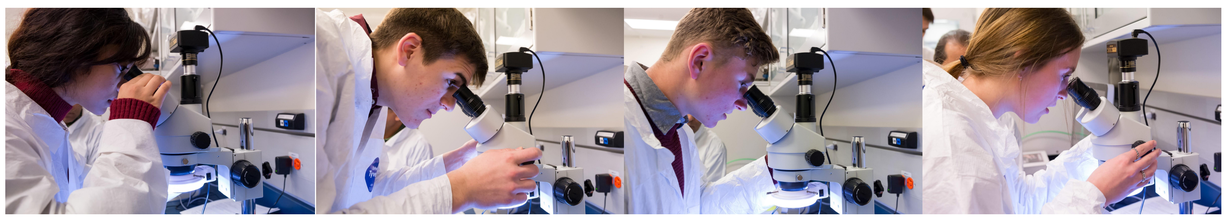
MATERIALS & PROCEDURE

- Multifunctional Tribometer
- Steel Ball vs Steel Disc
- Load: 1N, Velocity: 0.1m/sec
- Test duration: 30 mins
- Test environment: Air and in dry nitrogen
- Graphene Spray coating
- Coefficient of Friction was recorded for each test



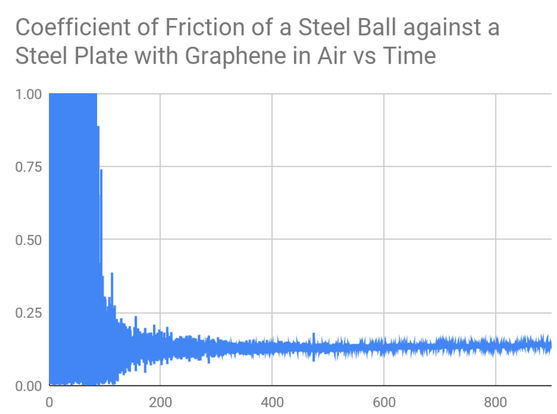
METHODS

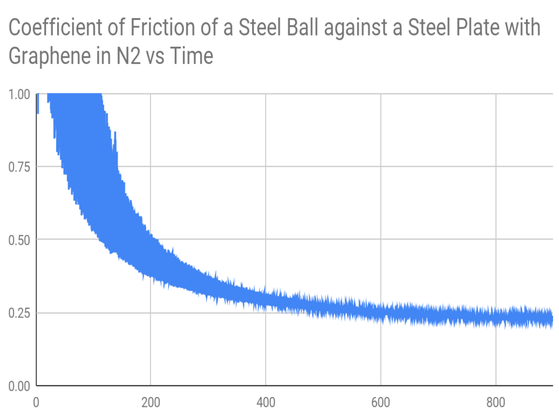
A multifunctional Tribometer was utilized to study the wear friction property of steel on steel surfaces.
All samples were subjected to Ball-on-disc type tribo-testing using standard test parameters. Each test was run for 30 mins and friction coefficient data was recorded during each run. After each test run, wear on the ball and on the flat steel substrates were be measured and recorded. A control experiment steel vs. steel in air was used to compare results. Graphene was spray coated on the steel substrates and the friction coefficient was calculated for air and Nitrogen medium.

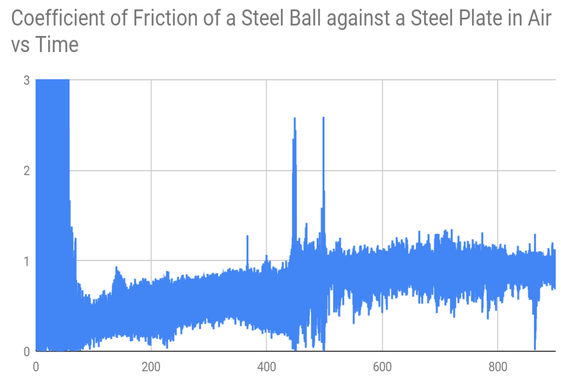


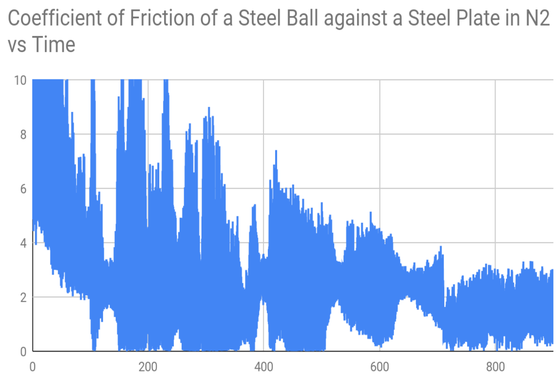
RESULTS FROM TESTING

Through running test of various combinations of running a steel ball on a steel plate spinning at 100mm/s, it was observed that the coefficient of friction was lowest when the steel plate was coated in graphene and when the chamber only had normal air. The coefficient of friction was highest when the steel ball was on a steel plate not coated with any lubricant and when the chamber was filled with N2 Gas.









CONCLUSIONS

- The friction coefficient of steel was reduced by almost 7 times in air and 10 times in dry nitrogen when graphene was used as a lubricant
- The slight increase in friction coefficient in dry nitrogen with graphene as a lubricant may suggests that carbon structure of graphene is breaking down although much slower
- Certain environmental conditions greatly affect the success in lowering the coefficient of friction (different air conditions requires slight changes in the graphene solution)

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