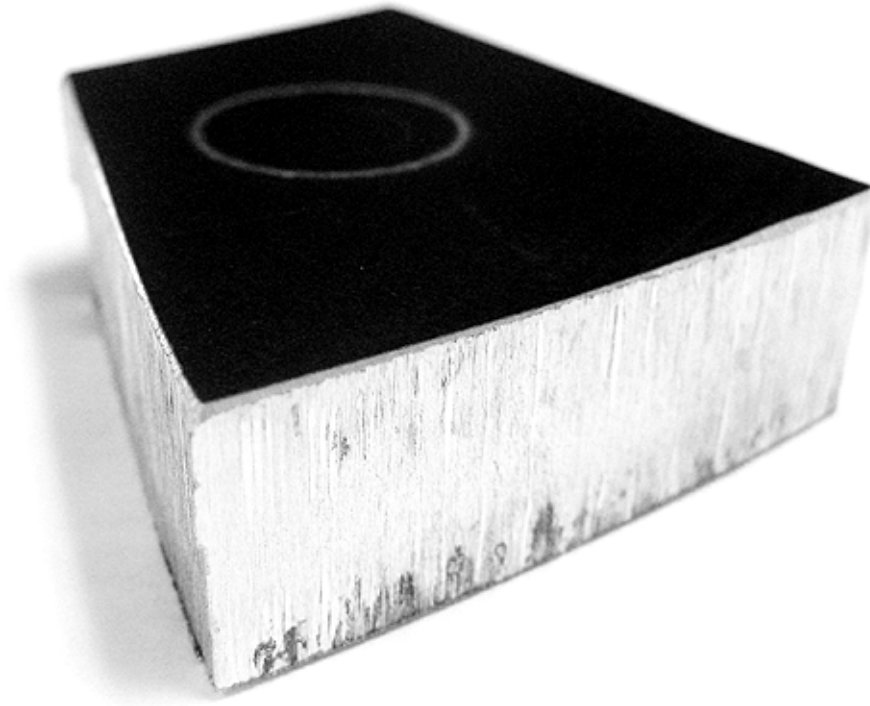


**COEFFICIENT OF FRICTION & WEAR TESTING
OF PLASMA COATING**



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INTRODUCTION

Plasma coatings are a covering that is applied to the surface of an object. In many cases plasma coatings are applied to improve surface properties of the substrate, such as appearance, adhesion, wettability, corrosion resistance, wear resistance, and scratch resistance. In particular, plasma coatings are used for engines and other applications alike since they are very thin and can be able to withstand very high levels of temperature and serve as insulators.

PLASMA CONCERNS

A major concern for plasma coatings is how wear resistant they will prove to be on the final product. Since plasma coatings are a popular use for automobile engines, these coatings are tested through strenuous conditions. If the coating on the engine itself wears off at a fast rate than the life expectancy of that particular engine or part becomes a problematic concern. With the plasma coating wearing off, the parts originally being protected will become exposed to melting temperatures, corrosion and other potentially destructive conditions. In order to avoid endangering valuable parts with destructive conditions it is very important to develop very thin plasma coatings with low wear rates.

MEASUREMENT OBJECTIVE

In this application, the Nanovea Tribometer (seen below) is used to measure the wear rate and coefficient of friction between a 6mm tungsten carbide ball and a plasma coating. Although the coefficient of friction value is gathered from the contact of the ball and the plasma coating over time, the wear rate is calculated by taking profile readings of the track itself with the use of an optical profiler. From the profile reading we are able to gather value for the area of the track which is then input in the Nanovea Tribometer Software's wear rate calculator.



PIN on DISK TRIBOMETER (TRB)

Principle of pin-on-disk measurements

A flat or a sphere shaped indenter is loaded on to the test sample with a precisely known force. The indenter (a pin or a ball) is mounted on a stiff lever, designed as a frictionless force transducer. As the disk is rotated, resulting frictional forces acting between the pin and the disk are measured by very small deflections of the arm using a strain gauge sensor. Wear coefficients for both the pin and sample are calculated from the volume of material lost during a specific friction run. This simple method facilitates the determination and study of friction and wear behavior of almost every solid state material combination, with varying time, contact pressure, velocity, temperature, humidity, lubrication, etc.

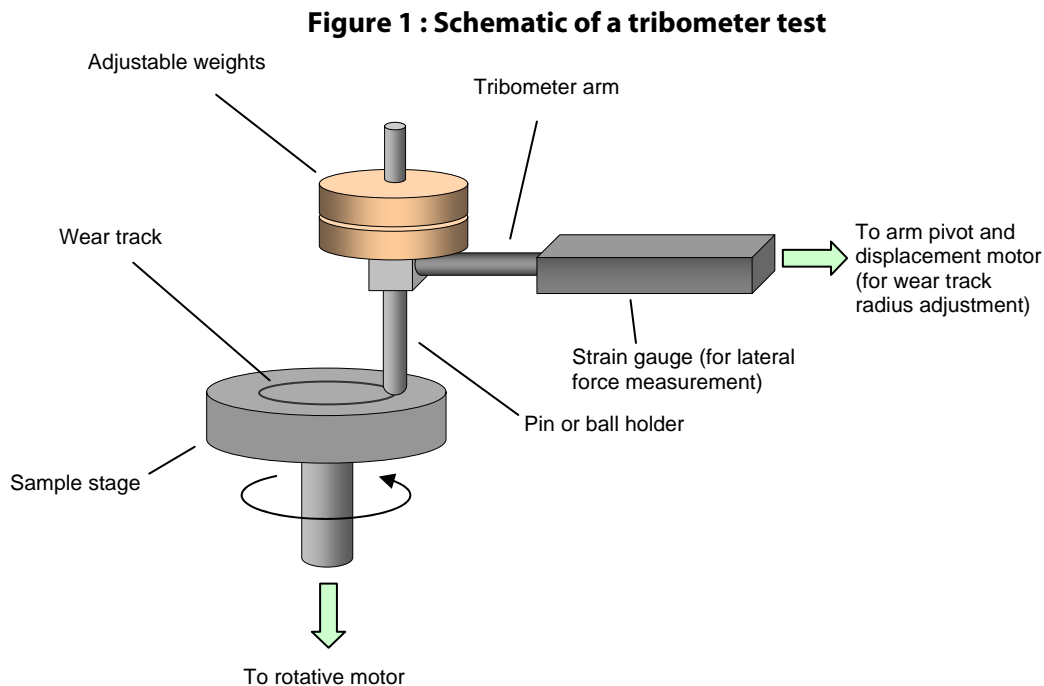
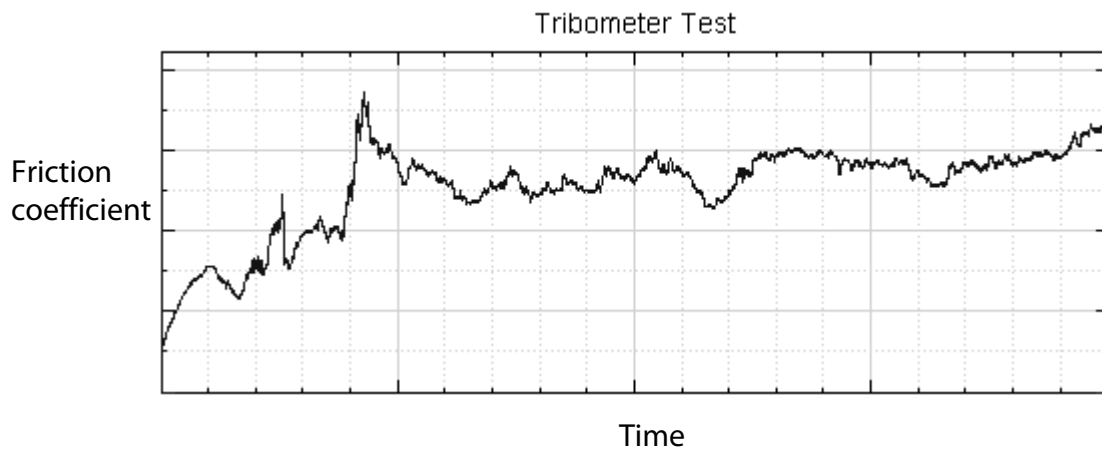


Figure 2 : Example of a friction curve in a tribometer test



Test procedure and conditions

The instrument base is first leveled in the horizontal position by screwing or unscrewing the adjustable rubber pads at each corner. A ball-holder containing a 3 or 6 mm diameter ball is held in the load arm and placed at a height that allow the tribometer arm to be leveled horizontally when resting on the sample to ensure that normal load will be applied vertically. The arm is then balanced with counter weights to ensure that the arm and ball holder initially apply no force on the sample surface. Finally, weights corresponding to the load required for the test are finely placed on the arm over the ball holder. Through software, the test is then launched and the test is performed at a specified speed for a specified duration, and the frictional force is recorded over time.

Test conditions

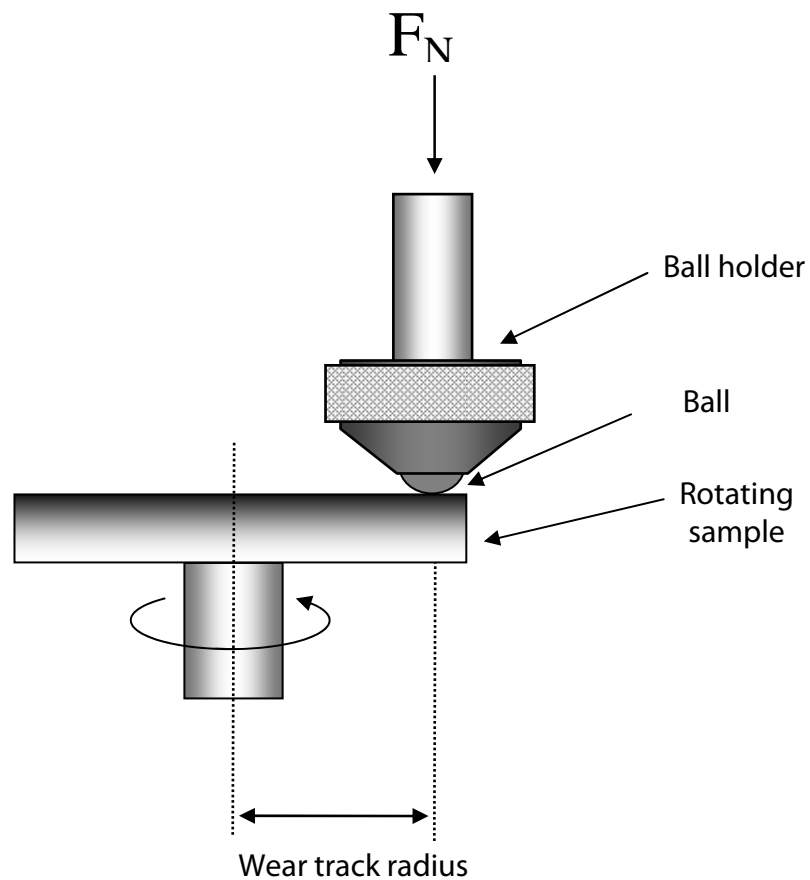
Test parameters

Load	20 N
Duration of test	83.3 mins
Rotational rate	300 rpm
Radius of track	20 mm
Revolutions	24994.9
Ball Diameter	6 mm
Ball Material	WC

Environmental conditions

Lubricant	None
Atmosphere	Air
Temperature	23°C (room)
Humidity	35%

Figure 3 : Schematic of the contact on the sample



Results

This section includes the following results:

- Numerical results of wear rate and coefficient of friction values
- Graphs of coefficient of friction over time
- Profile and area loss values of wear track
- Height reference for wear track
- 3D images of wear track

	Average	Sample Area of Wear Track [microns ²]	Sample Wear Rate [10 ⁻⁶ mm ³ /Nm]
X	0.361	2141.03	4.283

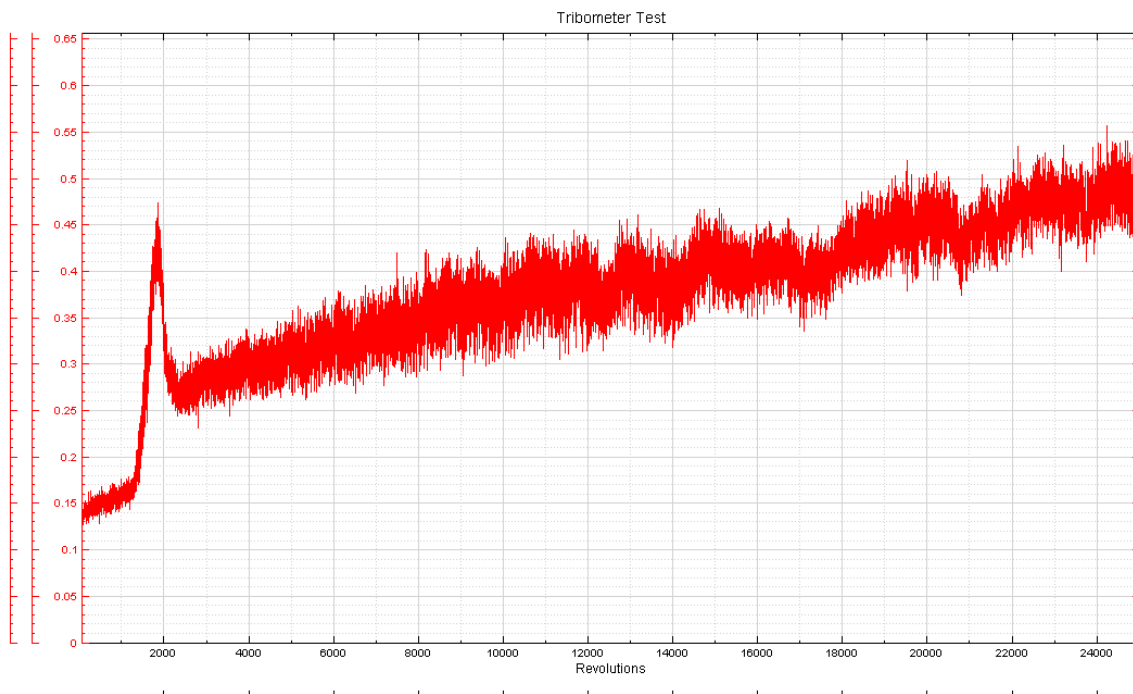


Figure 4: Graph of coefficient of friction – Sample X

(Results continued in pages below)

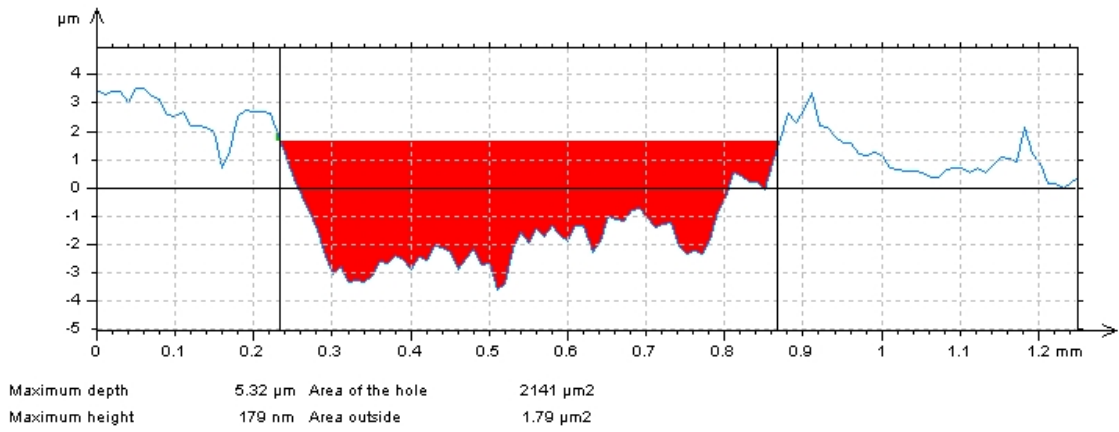


Figure 5: Profile and area loss values of wear track – Sample X

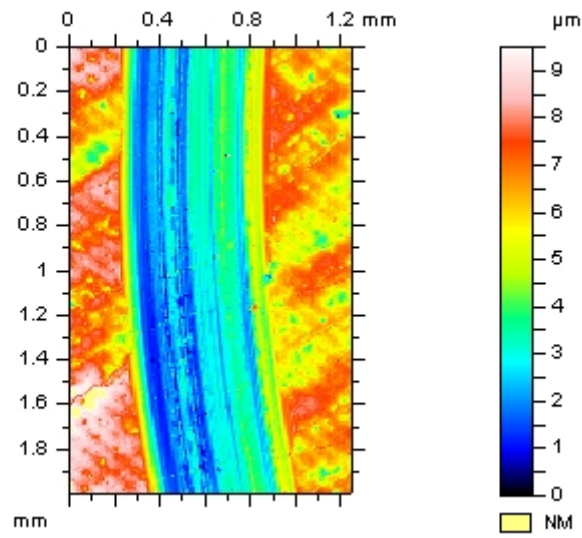


Figure 6: 3D Profilometry height reference for wear track – Sample X

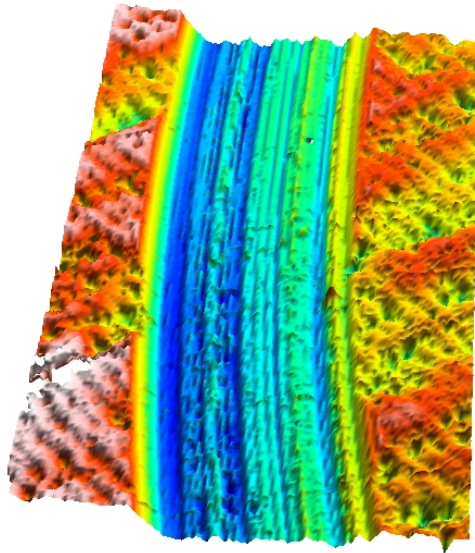


Figure 7: 3D Profilometry of wear track: Top View – Sample X

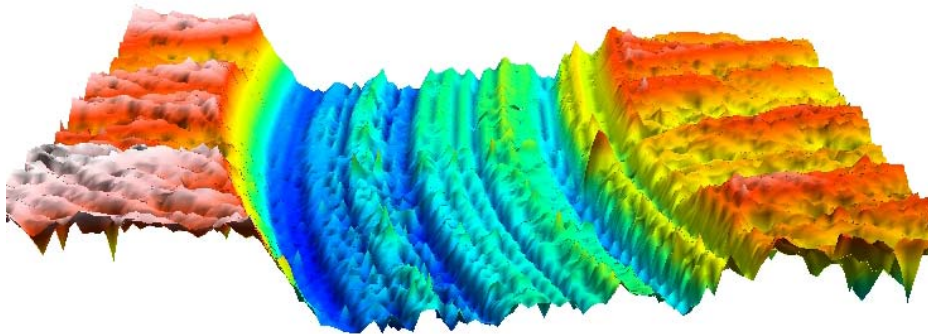


Figure 8: 3D Profilometry of wear track: Side View – Sample X

Conclusion

The Nanovea Tribometer allowed for the coefficient of friction between a tungsten carbide ball and a plasma coated sample to be measured by performing the test through a pin-on-disk method. We were then able to use the track and recorded values for the test to determine the wear rate for the coating. This was done in a controlled and repeatable fashion, which will allow the testing and comparing of plasma coated samples under identical conditions. The test parameters can be adjusted, such as varying the load, speed and testing time to better simulate real-life applications. In conclusion, the Nanovea Tribometer is a very effective way to test and compare plasma coated samples for their coefficient of friction and wear rate over time and varying conditions.