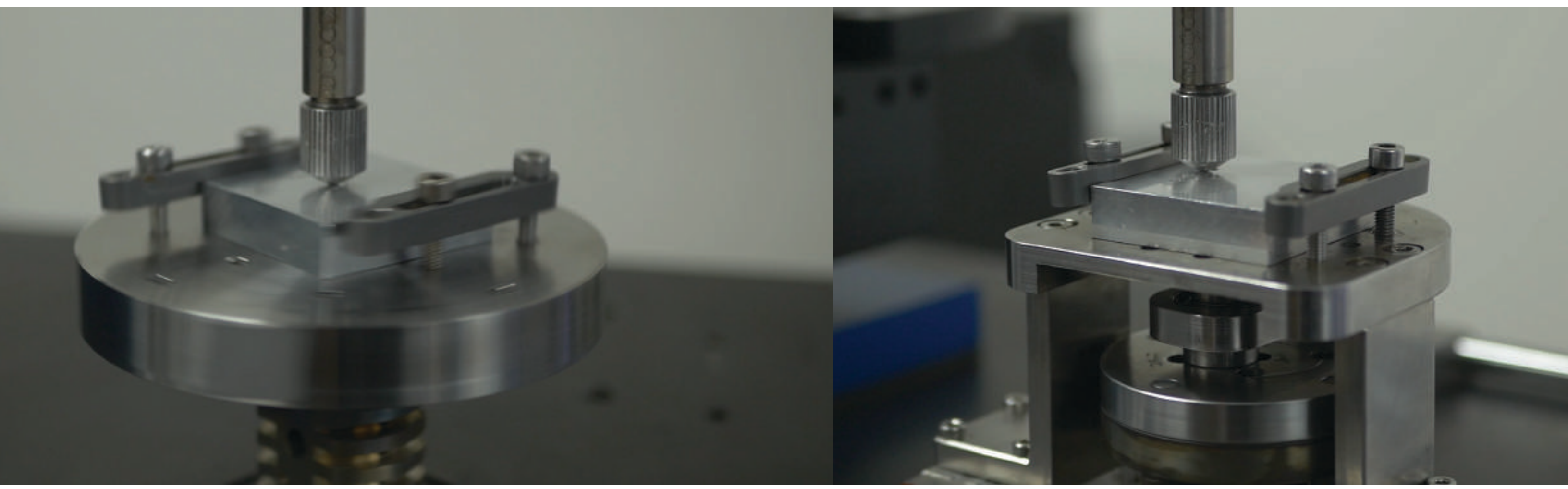
NANOVEA
A Better Measure

www.nanovea.com
info@nanovea.com
euro@nanovea.com
mexinfo@nanovea.com
(949)-461-9292

ROTATIVE OR LINEAR WEAR & COF?

A COMPREHENSIVE STUDY USING THE NANOVEA TRIBOMETER



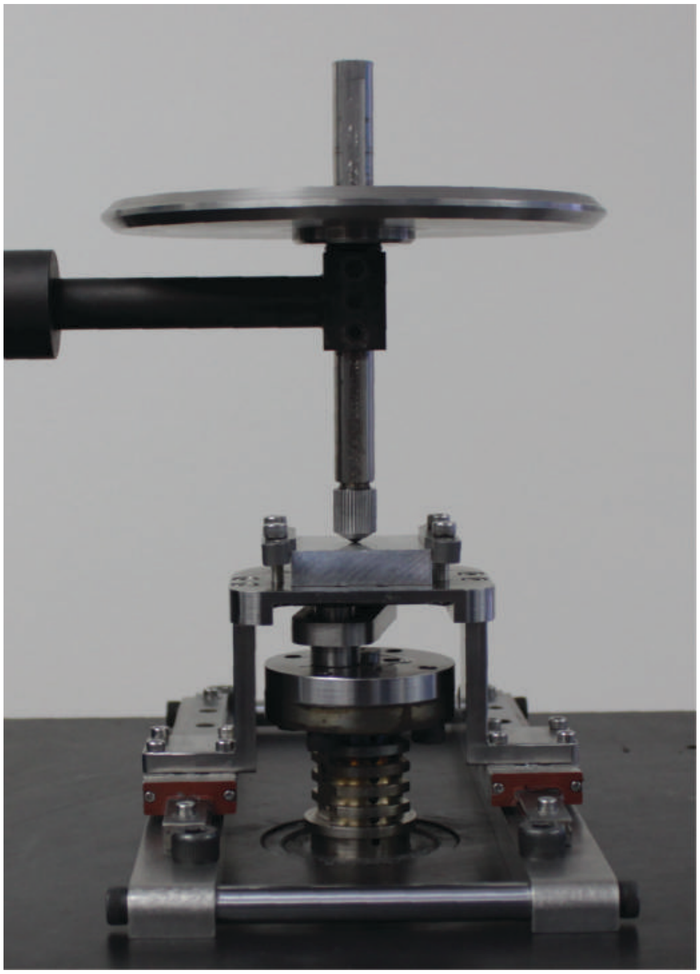
Prepared by
Xavier Herrera-Keehn and Jocelyn Esparza

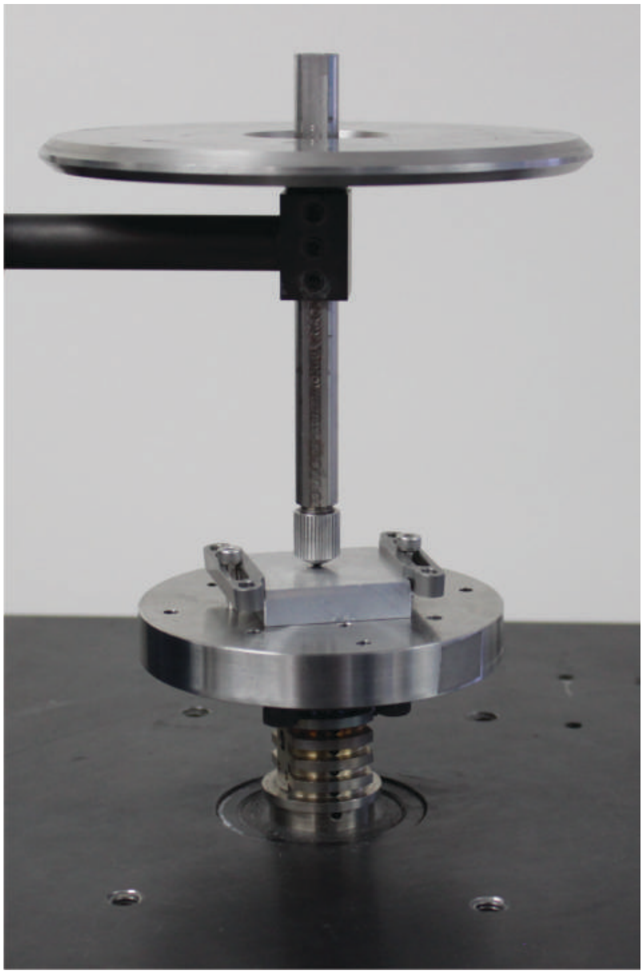
www.nanovea.com
info@nanovea.com
euro@nanovea.com
mexinfo@nanovea.com
(949)-461-9292

Introduction

Wear is the process of removal and deformation of material on a surface as a result of mechanical action of the opposite surface[1]. It is influenced by a variety of factors, including unidirectional sliding, rolling, speed, temperature, and many others. The study of wear, tribology, spans many disciplines, from physics and chemistry to mechanical engineering and material science. The complex nature of wear requires isolated studies towards specific wear mechanisms or processes, such as adhesive wear, abrasive wear, surface fatigue, fretting wear and erosive wear[2]. However, "Industrial Wear" commonly involves multiple wear mechanisms occurring in synergy.

Linear reciprocating and Rotative (Pin on Disk) wear tests are two widely used ASTM compliant setups[34] for measuring sliding wear behaviors of materials. Since the wear rate value of any wear test method are often used to predict the relative ranking of material combinations, it is extremely important to confirm the repeatability of the wear rate measured using different test setups. This enables users to carefully consider the wear rate value reported in literature, which is critical in understanding the tribological characteristics of materials.





Equipment Featured

NANOVEA T50

Versatile Wear & Friction Tester

Multi-Module System

Speed Control from 0.01-5000 RPM

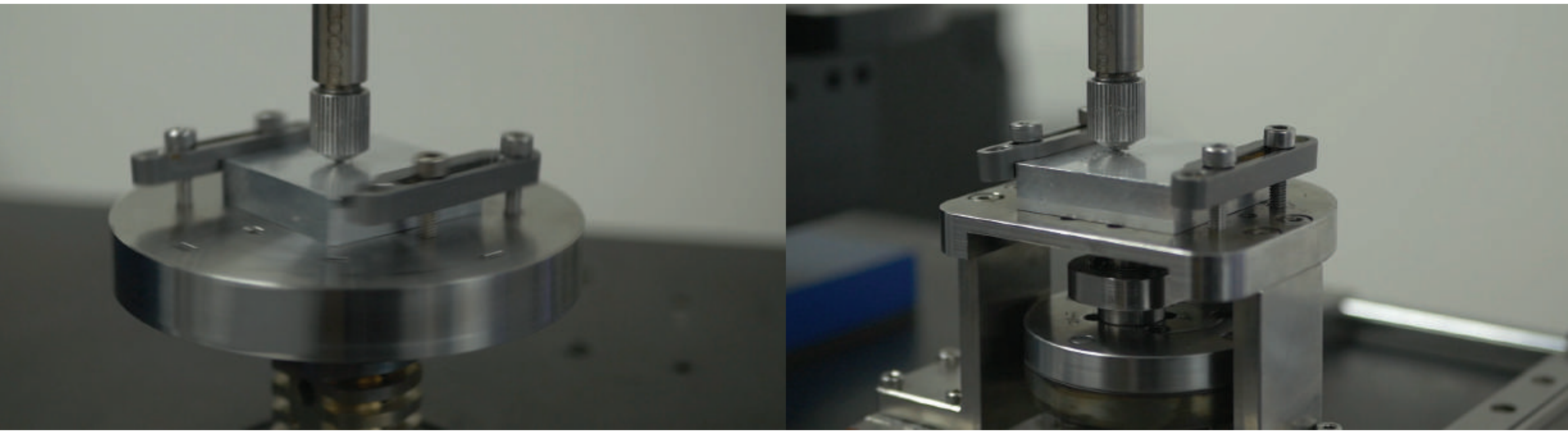
Robust with Open Platform

Wide Rang of Environmental Conditions

Learn More about the T50

Measurement Objectives

In this study, the wear rate of an aluminum sample is measured in a controlled and monitored manner using the linear reciprocating and rotative wear test setups of the Nanovea Tribometer for comparison. The versatility of the Nanovea Tribometer is showcased when measuring the wear rate of a single sample using different setups.



Sample tested on T50 (Rotative and Linear)

Tribology Results

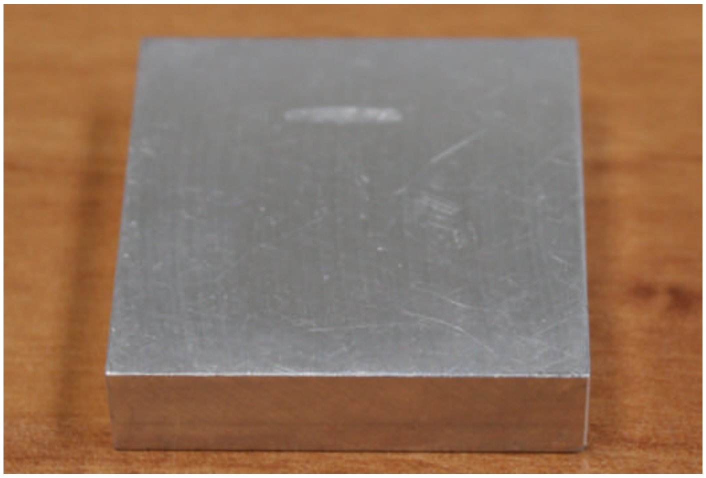
Measurement Parameters

The wear behavior, e.g. coefficient of friction (COF) and wear resistance of the aluminum sample was evaluated using the Nanovea Tribometers linear reciprocating and rotative modules for comparison. An SS440 ball tip, 6mm in diameter, was applied against the tested sample. The COF was monitored in situ. Finally, the volume loss of each test was measured using the Nanovea HS2000 Line Sensor to determine the respective wear rate of the two tests conducted.

Instrument	T50
Normal Force (N)	10
Rotative Speed (RPM)	60
Linear Speed	1 Hz for reciprocating wear
Number of Strokes	1200
Duration of Test (minutes)	20
Distance Traveled (m)	12

Table 1:Test parameters for COF and wear measurements

Sample Tested



Sample of aluminum

Results & Discussion

It is important to note that for the linear testing, a stroke will be defined as the travel in one direction. This attempts to minimize the difference in speed at which the sample is traveling when comparing the rotative and linear results. The COF per test was recorded in situ and is shown in Figure 1. The two testing methods produced distinct values for their average COF, 0.575 for linear and 0.407 for rotative. This discrepancy can be attributed to a multitude of factors, one of them being a greater wear rate which increases the ball bearings' contact area. This can also create more debris, that may enter the wear track, influencing the surface which the ball bearing is reciprocating on.

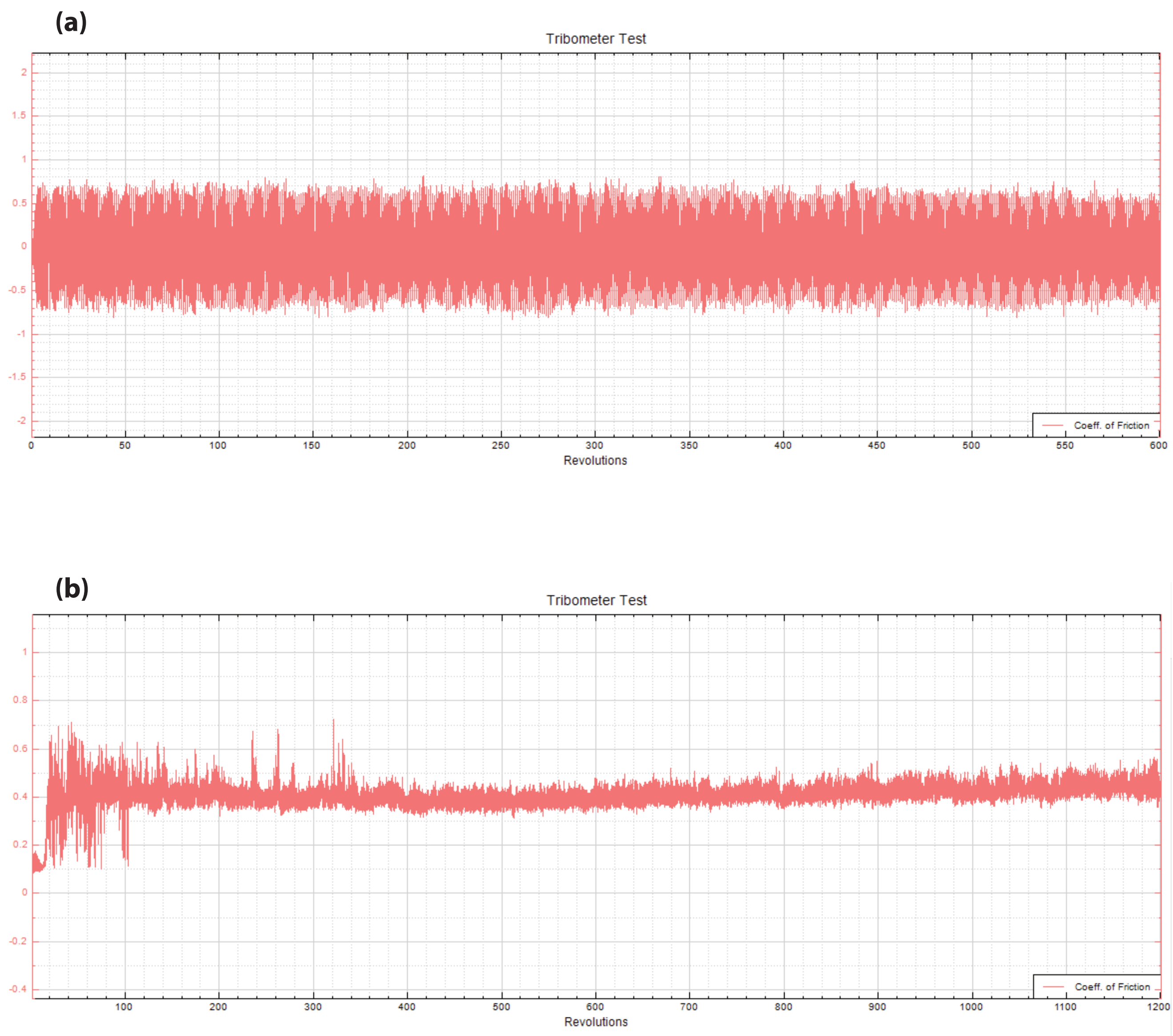


Figure 1: Coefficient of friction during (a) linear reciprocating and (b) rotative wear tests

Results & Discussion

The subsequent wear tracks were evaluated using the Nanovea HS2000 Line Sensor, allowing us to compare their respective wear rates and track depths shown in Figures 2, 3, and 5. It is interesting to note the stark difference in wear rates when comparing the linear versus the rotative results. The wear rate for the linear test was 998.88 x 10-5 mm3/Nm and 100.67 x 10-5 mm3/Nm for the rotative test. Both samples underwent similar testing parameters but the linear test achieved a wear rate of 10 times the rotative. This disparity can also be seen in the wear tracks for each sample. Figures 3 depicts a much more significant wear track when compared to Figure 2. This is to be expected given their wear rates.

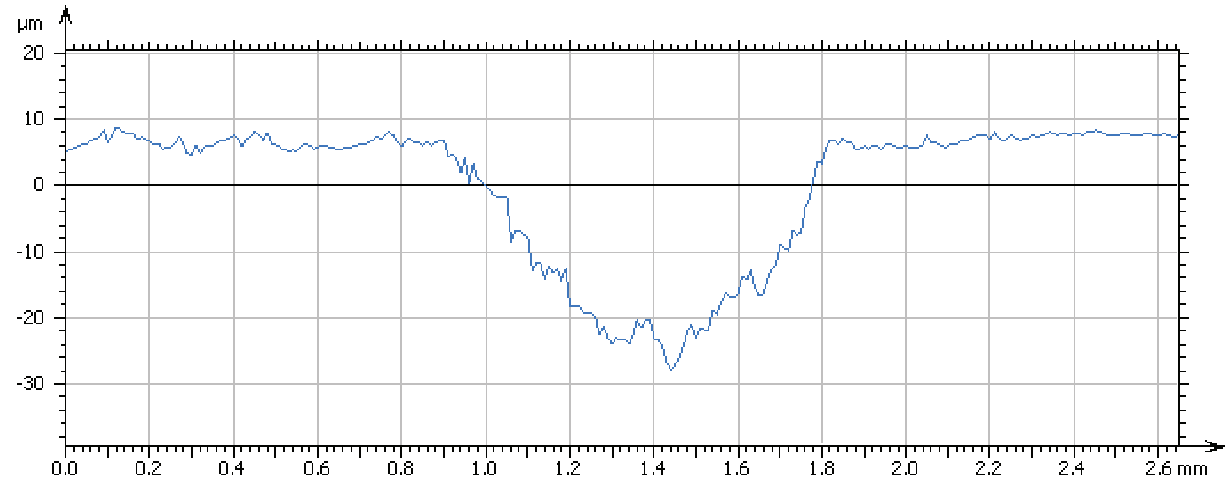


Figure 2: Rotative wear track profile

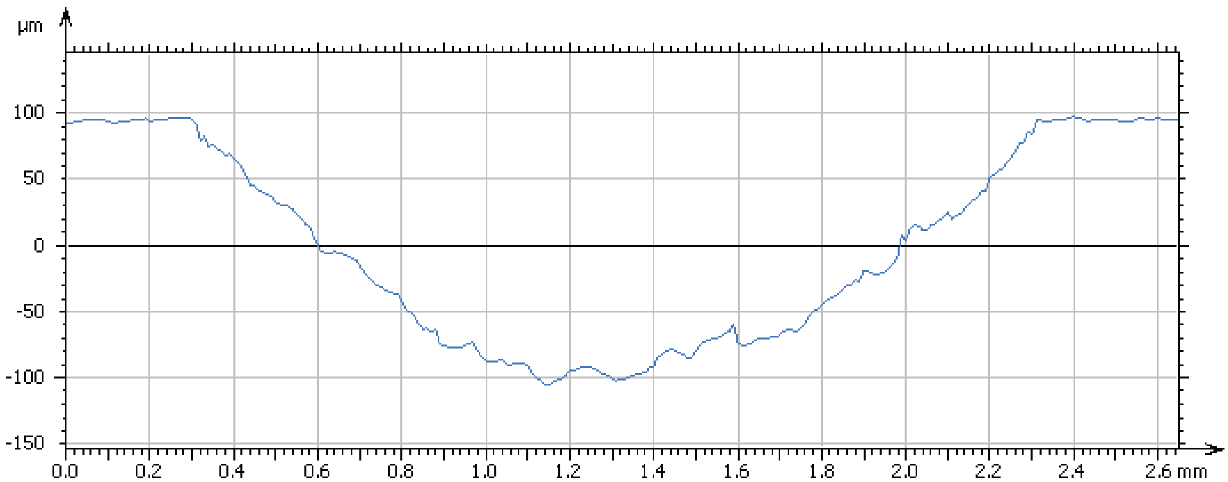


Figure 3: Linear wear track profile

Results & Discussion

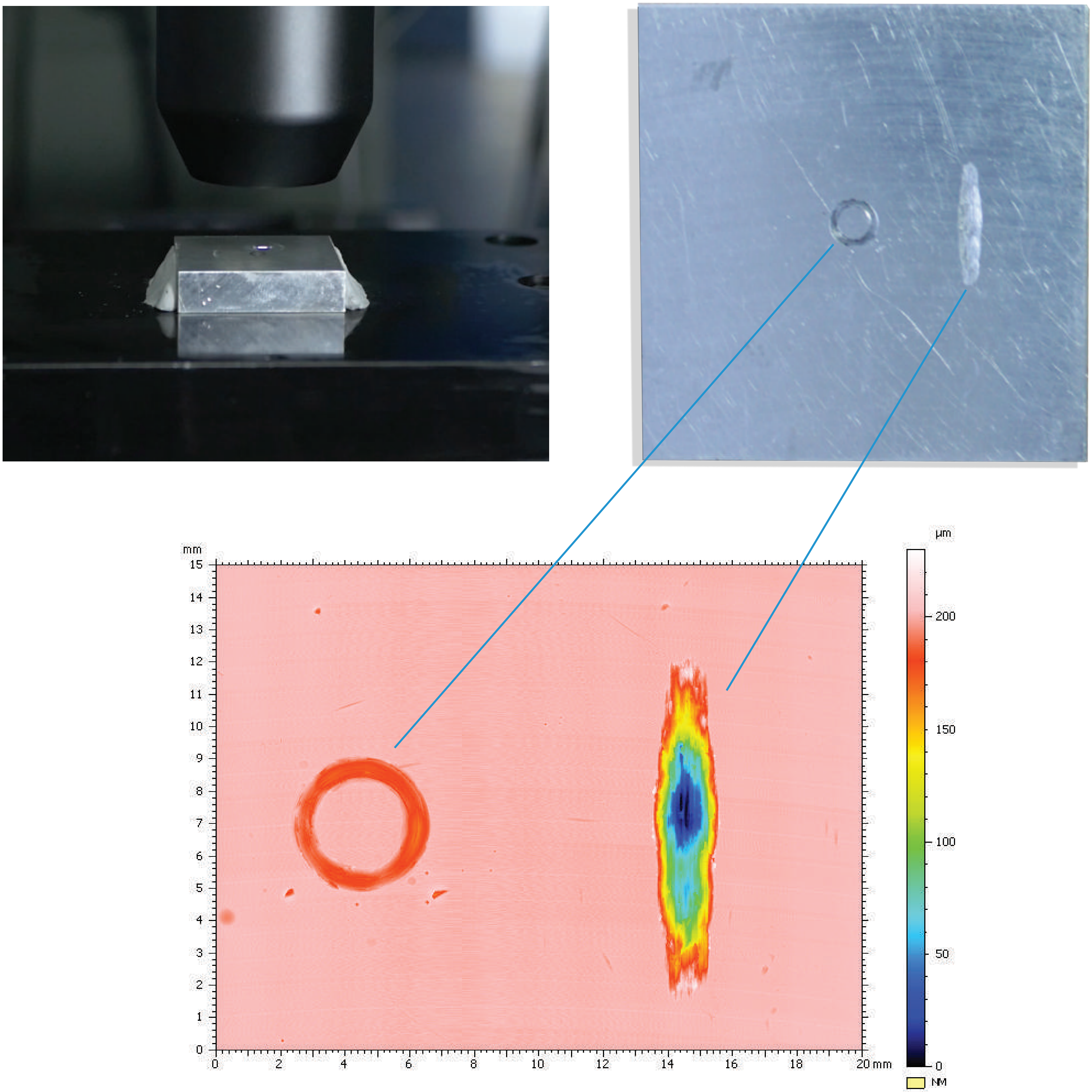


Figure 4: 3D profile of rotative and linear test respectively

Results & Discussion

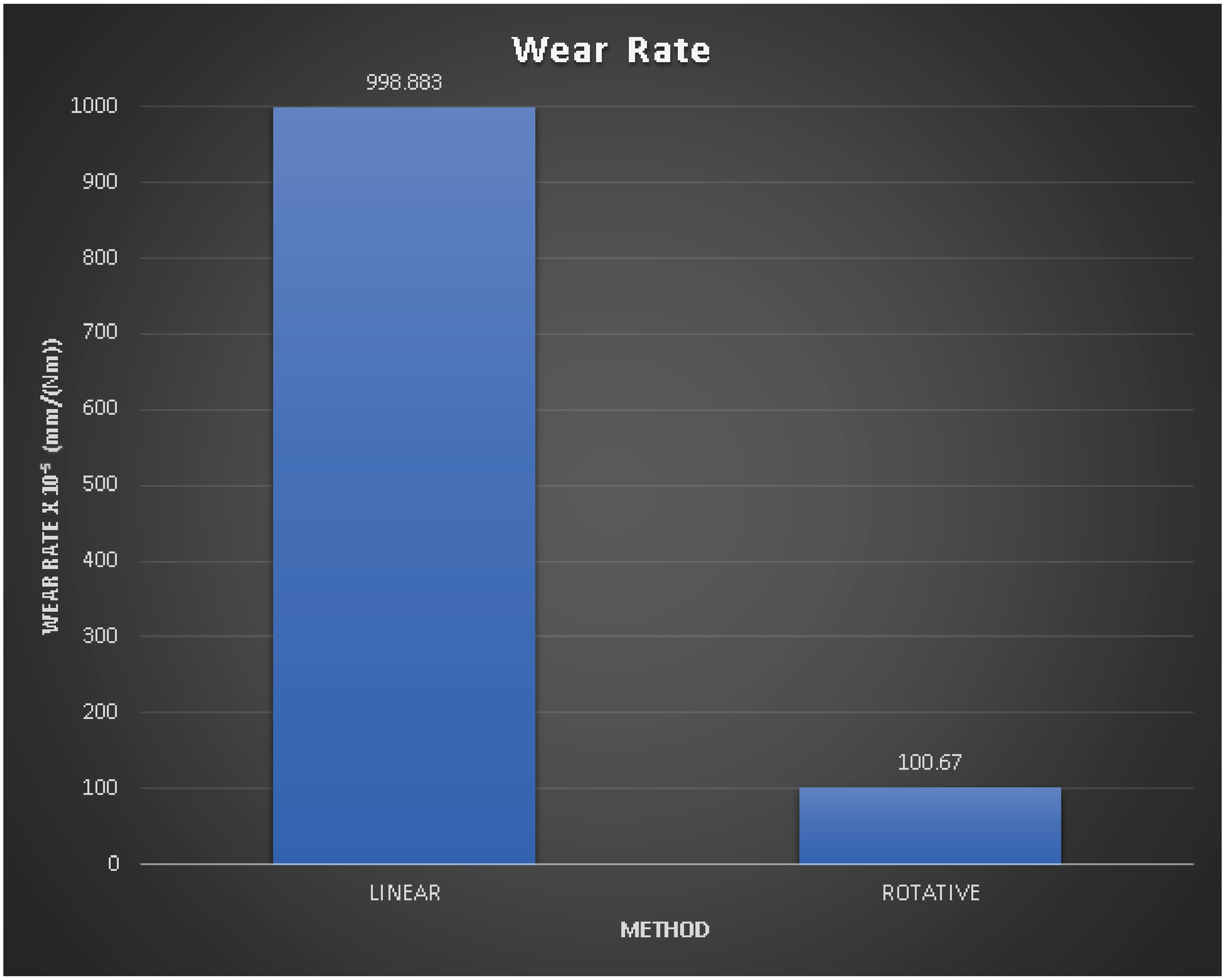
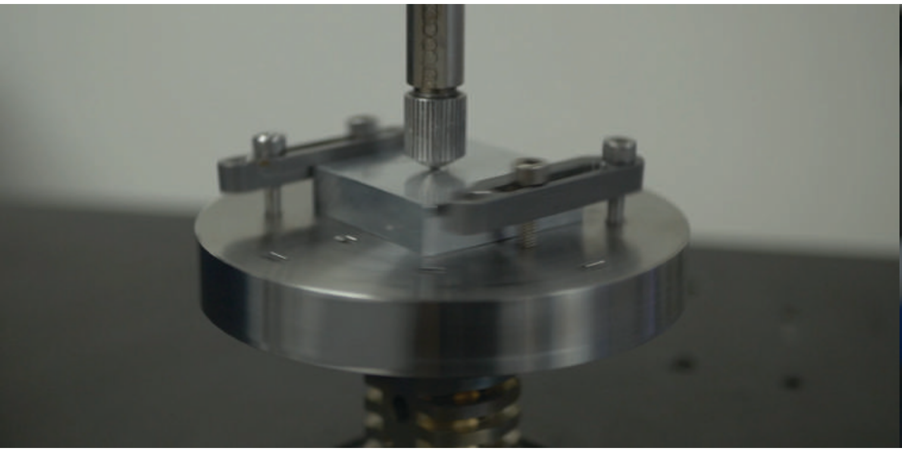
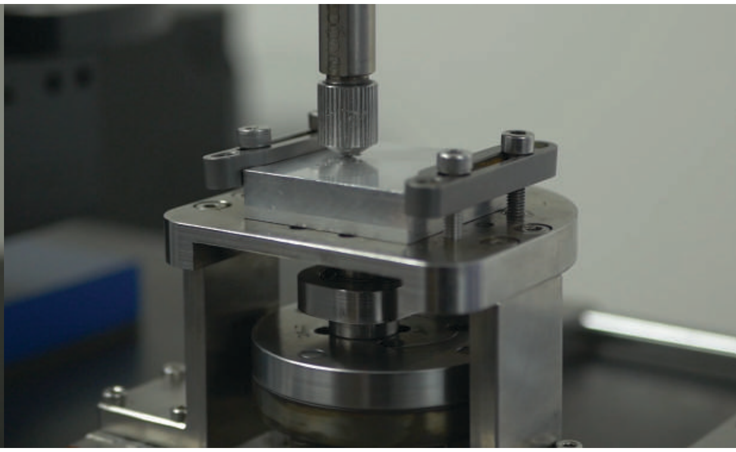


Figure 5: Wear Rate for Linear vs. Rotative

The substantially different wear resistance measured in two commonly used wear test setups shows the importance of comparing wear resistance of the materials using identical experimental setup and test conditions. It illustrates that wear can change drastically when small changes in testing conditions are introduced into the tribometer system. The versatility of the Nanovea Tribometer allows the user to measure both rotative and linear reciprocating wear on one single system under various environmental conditions, including high temperature, lubrication, tribo-corrosion etc. and test parameters. Making it an ideal tool for research/testing labs dealing with a variety of materials applied in different tribological conditions.

NANOVEA
A Better Measure
www.nanovea.com
info@nanovea.com
euroinfo@nanovea.com
mexinfo@nanovea.com
+1 (949) 461-9292





Conclusion

Based on the comprehensive tribological analysis in this study, we show that the aluminum sample exhibits significantly different wear rates measured under linear reciprocating and rotative pin on disk setups. This demonstrates the importance of caution in comparing the wear rate measured using different test setups, even though many of the parameters were similar in this study.

Nanovea Tribometer offers precise and repeatable wear and friction testing using ISO and ASTM compliant rotative and linear modules. It also provides optional high temperature wear, lubrication, and tribo-corrosion modules available in one pre-integrated system. Such versatility allows users to better simulate the real application environment and improve fundamental understanding of the wear mechanism and tribological characteristics of various materials.

Optionally, a 3D non-contact profilometer is available to acquire high resolution 3D images of a samples' wear track, in addition to other surface measurements such as roughness.

Check out our full application notes library!

References

1 Rabinowicz, E. (1995). Friction and Wear of Materials. New York, John Wiley and Sons

2 Jones, M., H and D. Scott, Eds. (1983). Industrial Tribology: the practical aspects of friction, lubrication, and wear. New York, Elsevier Scientific Publishing Company.

3 ASTM G133-05(2010). Standard Test Method for Linearly Reciprocating Ball-on-Flat Sliding Wear.

4 ASTM G99-05(2010). Standard Test Method for Wear Testing with a Pin-on-Disk Apparatus.