NANOVEA

POLYMER BELTS

WEAR AND FRICTION USING A TRIBOMETER

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INTRODUCTION

Belt drive transmits power and tracks relative movement between two or more rotating shafts. As a simple and inexpensive solution with minimal maintenance, belt drives are widely used in a variety of applications, such as bucksaws, sawmills, threshers, silo blowers and conveyors. Belt drives can protect the machinery from overload as well as damp and isolate vibration.

IMPORTANCE OF WEAR EVALUATION FOR BELT DRIVES

Friction and wear are inevitable for the belts in a belt-driven machine. Sufficient friction ensures effective power transmission without slipping, but excessive friction may rapidly wear the belt. Different types of wear such as fatigue, abrasion and friction take place during the belt drive operation. In order to extend the lifetime of the belt and to cut the cost and time on belt repairing and replacement, reliable evaluation of the wear performance of the belts is desirable in improving belt lifespan, production efficiency and application performance. Accurate measurement of the coefficient of friction and wear rate of the belt facilitates R&D and quality control of belt production.

MEASUREMENT OBJECTIVE

*In this study, we simulated and compared the wear behaviours of belts with different surface textures to showcase the capacity of the **NANOVEA** T2000 Tribometer in simulating the wear process of the belt in a controlled and monitored manner.*

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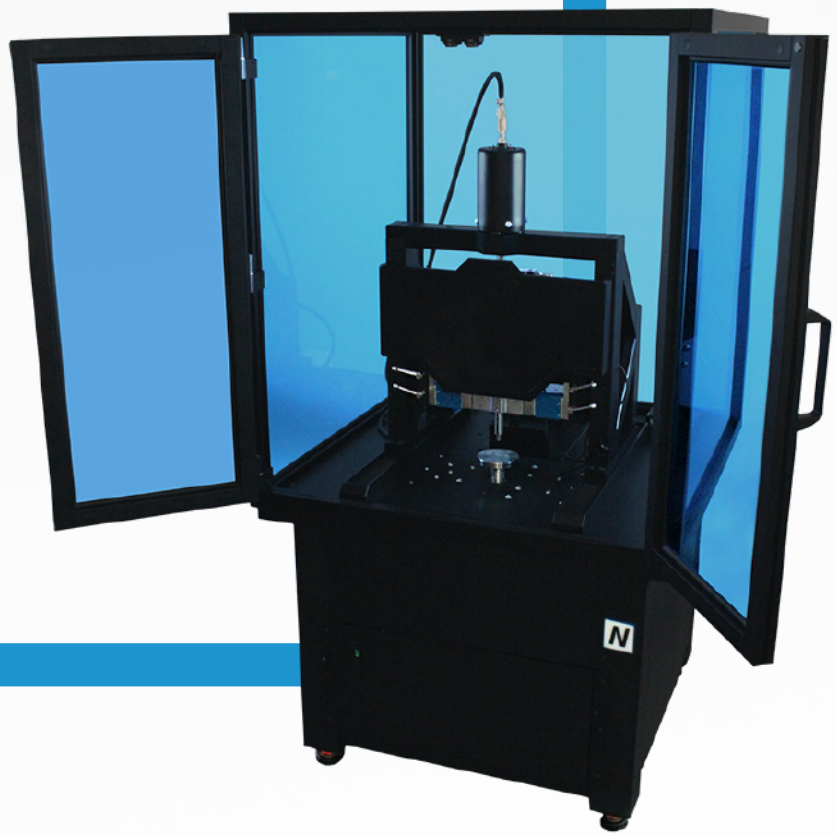
NANOVEA T2000



TEST PROCEDURES

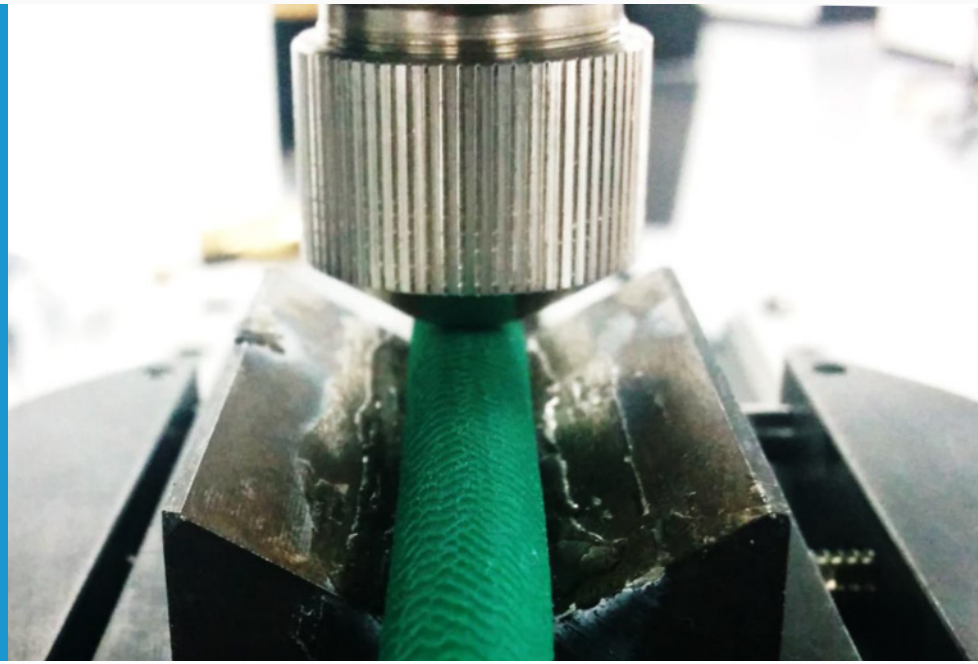
The coefficient of friction, COF, and the wear resistance of two belts with different surface roughness and texture were evaluated by the ***NANOVEA*** High-Load Tribometer using Linear Reciprocating Wear Module. A Steel 440 ball (10 mm diameter) was used as the counter material. The surface roughness and wear track were examined using an integrated 3D Non-Contact profilometer. The wear rate, ***K***, was evaluated using the formula ***K=Vl(Fxs)***, where ***V*** is the worn volume, ***F*** is the normal load and ***s*** is the sliding distance.

Please note that a smooth Steel 440 ball counterpart was used as an example in this study, any solid material with different shapes and surface finish can be applied using custom fixtures to simulate the actual application situation.

TEST PARAMETERS

of the wear measurements.

SAMPLES ..... TEXTURED & SMOOTH BELTS
SAMPLE DIAMETER ..... 8 mm
SAMPLE MATERIAL ..... URETHANE
NORMAL FORCE ..... 10 N & 100 N
AMPLITUDE ..... 25 mm
SPEED ..... 60 cycles/min
DURATION OF TEST ..... 10 min



RESULTS & DISCUSSION

The Textured Belt and Smooth Belt have a surface roughness Ra of 33.5 and 8.7 um, respectively, according to the analyzed surface profiles taken with a ***NANOVEA*** 3D Non-Contact Optical rofiler. The COF and wear rate of the two tested belts were measured at 10 N and 100 N, respectively, to compare the wear behavior of the belts at different loads.

FIGURE 1 shows the evolution of COF of the belts during the wear tests. The belts with different textures exhibit substantially different wear behaviours. It is interesting that after the run-in period during which the COF progressively increases, the Textured Belt reaches a lower COF of ~0.5 in both the tests conducted using loads of 10 N and 100 N. In comparison, the Smooth Belt tested under the load of 10 N exhibits a significantly higher COF of~ 1.4 when the COF gets stable and maintains above this value for the rest of the test. The Smooth Belt tested under the load of 100 N rapidly was worn out by the steel 440 ball and formed a large wear track. The test was therefore stopped at 220 revolutions.

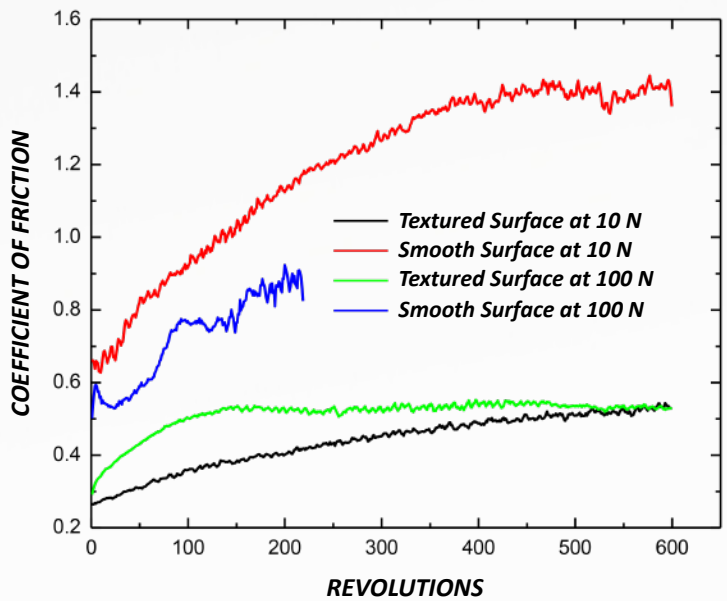


FIGURE 1: ***Evolution of COF of the belts at different loads.***

The Samples

FIGURE 2 compares the 3D wear track images after the tests at 100 N. The ***NANOVEA*** 3D non-contact profilometer offers a tool to analyze the detailed morphology of the wear tracks, providing more insight in fundamental understanding of wear mechanism.

	WEAR SCAR DEPTH	WEAR SCAR VOLUME	WEAR RATE
TEXTURED BELT	1.01 mm	14.0 mm³	0.0047 mm³/Nm
SMOOTH BELT	2.07 mm	75.7 mm³	0.0688 mm³/Nm

TABLE 1: ***Result of wear track analysis.***

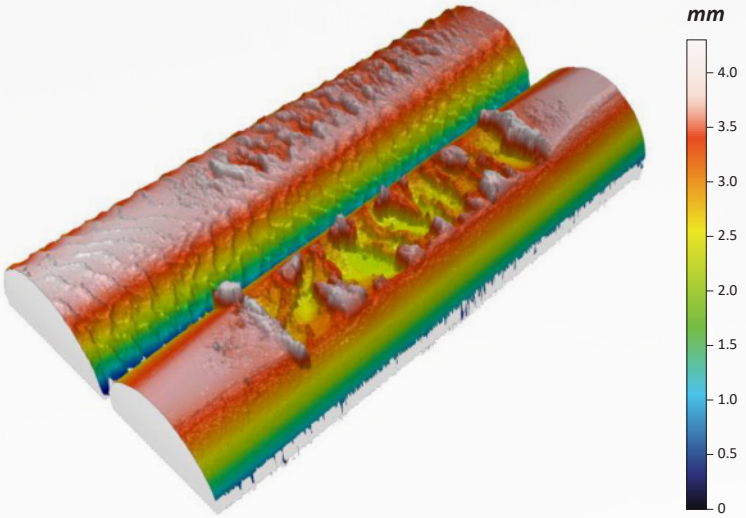


FIGURE 2: ***3D view of the two belts after the tests at 100 N.***

The 3D wear track profile allows direct and accurate determination of the wear track volume calculated by the advanced analysis software as shown in ***TABLE 1***. In a wear test for 220 revolutions, the Smooth Belt has a much larger and deeper wear track with a volume of 75.7 mm³, compared to a wear volume of 14.0 mm³ for the Textured Belt after a 600-revolution wear test. The significantly higher friction of the Smooth Belt against the steel ball leads to a 15 fold higher wear rate compared to the Textured Belt.

Such a drastic difference of COF between the Textured Belt and Smooth Belt is possibly related to the size of the contact area between the belt and the steel ball, which also leads to their different wear performance. ***FIGURE 3*** shows the wear tracks of the two belts under the optical microscope. The wear track examination is in agreement with the observation on COF evolution: The Textured Belt, which maintains a low COF of ~0.5, exhibits no sign of wear after the wear test under a load of 10 N. The Smooth Belt shows a small wear track at 10 N. The wear tests carried out at 100 N create substantially larger wear tracks on both the Textured and Smooth Belts, and the wear rate will be calculated using 3D profiles as will be discussed in the following paragraph.

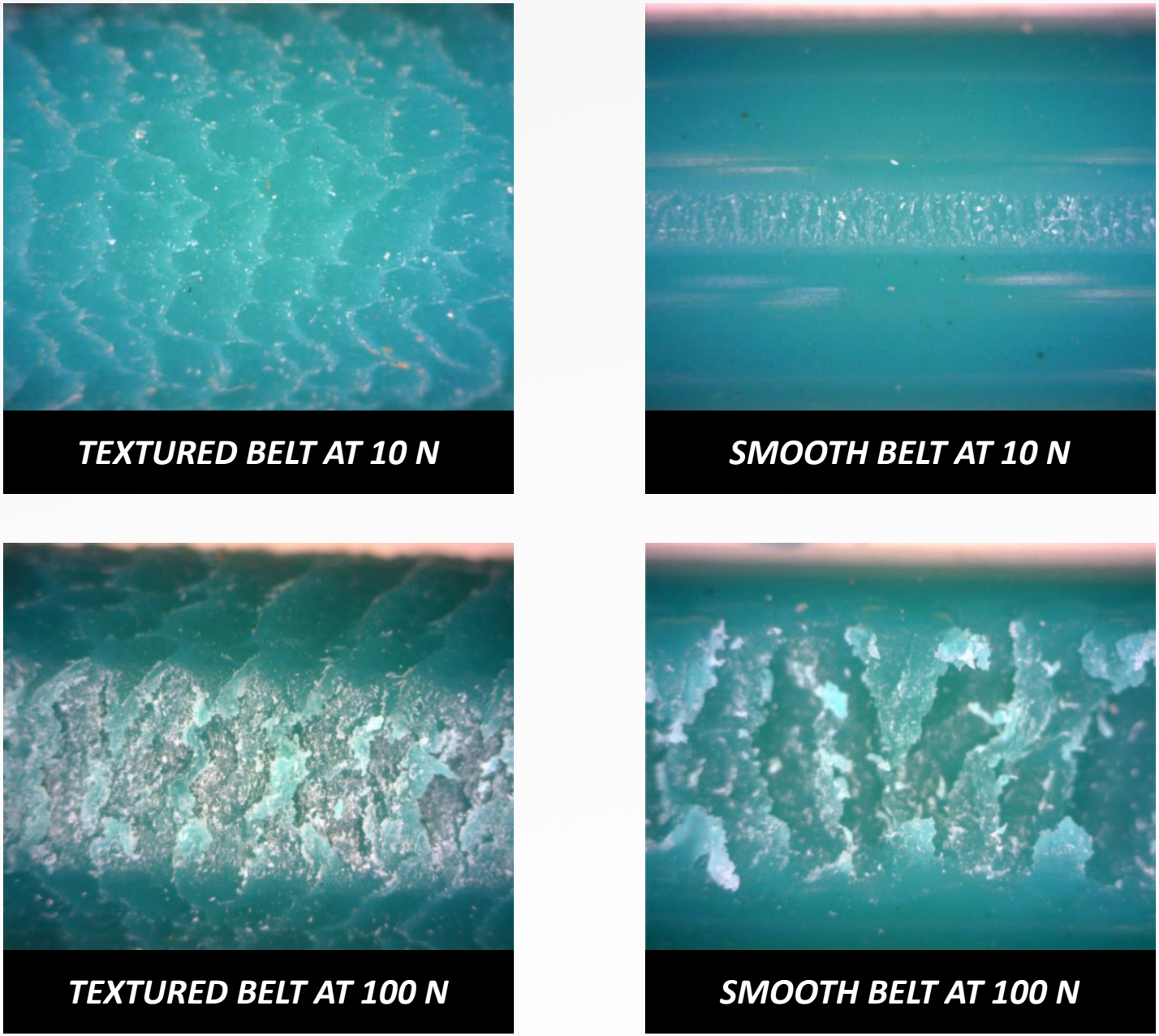


FIGURE 3: ***Wear tracks under optical microscope.***

CONCLUSION

In this study, we showcased the capacity of the ***NANOVEA*** T2000 Tribometer in evaluating the coefficient of friction and wear rate of belts in a well-controlled and quantitative manner. The surface texture plays a critical role in the friction and wear resistance of the belts during their service performance. The textured belt exhibits a stable coefficient of friction of ~0.5 and possesses a long lifetime, which results in reduced time and cost on tool repairing or replacement. In comparison, the excessive friction of the smooth belt against the steel ball rapidly wears the belt. Further, the loading on the belt is a vital factor of its service lifetime. Overload creates very high friction, leading to accelerated wear to the belt.

The ***NANOVEA*** T2000 Tribometer offers precise and repeatable wear and friction testing using ISO and ASTM compliant rotative and linear modes, with optional high temperature wear, lubrication and tribocorrosion modules available in one pre-integrated system. Nanovea's unmatched range is an ideal solution for determining the full range of tribological properties of thin or thick, soft or hard coatings, films and substrates.