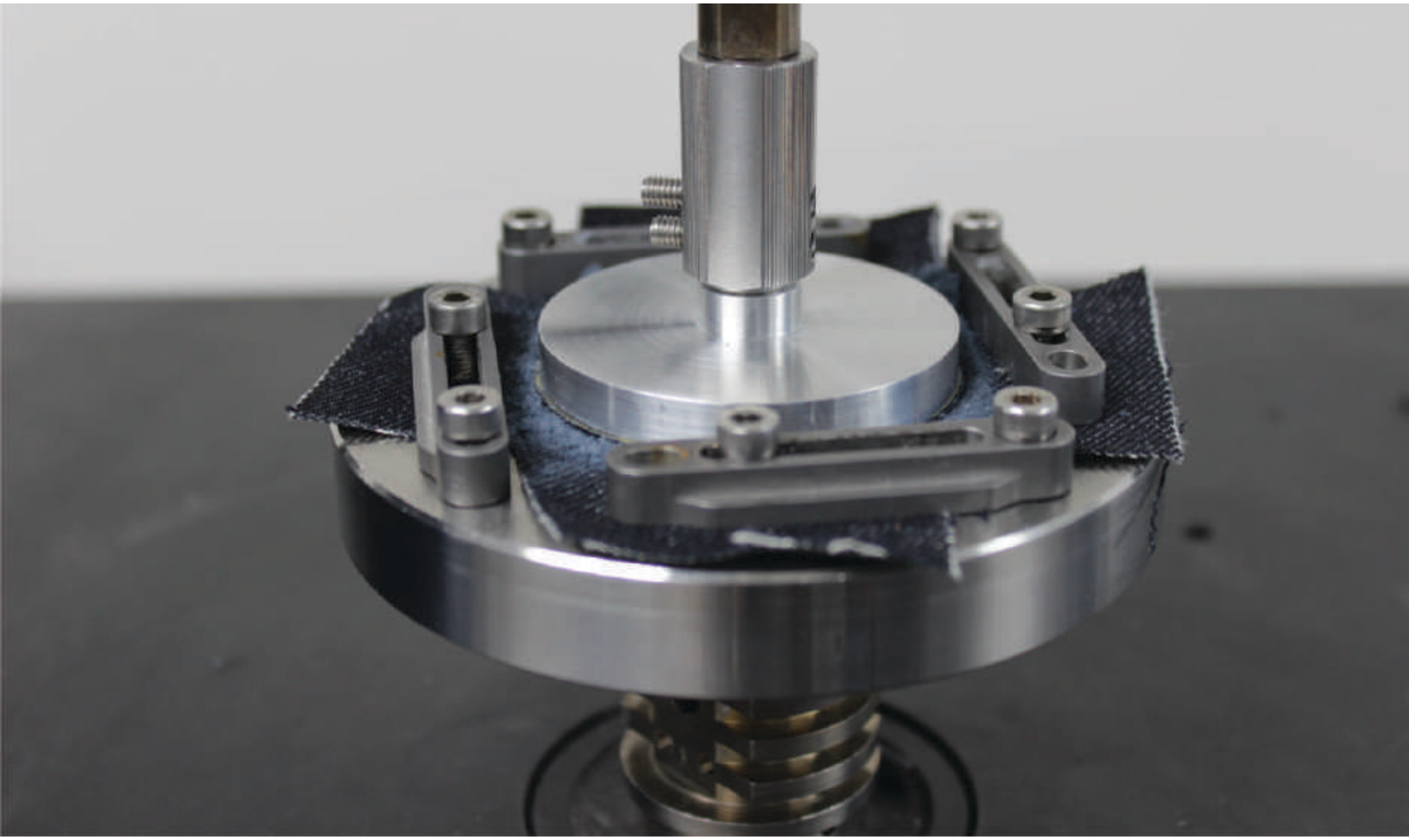
NANOVEA
A Better Measure

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

COMPARING ABRASION WEAR ON DENIM



Prepared by

Xavier Herrera-Keehn and Jocelyn Esparza

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

Introduction

The form and function of a fabric is determined by its quality and durability. Daily usage of fabrics cause wear and tear on the material, e.g. piling, fuzzing, and discoloration. Subpar fabric quality used for clothing can often lead to consumer dissatisfaction and brand damage.

Attempting to quantify the mechanical properties of fabrics can pose many challenges. The yarn structure and even the factory in which it was produced can result in poor reproducibility of test results. Making it difficult to compare test results from different laboratories. Measuring the wear performance of fabrics is critical to the manufacturers, distributors, and retailers in the textile production chain. A well-controlled and reproducible wear resistance measurement is crucial to ensure reliable quality control of the fabric.

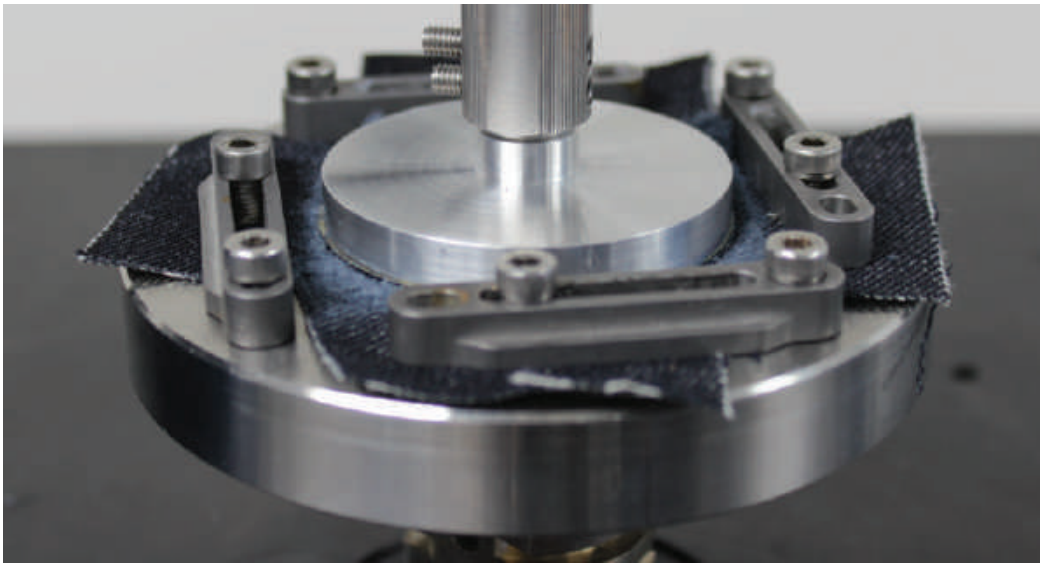
Importance of Wear Analysis on Denim

Denim can be found in an almost infinite number of configurations, from the many different washes to the way the fabric is woven. This study will be focused on the two most common denim samples: non-selvedge raw and washed.

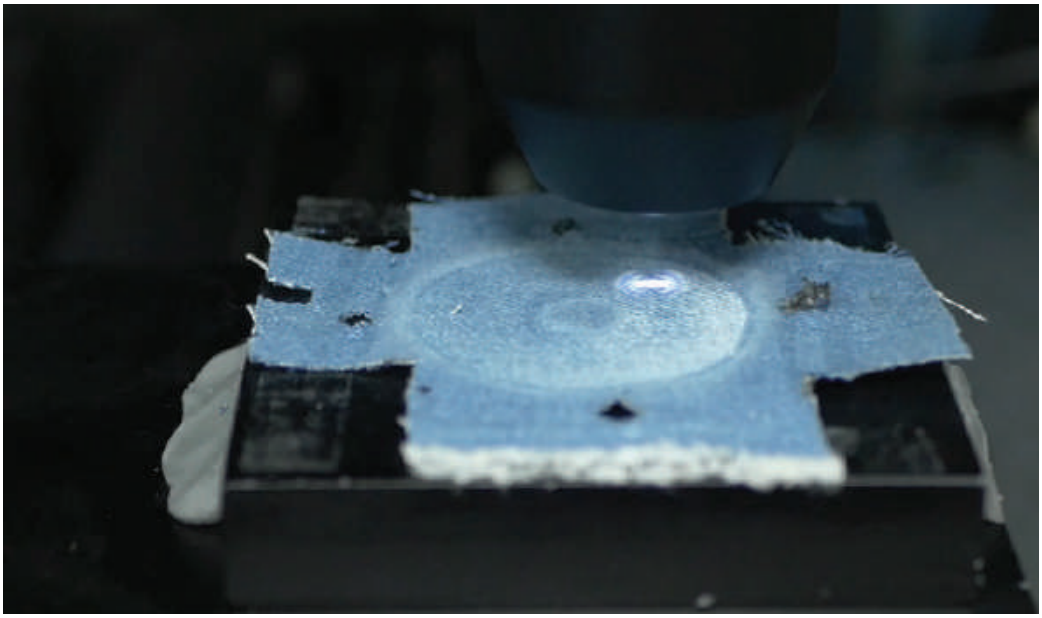
Washed denim has undergone a process to create a worn appearance to the garment and reduces the possibility of shrinking. By doing this, the fabric becomes much softer. Raw denim apparel on the other hand has not undergone this process and is much more rigid when compared to its washed counterpart. This leads to different wear abrasions between the two denim types when tested under the same measurement conditions. Quantifying this difference can be critical to textile manufacturers and apparel companies trying to create high quality garments.

Measurement Objectives

The abrasion wear process of two denim samples, raw and washed 10oz indigo denim, is simulated in a controlled and monitored manner using the Nanovea T50 Tribometer. In conjunction with the Nanovea T50 Tribometer, the wear evolution will be evaluated using the Nanovea HS2000 Line Sensor to quantify the wear abrasions.



Sample tested on T50



Sample analyzed on HS2000

Measurement Parameters

A pin with 120 grit sand paper was applied to the surface of the denim while a known load was applied on the pin. The evolution of the wear is recorded with the Nanovea HS2000 Line Sensor and microscope images taken with a Dino-Lite microscope. A more detailed summary of the test parameters can be found below.

Instrument	T50
Normal Force (N)	5
Rotative Speed (RPM)	100
Duration of Test	3000 cycles

Table 1: Test parameters

Figure 1 : Raw denim sample (left) and washed denim (right)

Results and Discussion | Wear

In this study, an abrasion wear test was conducted on each denim sample . A total of 3000 circular wear cycles were performed in intervals over the same area. Wear track images were taken after 200 cycles, 1000 cycles and 3000 cycles on the raw and washed denim samples in order to visually monitor and compare their evolution of wear.

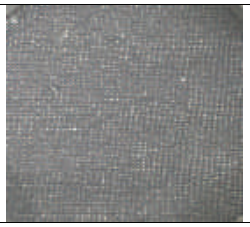
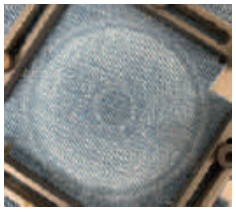
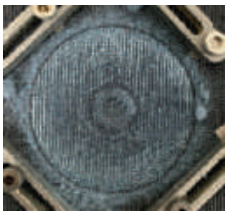
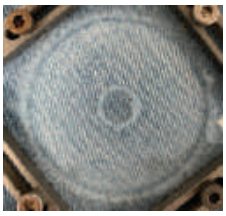
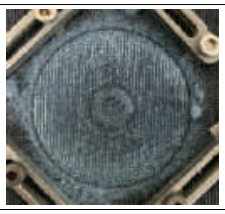
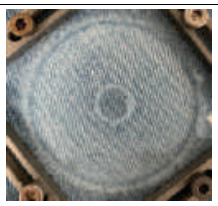
Cycle	Raw Denim	Washed Denim
0		
200		
1000		
3000		

Table 2: Images of denim samples after 0, 200, 1,000, and 3,000 wear cycles

Table 2 shows the microscope images after each cycle interval for both samples. It is interesting to note that throughout the course of the tests, the washed sample underwent fewer visual changes in wear than the raw denim between cycle intervals. This is also observed when comparing the material build up on both samples between wear cycles. The washed denim sample accumulates less material build up than the raw denim. This could be due to the more rigid nature of the raw denim weave which does not allow for malleability of the fibers but allows it to retain its' original structure best. This concept is well illustrated by **Figures 5**, the false color view of the raw denim sample taken with the Nanovea HS2000 Line Sensor before and after wear. We can see that the raw denim's initial pattern (in **Figure 5**) is of 'higher quality' in comparison to its' washed counterpart (in **Figure 4**) where the fibers have been loosened from the weave due to the washing process. It can be assumed that due to the washing process, the weave of the denim becomes more malleable (softer) as well and the material will visually wear less as a result in comparison to the raw denim.

Microscope images of the surface can be found in **Figures 2** and **3**. The two circled areas in each figure compare the unworn region versus the worn region of each sample. The worn regions (yellow) showing significant discoloration of the surface threads which is not noticeable in the neighboring unworn regions (red) for both samples.

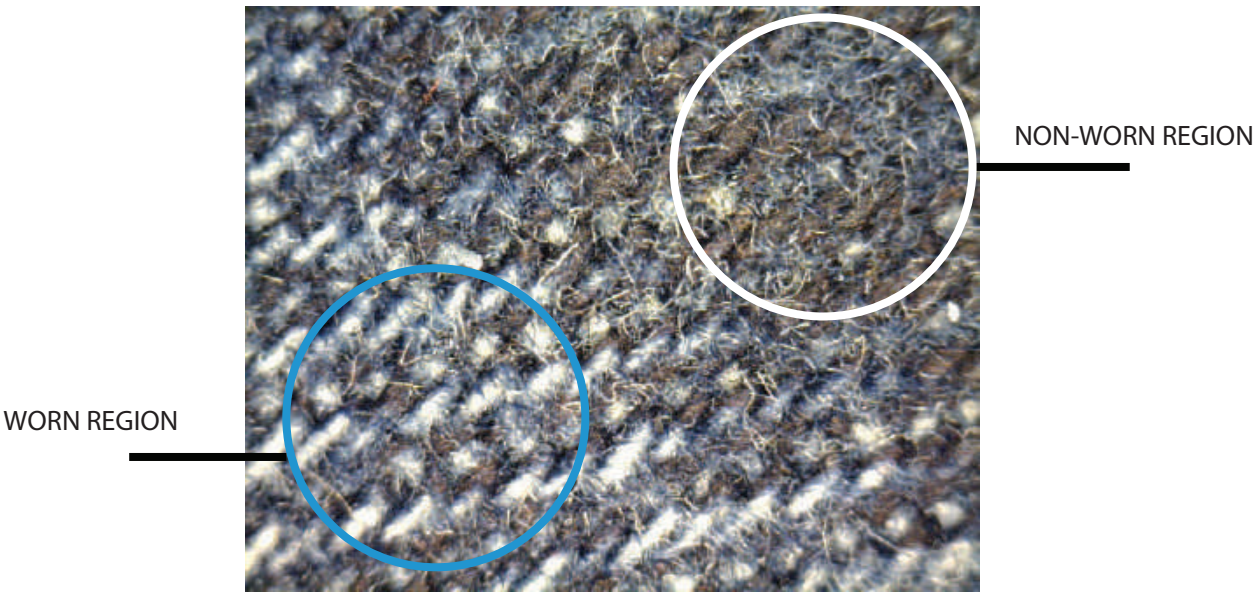


Figure 2: Microscope image of the raw denim sample after 3000 cycles

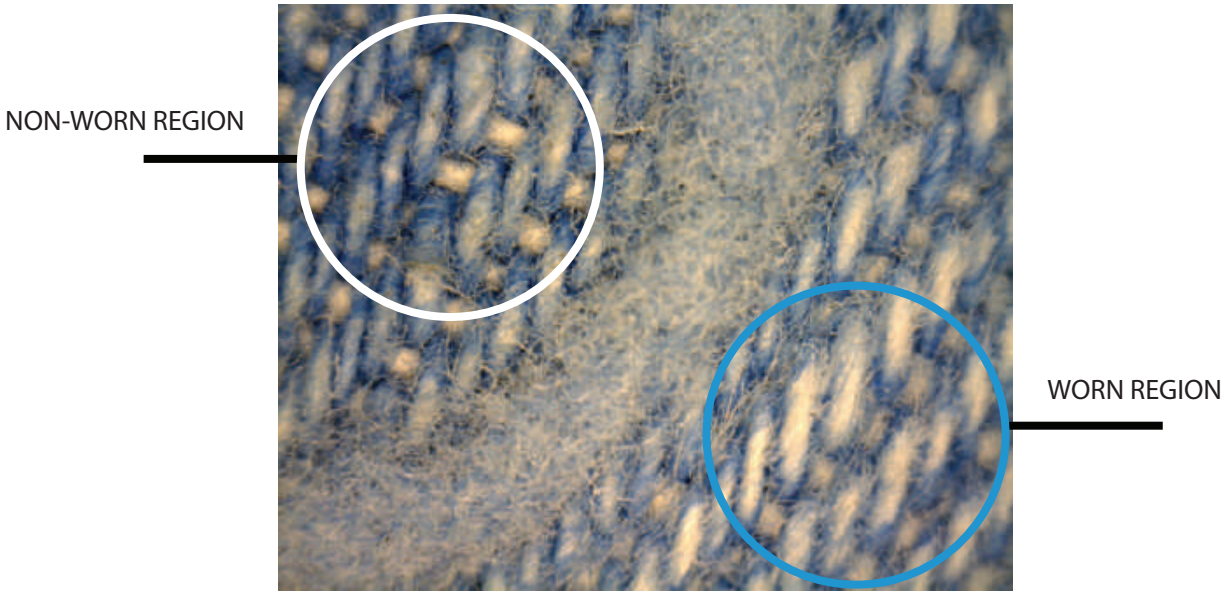


Figure 3: Microscope image of the washed denim sample after 3000 cycles

Results and Discussion | Surface Roughness

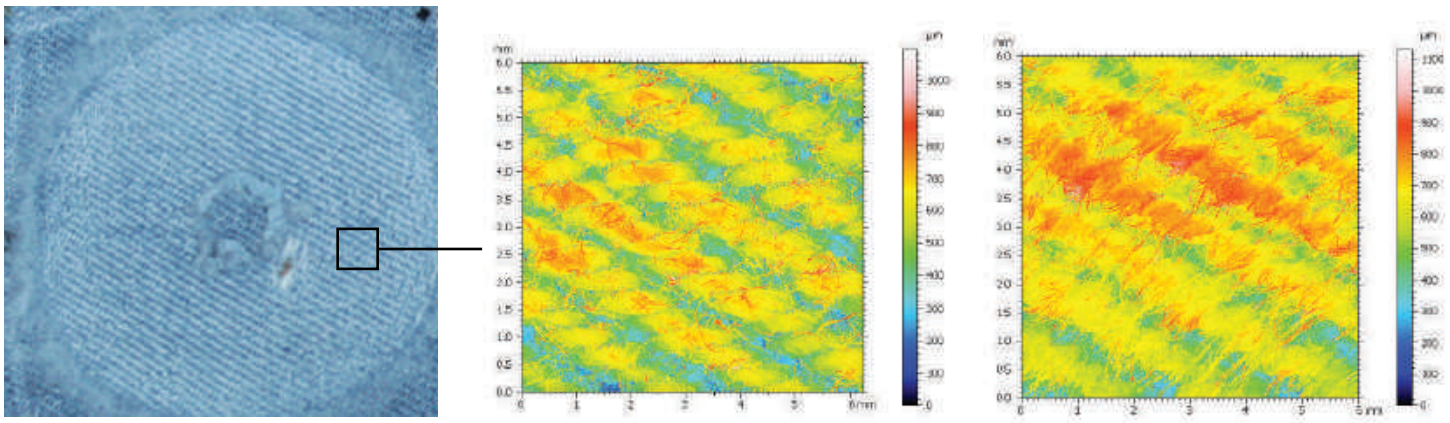


Figure 4: False color views of the before (left) and after (right) the abrasion test for the washed denim sample

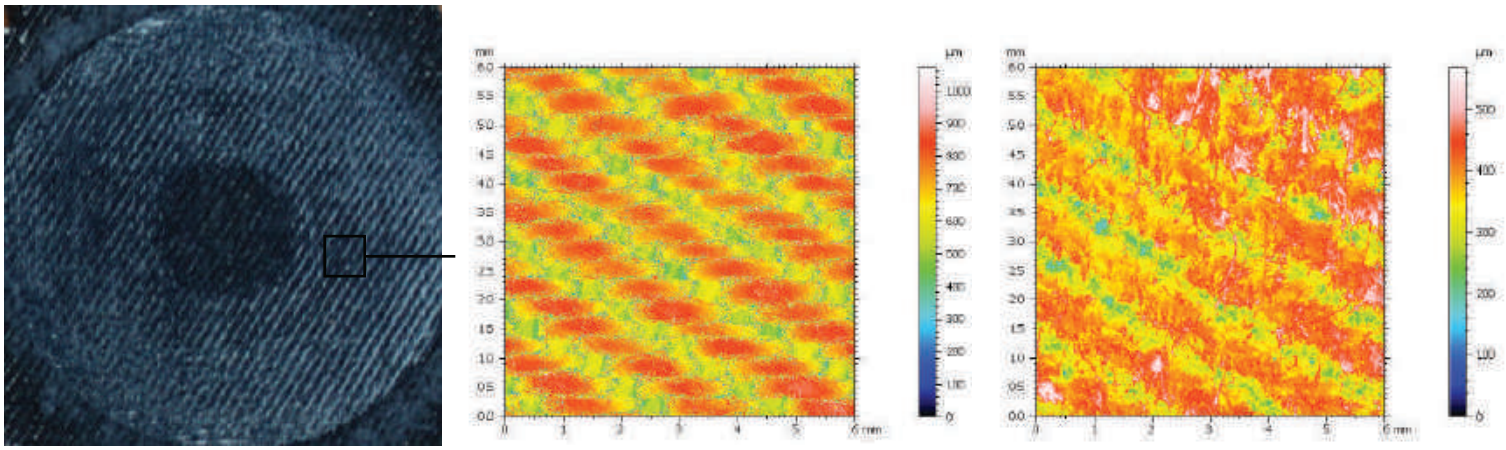
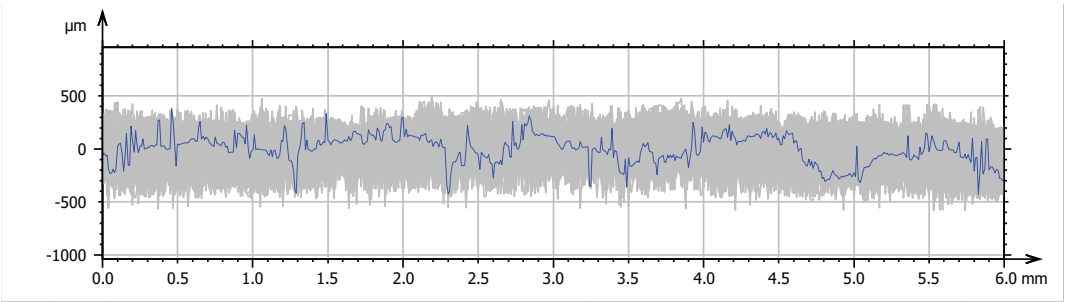


Figure 5: False color views of the before (left) and after (right) the abrasion testing for the raw denim sample

Results and Discussion | Surface Roughness

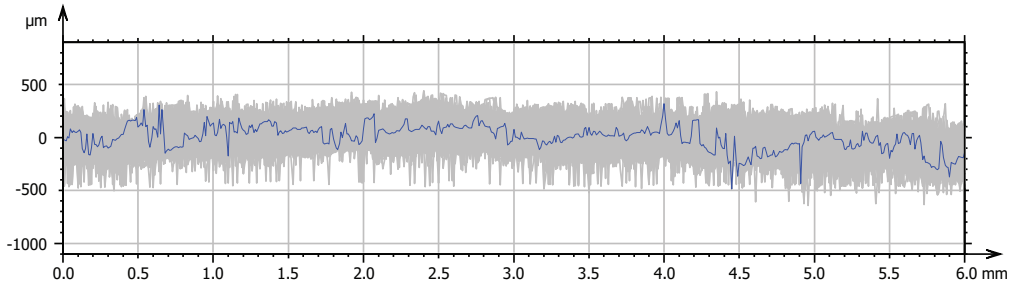
The surface profile studies in **Figures 6-9** below support a quantifiable approach for determining the difference in wear between the two samples. The R and P values are calculated for the series of profiles that make up the area scans depicted in **Figures 4** and **5**.

As the denim samples continually wear, their Rc, Rt & Pc, Pt values decreased due to the pre-existing surface roughness becoming 'polished' by the abrasive as the wear test progressed. When the R & P values in **Figures 6** and **7** were compared, a small but noticeable difference in surface roughness was found between the pre-wear and post-wear washed denim scans, indicating that the surface underwent minimal wear. Comparing the respective values of the raw denim sample in **Figures 8** and **9** depict a much more dramatic change in surface roughness. Further aiding the conclusion that the raw denim sample wore much more than its' washed counterpart.



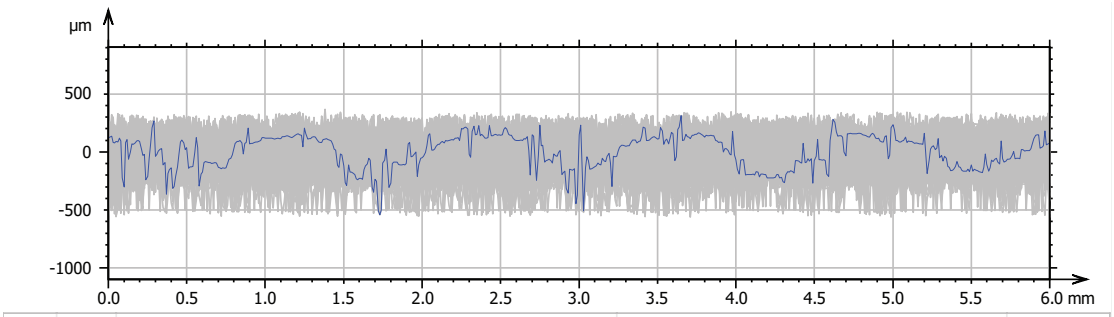
		Context	Description	Mean
ISO 4287				
Amplitude parameters - Roughness profile				
Rc	**µm**	*Gaussian filter, 0.25 mm, ISO 4287 w/o amendment 2*	*Mean height of the roughness profile elements.*	**153.641**
Rt	**µm**	*Gaussian filter, 0.25 mm*	*Total height of roughness profile.*	**553.784**
Amplitude parameters - Primary profile				
Pc	**µm**	*ISO 4287 w/o amendment 2*	*Mean height of the raw profile elements.*	**273.187**
Pt	**µm**		*Total height of raw profile.*	**738.774**

Figure 6: Series of profiles and height parameters for pre tested washed denim



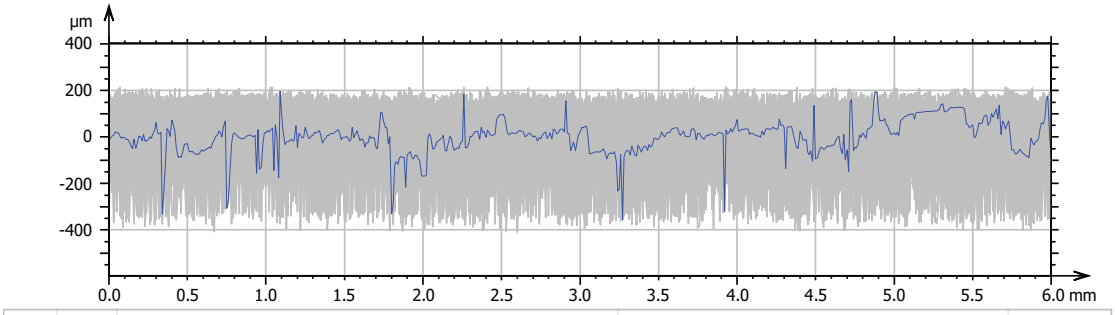
		Context	Description	Mean
ISO 4287				
Amplitude parameters - Roughness profile				
Rc	**µm**	*Gaussian filter, 0.25 mm, ISO 4287 w/o amendment 2*	*Mean height of the roughness profile elements.*	**134.177**
Rt	**µm**	*Gaussian filter, 0.25 mm*	*Total height of roughness profile.*	**505.080**
Amplitude parameters - Primary profile				
Pc	**µm**	*ISO 4287 w/o amendment 2*	*Mean height of the raw profile elements.*	**231.772**
Pt	**µm**		*Total height of raw profile.*	**678.395**

Figure 7: Series of profiles and height parameters for post tested washed denim



		Context	Description	Mean
ISO 4287				
Amplitude parameters - Roughness profile				
Rc	**µm**	*Gaussian filter, 0.25 mm, ISO 4287 w/o amendment 2*	*Mean height of the roughness profile elements.*	**164.042**
Rt	**µm**	*Gaussian filter, 0.25 mm*	*Total height of roughness profile.*	**555.214**
Amplitude parameters - Primary profile				
Pc	**µm**	*ISO 4287 w/o amendment 2*	*Mean height of the raw profile elements.*	**299.669**
Pt	**µm**		*Total height of raw profile.*	**704.802**

Figure 8: Series of profiles and height parameters for pre tested raw denim



		Context	Description	Mean
ISO 4287				
Amplitude parameters - Roughness profile				
Rc	**µm**	*Gaussian filter, 0.25 mm, ISO 4287 w/o amendment 2*	*Mean height of the roughness profile elements.*	**113.077**
Rt	**µm**	*Gaussian filter, 0.25 mm*	*Total height of roughness profile.*	**483.588**
Amplitude parameters - Primary profile				
Pc	**µm**	*ISO 4287 w/o amendment 2*	*Mean height of the raw profile elements.*	**179.223**
Pt	**µm**		*Total height of raw profile.*	**499.509**

Figure 9: Series of profiles and height parameters for post tested raw denim

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

Conclusion

In this study we showcase the capability of the Nanovea T50 Tribometer and the Nanovea HS2000 Line Sensor by measuring the abrasion resistance of two denim samples. Based on the tribological and profilometry analysis on the raw and washed denims tested in this study, we show that the raw denim exhibits a higher wear rate when compared to the washed denim sample.

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!

NANOVEA

A Better Measure

www.nanovea.com

info@nanovea.com
euroinfo@nanovea.com
mexinfo@nanovea.com

+1 (949) 461-9292

T50
Tribometer

Versatile Wear & Friction Tester

Multi-Module System

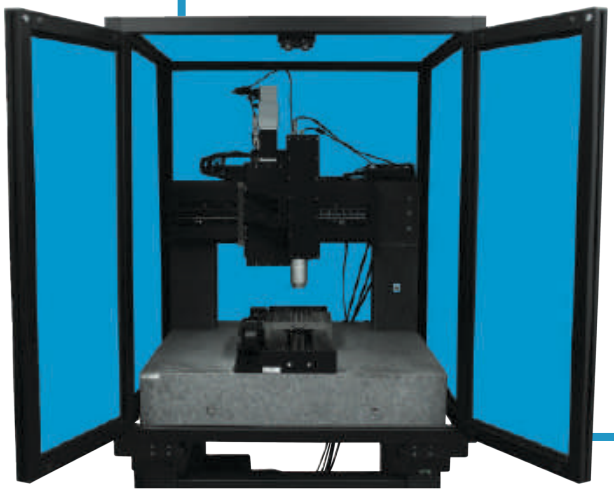
Speed Control from 0.01-5000 RPM

Robust with Open Platform

Wide Range of Environmental Conditions

Learn More about the T50

HS2000
Profiler



High Speed Inspection & Precision Flatness Measurement

Advanced Automation with customizable options

High Speeds up to 384,000 points per second

Designed for large area flatness measurement

Full granite base with integrated anti-vibration table

Learn More about the HS2000

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

Thank you for reading!

We appreciate your interest in our technology and services. Read more about all of our product line and lab services at www.nanovea.com

Call to Schedule a demo today!

If you have any questions please email us at info@nanovea.com

Recommended Reading

Check out our other application note where we conduct a Viscoelastic Analysis on Rubber with Nanoindentation

https://nanovea.com/viscoelastic-analysis-of-rubber/