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TRIBOLOGY STUDY OF DENTAL DOG TREATS

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INTRO

Oral and dental hygiene is an often-overlooked but vital factor in the dog's overall health. Proper dental cleaning ensures clean teeth, freshened breath and prevention of plaque and tartar. A variety of measures have been applied to clean dog's teeth, such as routine brushings, food selection, dental treats and oral rinse aids. There are several factors to consider in order to find the right products, including the dog size, temperament, tooth health condition, etc.

IMPORTANCE OF FRICTION EVALUATION FOR DOG DENTAL TREAT

Flavored dental treats have been demonstrated as an effective, comfortable and easy to use method for dog dental cleaning. The Flavorful and chewy dental treats make teeth and gums cleaning an enjoyable procedure. During the chewing mechanical actions, the dental treat creates friction against the surface of the teeth to remove tartar and bacteria films. A reliable friction measurement is needed to quantitatively compare the effectiveness of dog dental treats of different surface texture and roughness, and to provide insight of the correlation of the surface roughness, texture and friction to facilitate the R&D and quality control of the dental treat production.

MEASUREMENT OBJECTIVE

In this study, we compared the frictional behaviors of dog dental treats with different surface texture and roughness to showcase the capacity of Nanovea Tribometer in providing quantitative friction measurement in a controlled and monitored manner.

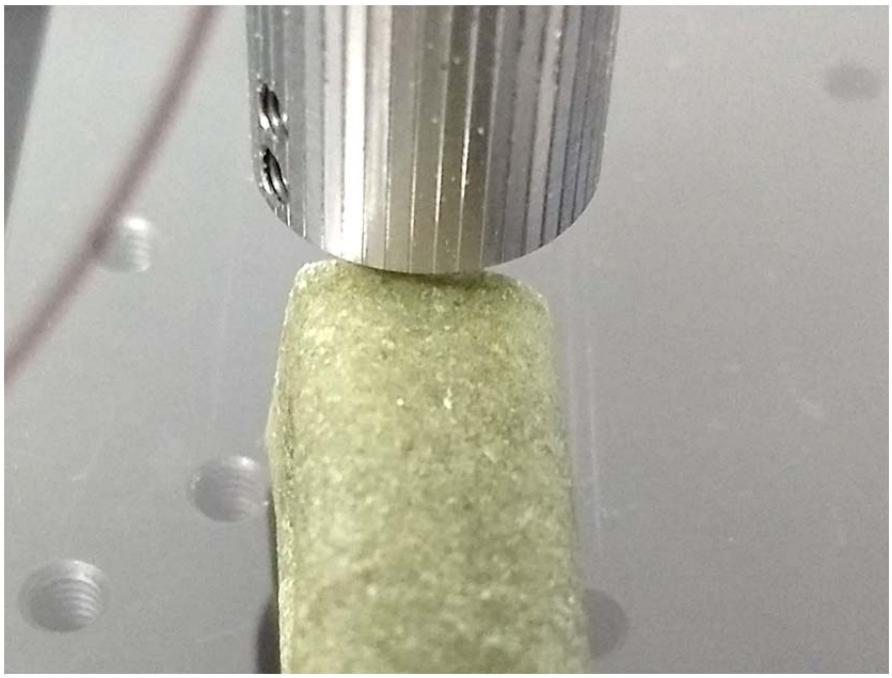


Fig. 1: Setup of the friction measurement.

TEST PROCEDURE

The coefficient of friction, COF of two dog dental chews samples made by different processes were evaluated by Nanovea Tribometer using Linear Reciprocating Wear Module. A Steel 440 ball (6 mm diameter) was used as the counter material. The surface roughness of the samples was examined using Nanovea 3D non-contact profilometer. The test parameters are summarized in Table 1.

Please note that a smooth Steel 440 ball as a counter material was used as an example in this study, any solid material with different shapes and surface finish can be applied using custom fixture to simulate the actual application situation. Such tests can also be performed in the liquid environment to simulate the presence of slaver during the chewing process.

Load	**1 N**
Duration of test	**20 min**
Speed rate	**100 cycles/min**
Length	**5 mm**
Number of cycles	**2000**
Ball Diameter	**6 mm**
Ball Material	**SS440**
Atmosphere	**Air**
Temperature	**24°C (room)**
Humidity	**40%**

Table 1: Test parameters of the measurements.

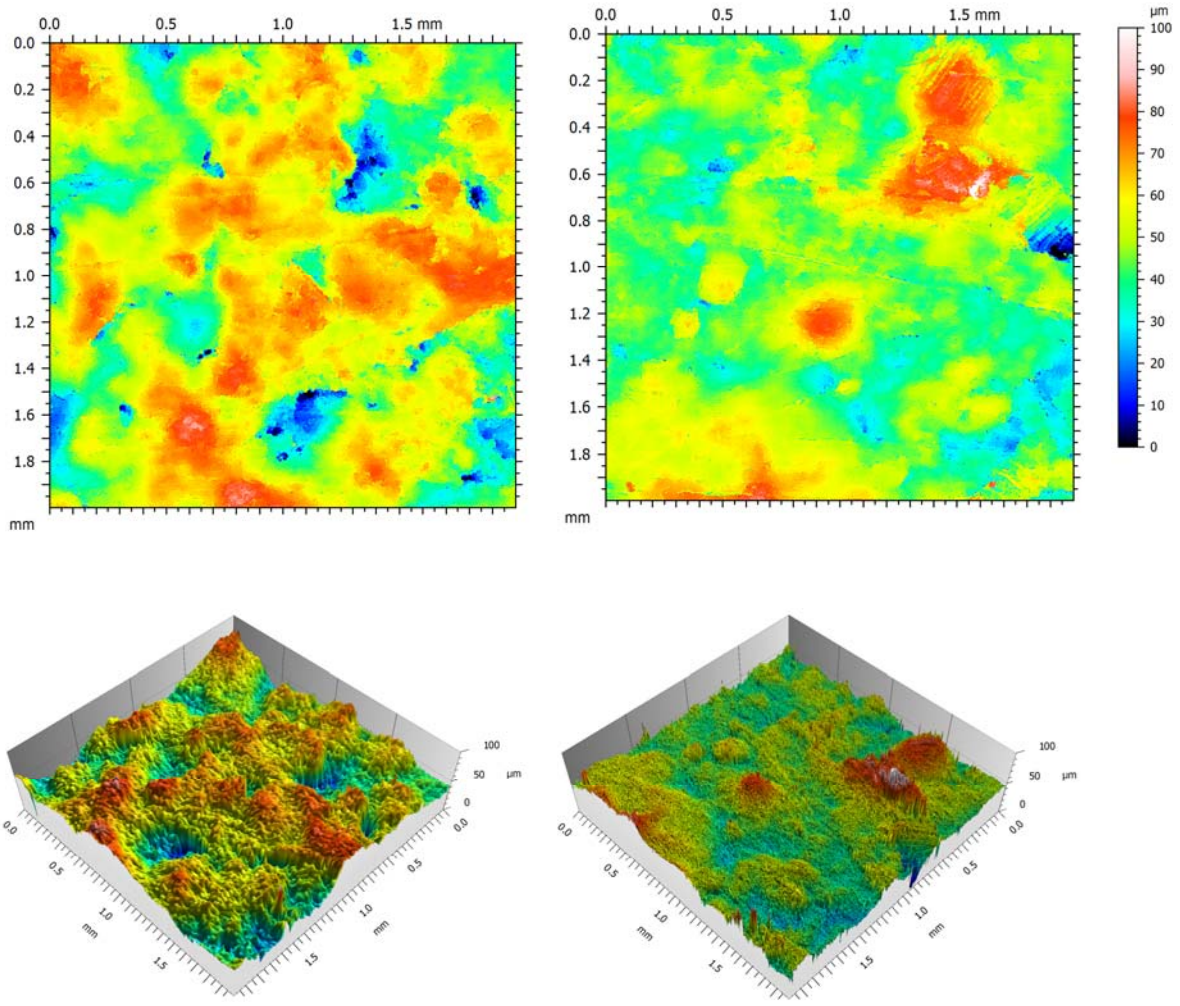
RESULTS AND DISCUSSION

The 3D view, false color view and roughness analysis of the two dog dental treat samples are compared in Fig. 2. The 3D View images provide users a straightforward tool to directly observe the morphology of the surface from different angles. The 2D profiles in Fig. 3 extracted from the 3D topography image provide more information of the peak and valley features of the samples.

Sample 1 shows a rougher surface of a Sa value of 11.1 µm, compared to 8.33 µm for Sample 2, according to the surface topography analysis by Nanovea 3D non-contact profilometer. The rough surface may increase the surface area in contact with the slaver during the chewing process, accelerate the release of the flavor and improve digestibility of the treats.

Sample 1:

Sample 2:



ISO 25178		
Height Parameters		
Sq	13.7	µm
Ssk	-0.567	
Sku	3.18	
Sp	35.9	µm
Sv	53.5	µm
Sz	89.5	µm
Sa	11.1	µm

ISO 25178		
Height Parameters		
Sq	11.1	µm
Ssk	0.622	
Sku	4.48	
Sp	57.0	µm
Sv	47.3	µm
Sz	104	µm
Sa	8.33	µm

Fig. 2: False color view, 3D view and surface roughness of the dog dental chews samples.

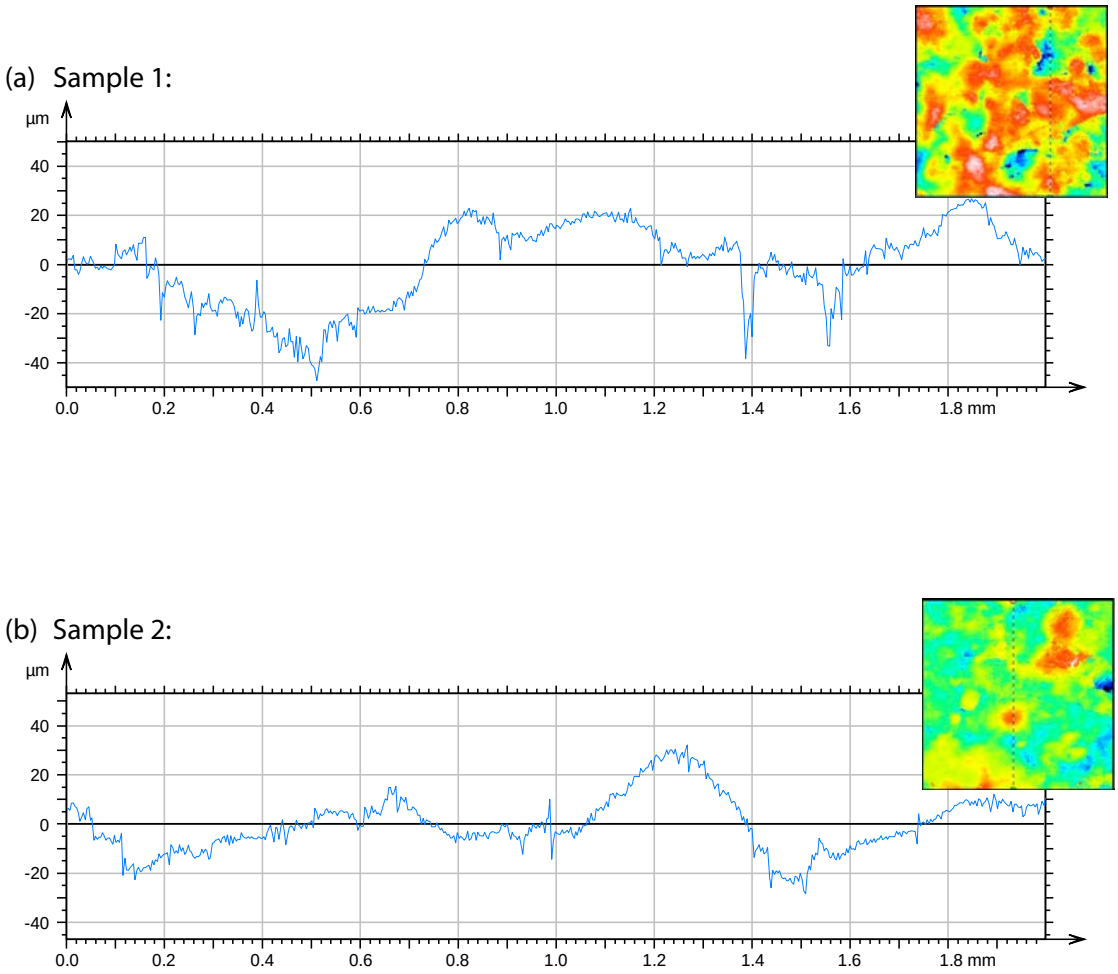


Fig. 3: 2D profiles of the sample surface.

Fig. 4 compares the evolution of the coefficient of friction, COF of the samples during the reciprocating wear measurement. The linear reciprocating wear test setup is used here to simulate the back-and-forth chewing motion at the contact of the teeth against the dental treats. Sample 1 exhibits a higher friction throughout the test, resulting an average COF of ~0.182, compared to a COF of ~0.081 for Sample 2. Such a difference in the COF of the two samples may lead to their different dental cleaning performance. The higher friction of Sample 1 provides better friction to effectively remove tartar and bacteria films on the teeth and gums during the chewing process.

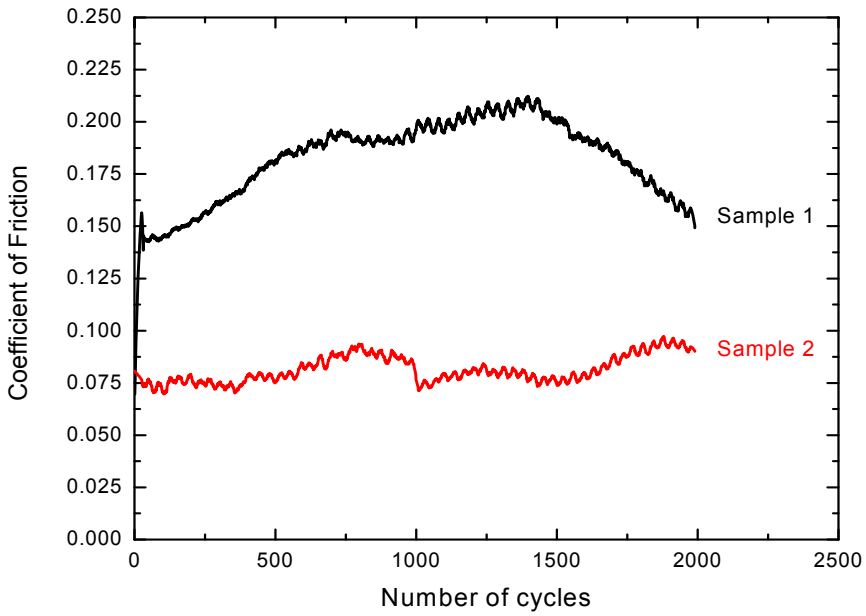


Fig. 4: Evolution of COF of the samples during the test.

CONCLUSION

In this study, we showcased the capacity of Nanovea Profiler and Tribometer in evaluating the surface roughness and coefficient of friction of the dog dental chews samples in a well-controlled and quantitative manner. The surface texture plays a critical role in the friction of the chews against the dog teeth, providing sufficient frictional force to remove tartar and bacteria films on the tooth surface. Oral hygiene is an often-overlooked but important factor in the dog's overall health. A better understanding of the surface texture and friction during the chewing mechanical actions enables R&D of high-quality dental dog treats.

Nanovea 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 tribo-corrosion 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.

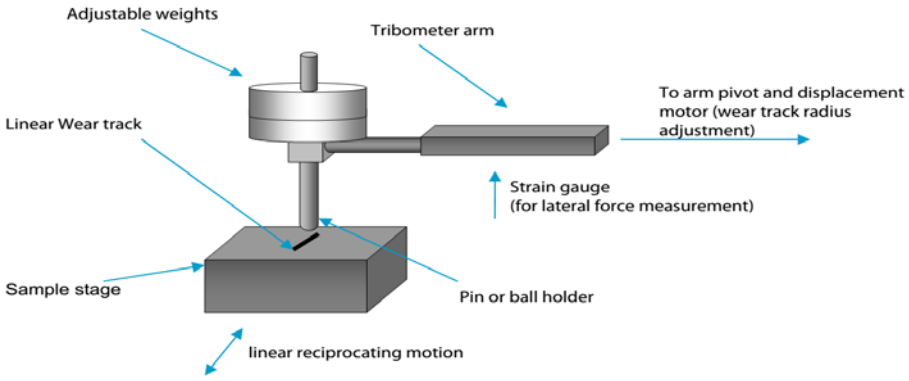
Learn More about the Nanovea Tribometer, Nanovea Profilometer and Lab Service

APPENDIX: MEASUREMENT PRINCIPLE

RECIPROCATING WEAR PRINCIPLE

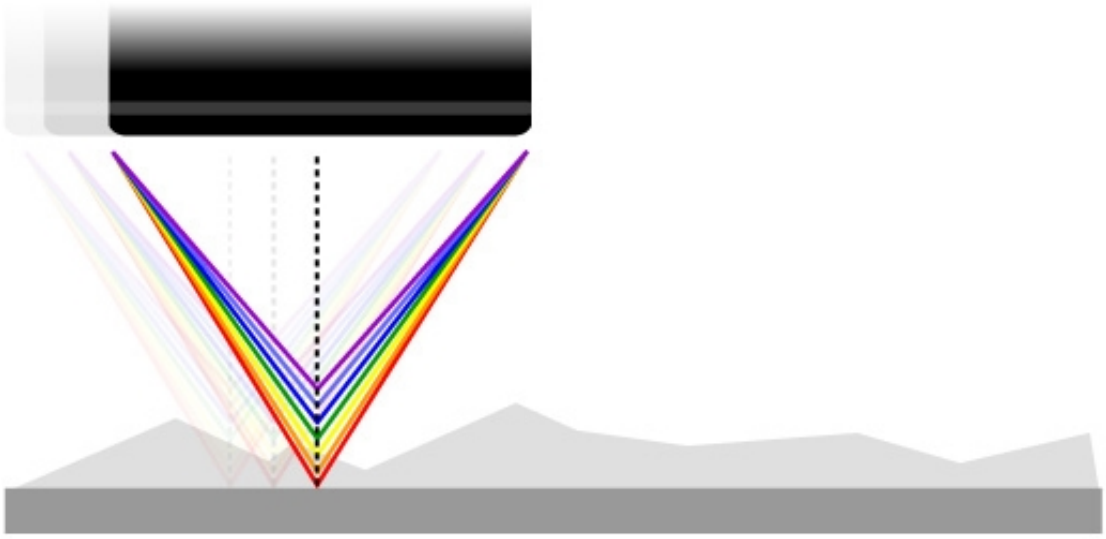
A flat or a sphere shaped indenter is loaded on the test sample with a precisely known force. The indenter (a pin or a ball) is mounted on a stiff lever, designed as a frictionless force transducer. As the plate slides in a linear reciprocating motion, the resulting frictional forces

between the pin and the plate are measured using a strain gage sensor on the arm. Wear rate values for both the pin and sample may also be 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.



3D NON-CONTACT PROFILOMETER PRINCIPLE

The axial chromatism technique uses a white light source, where light passes through an objective lens with a high degree of chromatic aberration. The refractive index of the objective lens will vary in relation to the wavelength of the light. In effect, each separate wavelength of the incident white light will re-focus at a different distance from the lens (different height). When the measured sample is within the range of possible heights, a single monochromatic point will be focalized to form the image. Due to the confocal configuration of the system, only the focused wavelength will pass through the spatial filter with high efficiency, thus causing all other wavelengths to be out of focus. The spectral analysis is done using a diffraction grating. This technique deviates each wavelength at a different position, intercepting a line of CCD, which in turn indicates the position of the maximum intensity and allows direct correspondence to the Z height position.



Unlike the errors caused by probe contact or the manipulative Interferometry technique, White light Axial Chromatism technology measures height directly from the detection of the wavelength that hits the surface of the sample in focus. It is a direct measurement with no mathematical software manipulation. This provides unmatched accuracy on the surface measured because a data point is either measured accurately without software interpretation or not at all. The software completes the unmeasured point but the user is fully aware of it and can have confidence that there are no hidden artifacts created by software guessing. Nanovea optical pens have zero influence from sample reflectivity or absorption. Variations require no sample preparation and have advanced ability to measure high surface angles. Capable of large Z measurement ranges. Measure any material: transparent/opaque, specular/diffusive or polished/rough.