SELF-CLEANING GLASS COATING
FRICTION MEASUREMENT

Prepared by

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INTRO

Self-cleaning glass coating possesses a low surface energy that repels both water and oils. Such a coating creates an easy-clean and non-stick glass surface that protects it against grime, dirt and staining. The easy-clean coating substantially cuts the water and energy usage on glass cleaning. It does not require harsh and toxic chemical detergents, making it an eco-friendly choice for a wide variety of residential and commercial applications, such as mirrors, shower glasses, windows and windshields.

IMPORTANCE OF FRICTION FOR SELF-CLEANING GLASS COATING

Self-cleaning glass relies on the low surface energy coating to avoid dirt and mineral buildup. The hydrophobic surface creates a very high static water contact angle and low roll-off angle. The water and oil based dirt is therefore carried away by the rolling water droplets formed on the coating surface. There is a correlation between surface energy and coefficient of friction (COF): higher surface energy (greater wettability) usually leads to higher COF. A reliable and quantitative measurement of the COF allows one to compare the surface energy of the self-cleaning glass and investigate the solid–liquid interactions at the contact surface under different conditions.

MEASUREMENT OBJECTIVE

In this study, we measure the friction between the self-cleaning glass coating and the stylus with dry and wet contact under different loads using Nanovea Mechanical Tester.

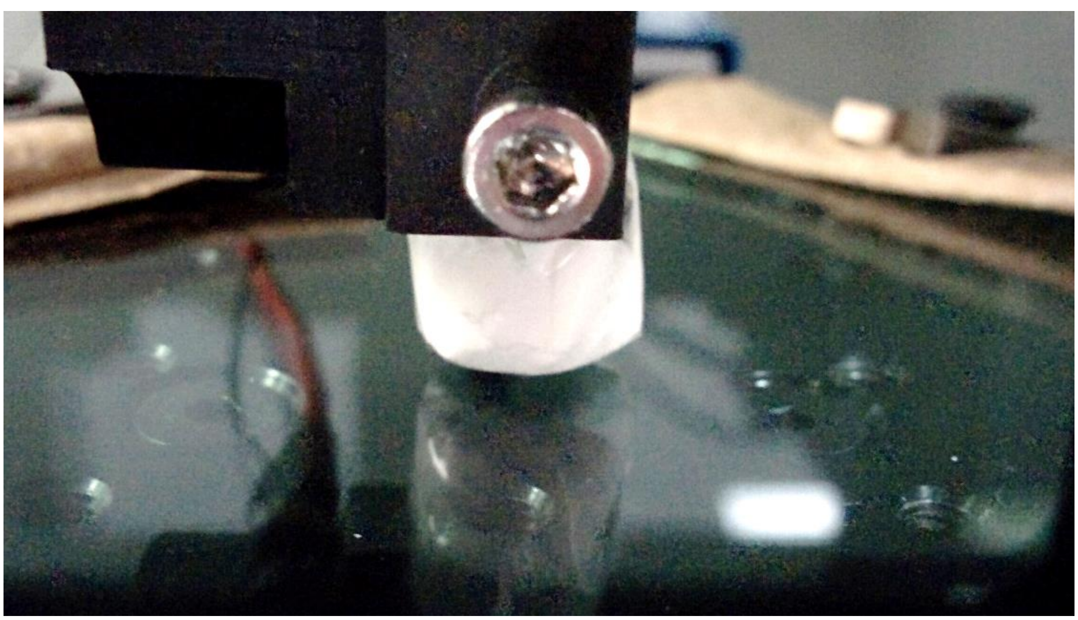

Fig. 1: Friction test setup.

TEST PROCEDURE

The self-cleaning glass coating was professionally coated on a tempered glass sheet sample. The coefficient of friction, COF, of the self-cleaning glass against a flat steel stylus (6 mm diameter) covered by a Kimwipe was measured using the Micro Module of the Nanovea Mechanical Tester. The stylus had been soaked in water to create a wet contact. The stylus applied a constant load on the glass sample and slid at a constant speed of 30 mm/min. The total sliding distance is 30 mm. The COF was also measured with a dry contact condition for comparison. The test parameters are summarized in Table 1.

Please note that the counter material in this study was used as an example, any solid material with different shapes can be applied using custom fixture to simulate the actual situation.

Sample	Coated Self-cleaning Glass, Uncoated Glass
Normal force (N)	1, 2, 3, 4, 5
Speed (mm/min)	30
Duration of test (min)	1

Table 1: Test parameters of the friction measurement.

RESULTS AND DISCUSSION

The COF of the Coated and Uncoated glass samples against the stylus with a dry and a wet contact are plotted in Fig. 2. The average COF at different loads is compared in Fig. 3. The Coated sample exhibits slightly decreased COF as the load increases from 1 to 5 N – the COF progressively decreases from 0.17 to 0.09 and from 0.21 to 0.12, respectively, for the friction test with a dry contact and with a wet contact. In comparison, the Uncoated Sample exhibits a similar frictional behavior with a dry contact – its COF gradually decreases from 0.11 to 0.07 as the applied load increases from 1 to 5 N. However, when the wet stylus slides on the uncoated glass, the average COF significantly increases to ~0.45 for the tests performed in the whole load range between 1 and 5 N. This clearly demonstrates the significant effect of the contact condition to the COF measurement. The self-clean glass coating possesses a lower surface energy under the wet contact, leading to lower measured COF in this study. Thanks to the combination of the precise force measurement and the fast position control, the stylus position can be promptly adjusted to keep a constant applied load, allowing us to perform reliable COF measurement under various test conditions.

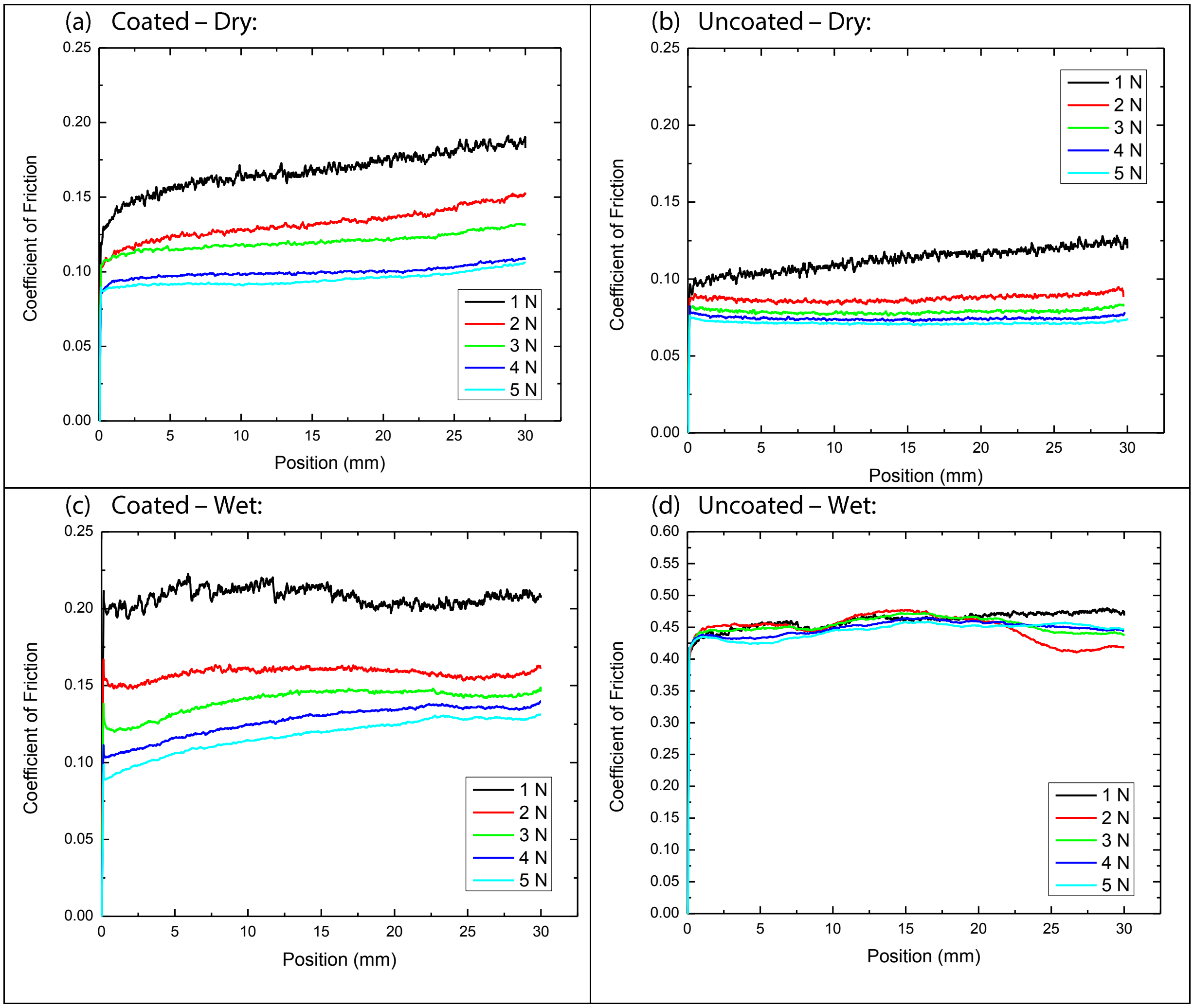

Fig. 2: COF of Coated and Uncoated Glass samples with a Dry and a Wet contact.

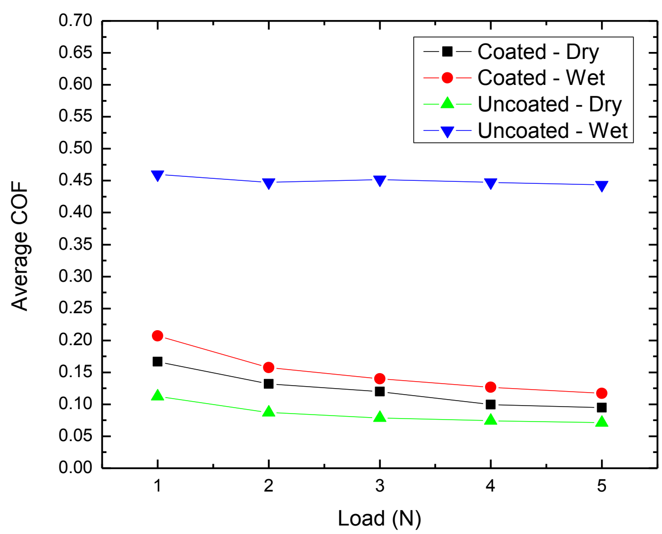

Fig. 3: Average COF of the Coated and Uncoated glass samples at different loads.

CONCLUSION

In this study, we showcased the capacity of Micro Module of Nanovea Mechanical Tester in measuring the coefficient of friction of self-clean glass coatings in a controlled and monitored manner. This friction measurement allows users to quantitatively assess the COF of the materials under different loads and test conditions and select the best candidate for the applications. The self-cleaning glass coating shows a lower friction than the uncoated glass in the wet contact condition, thanks to its low surface energy.

The Nano, Micro or Macro modules of the Nanovea Mechanical Tester all include ISO and ASTM compliant indentation, scratch and wear tester modes, providing the widest and most user friendly range of testing available in a single system. Nanovea Mechanical Tester provides comprehensive measurements of various mechanical properties, including hardness, Young's modulus, fracture toughness, adhesion, wear resistance and many others.

Learn More about the Nanovea Mechanical Tester and Lab Service

MEASUREMENT PRINCIPLE

FRICTION MEASUREMENT PRINCIPLE

During the test, the indenter makes contact with the surface at a very low controlled load. The positioning system and the load cell to quickly adjust the ball position to keep a constant applied load. The sample is then moved at a controlled speed and the lateral force is plotted versus displacement. In general a steel ball of a large diameter (6 mm) is used but other materials/shape/size can also be used to measure coefficient of friction (COF).

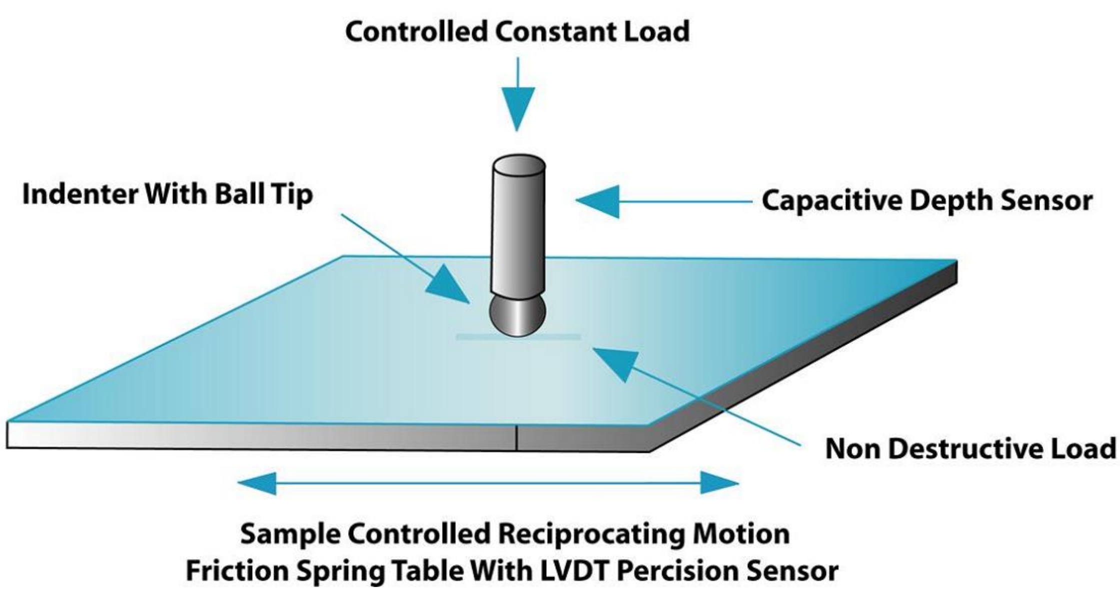

Fig. 4: Schematic of the friction measurement.