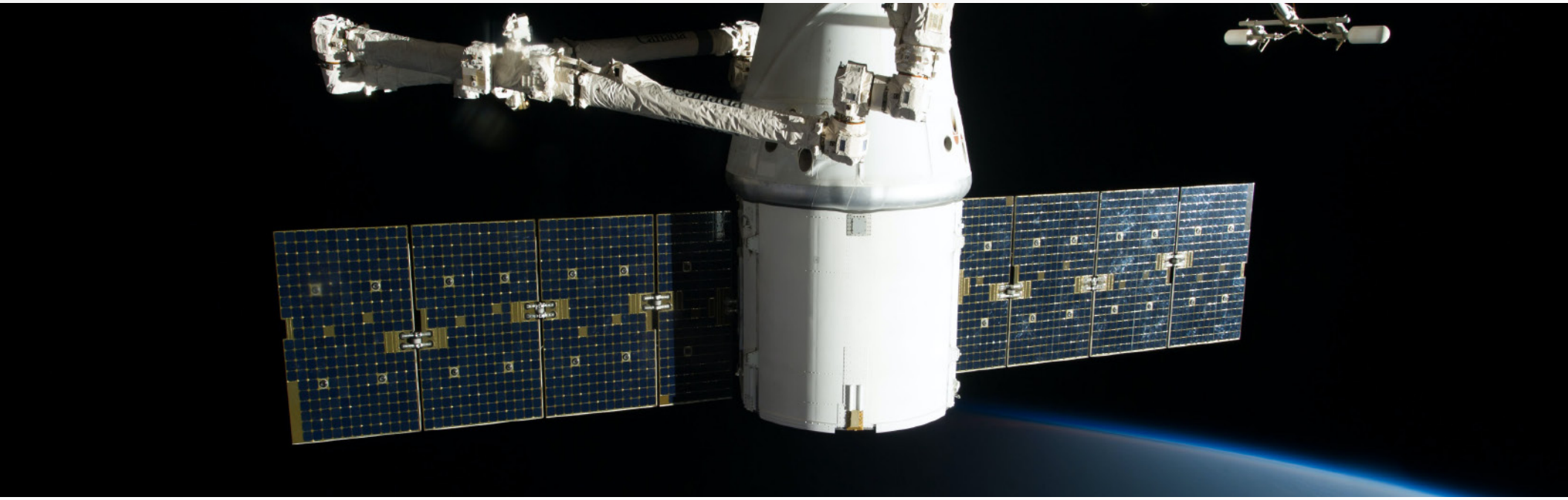
NANOVEA

ADHESION PROPERTIES OF GOLD COATING

ON QUARTZ CRYSTAL SUBSTRATE



Prepared by

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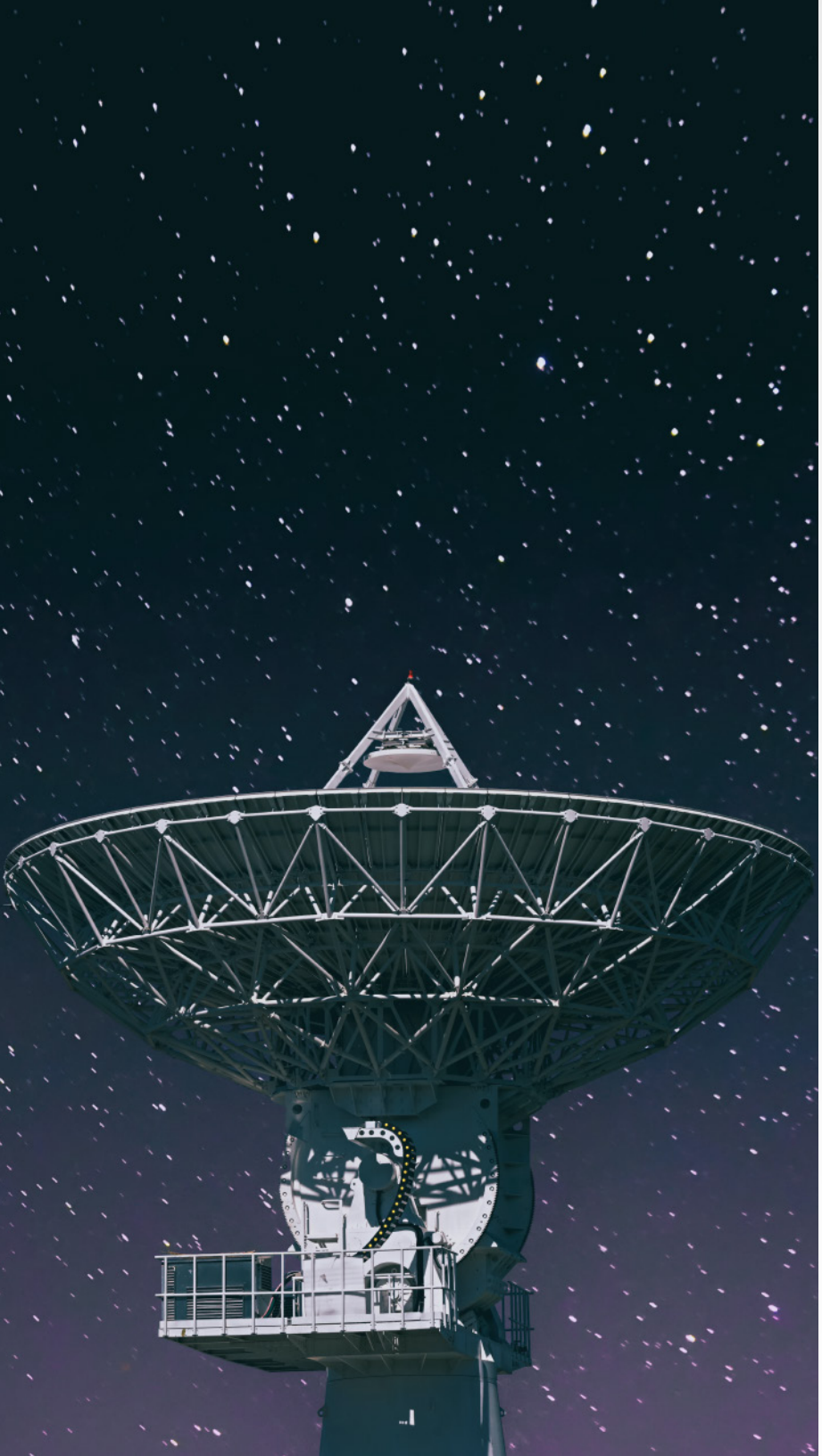

INTRODUCTION

The Quartz Crystal Microbalance (QCM) is an extremely sensitive mass sensor capable of making precise measurements of small mass in the nanogram range. QCM measures the mass change on the surface through detecting variations in resonance frequency of the quartz crystal with two electrodes affixed to each side of the plate. The capacity of measuring extreme small weight makes it a key component in a variety of research and industrial instruments to detect and monitor the variation of mass, adsorption, density, and corrosion, etc.

IMPORTANCE OF SCRATCH TEST FOR QCM

As an extremely accurate device, the QCM measures the mass change down to 0.1 nanogram. Any mass loss or delamination of the electrodes on the quartz plate will be detected by the quartz crystal and cause significant measurement errors. As a result, the intrinsic quality of the electrode coating and the interfacial integrity of the coating/substrate system play an essential role in performing accurate and repeatable mass measurement. The Micro scratch test is a widely used comparative measurement to evaluate the relative cohesion or adhesion properties of coatings based on comparison of the critical loads at which failures appear. It is a superior tool for reliable quality control of QCMs.

MEASUREMENT OBJECTIVE

*In this application, the **NANOVEA** Mechanical Tester, in Micro Scratch Mode, is used to evaluate the cohesive & adhesive strength of the gold coating on the quartz substrate of a QCM sample. We would like to showcase the capacity of the **NANOVEA** Mechanical Tester in performing micro scratch tests on a delicate sample with high precision and repeatability.*

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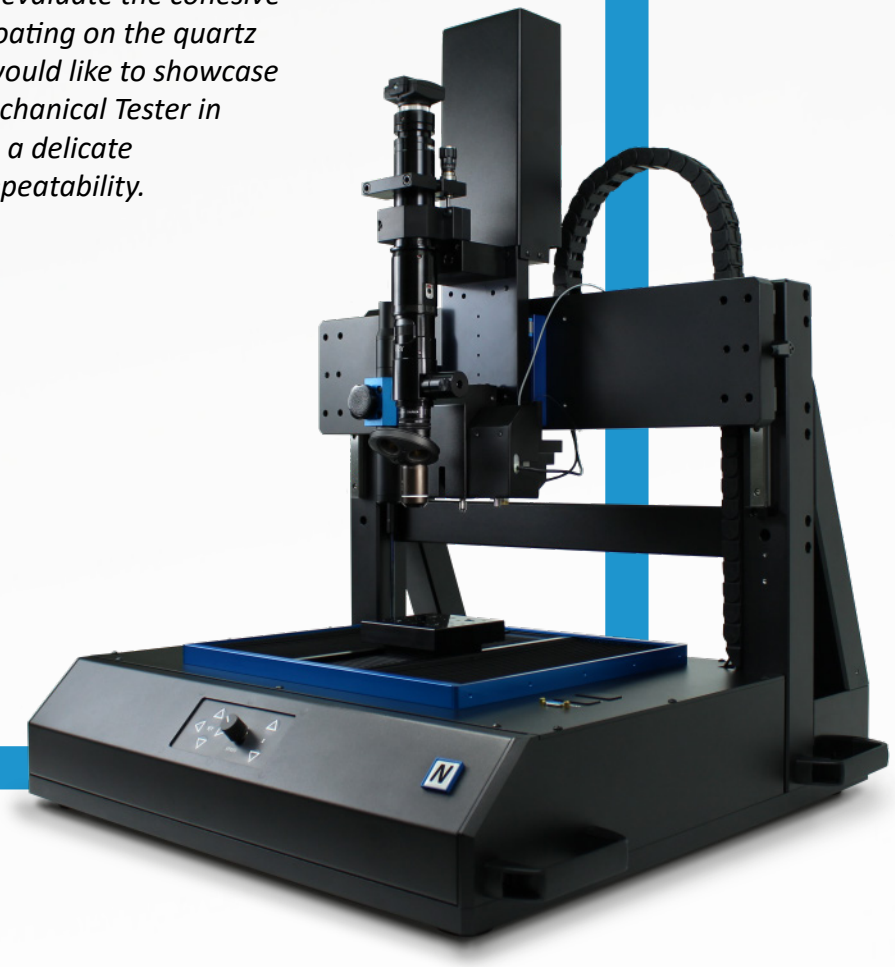
ABOUT THE INSTRUMENT

NANOVEA
PB1000



TEST CONDITIONS

The ***NANOVEA*** PB1000 Mechanical Tester was used to perform the micro scratch tests on a QCM sample using the test parameters summarized below. Three scratches were performed to ensure reproducibility of the results.

LOAD TYPE: *Progressive*

ATMOSPHERE: *Air 24°C*

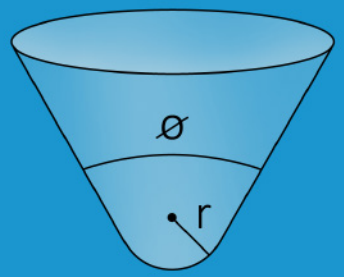
INITIAL LOAD	FINAL LOAD	SLIDING SPEED	SLIDING DISTANCE
0.01 N	30 N	2 mm/min	2 mm

INDENTER TYPE

Rockwell

Diamond 120° Cone

100 µm tip radius



RESULTS & DISCUSSION

The full micro scratch track on the QCM sample is shown in ***FIGURE 1***. The failure behaviors at different critical loads are displayed in ***FIGURE 2***, where critical load, L_{C1} is defined as the load at which the first sign of adhesive failure occurs in the scratch track, L_{C2} is the load after which repetitive adhesive failures take place, and L_{C3} is the load at which the coating is completely removed from the substrate. It can be observed that little chipping takes place at L_{C1} of 11.15 N, the first sign of coating failure. As the normal load continues to increase during the micro scratch test, repetitive adhesive failures occur after L_{C2} of 16.29 N. When L_{C3} of 19.09 N is reached, the coating completely delaminates from the quartz substrate.

Such critical loads can be used to quantitatively compare the cohesive and adhesive strength of the coating and select the best candidate for targeted applications.

* *QCM samples*

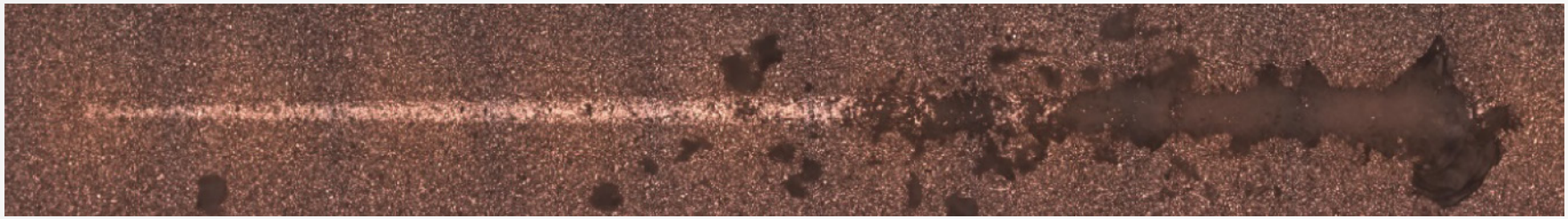


FIGURE 1: *Full micro scratch track on the QCM sample.*

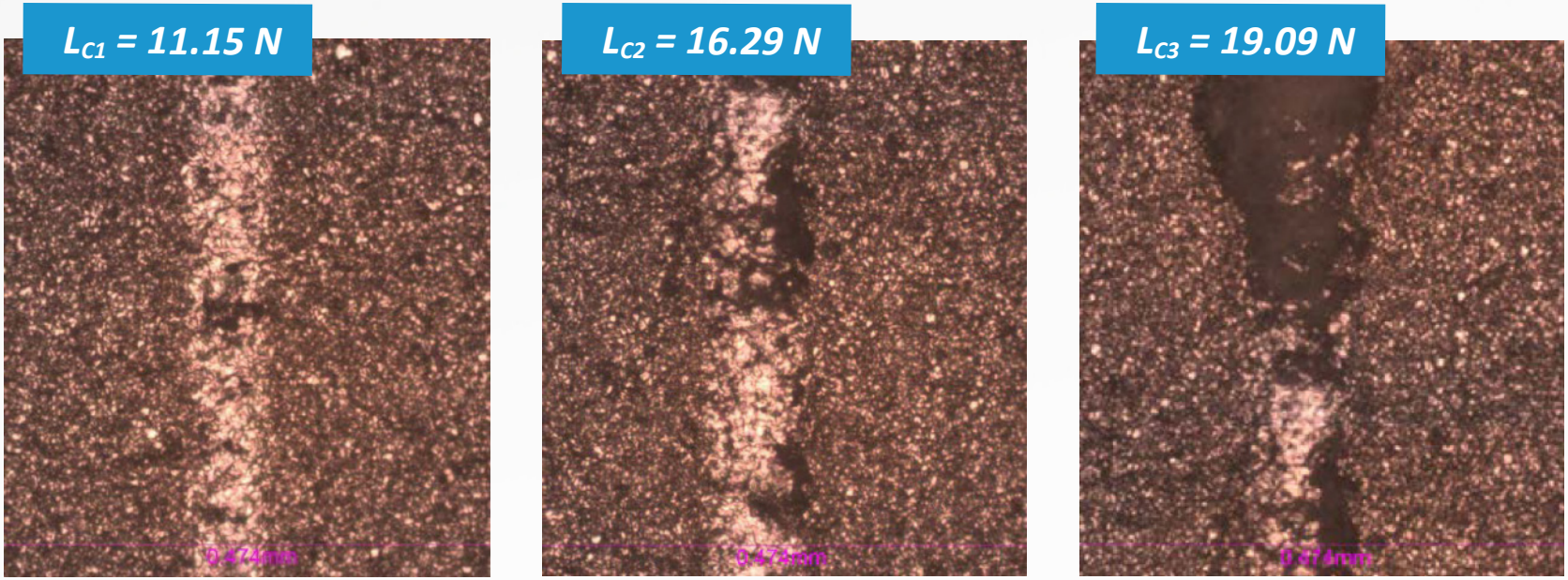


FIGURE 2: *Micro scratch track at different critical loads.*

FIGURE 3 plots the evolution of friction coefficient and depth that may provide more insight in the progression of coating failures during the micro scratch test.

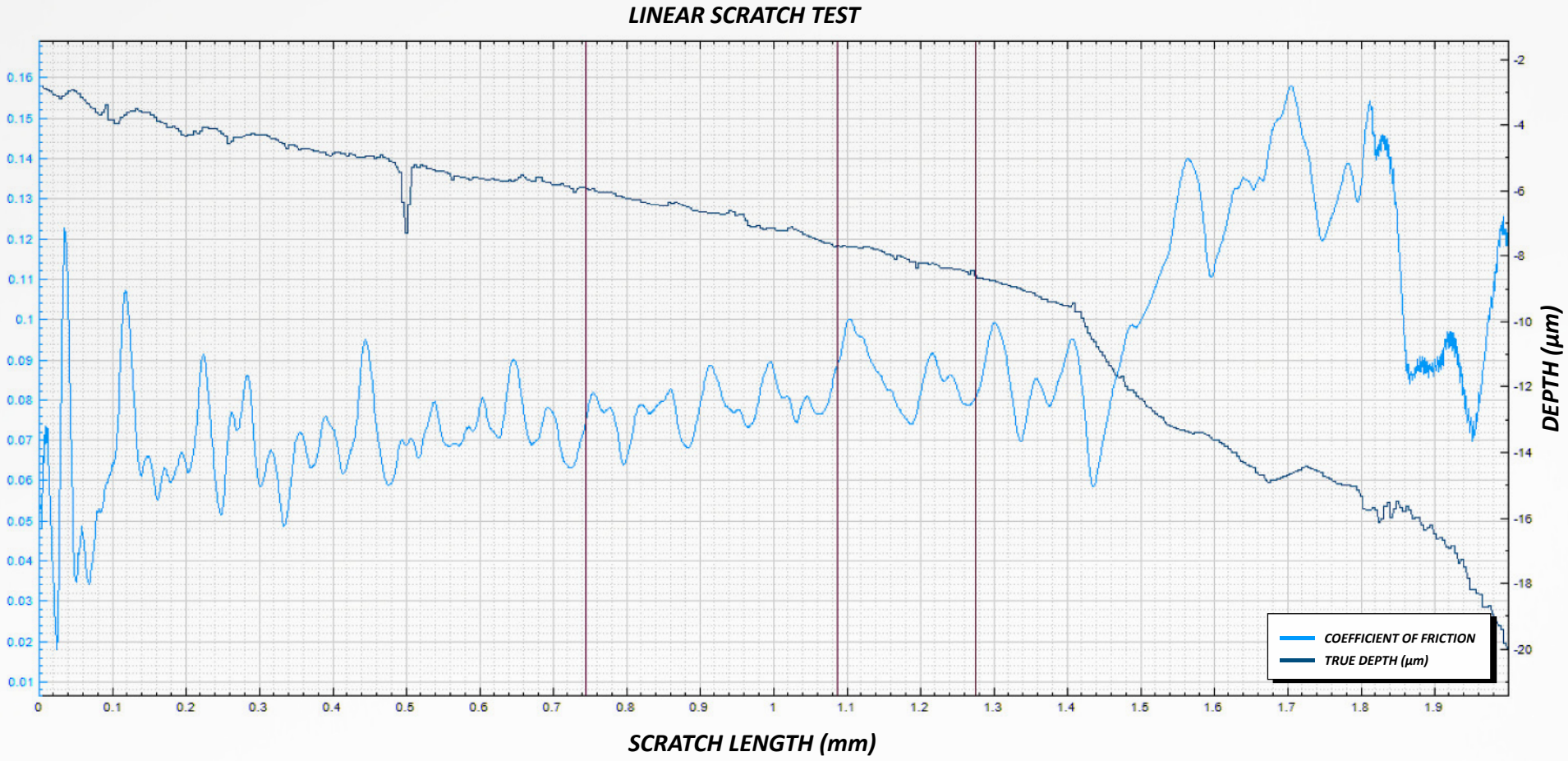


FIGURE 3: *Evolution of COF and Depth during the micro scratch test.*

CONCLUSION

In this study, we showcased that the ***NANOVEA*** Mechanical Tester performs reliable and accurate micro scratch tests on a QCM sample. By applying linearly increased loads in a controlled and closely monitored fashion, the scratch measurement allows users to identify the critical load at which typical cohesive and adhesive coating failure occurs. It provides a superior tool to quantitatively evaluate and compare the intrinsic quality of the coating and the interfacial integrity of the coating/substrate system for QCM.

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***'s unmatched range is an ideal solution for determining the full range of mechanical properties of thin or thick, soft or hard coatings, films and substrates, including hardness, Young's modulus, fracture toughness, adhesion, wear resistance and many others.

In addition, an optional 3D non-contact profiler and AFM module are available for high resolution 3D imaging of indentation, scratch and wear track in addition to other surface measurements, such as roughness and warpage.

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