

Adhesion measurement of decorative coatings

Relevant for: decorative coating, scratch testing, RST 300, RST 100, MCT³, NST³

Good adhesion properties are crucial for preserving the appearance and quality of decorative coatings over time. This report demonstrates how scratch testing provide precise, reproducible measurements to assess coating performance.



Figure 1 – Decorative coating samples

1 Decorative coatings

In industries where aesthetics meet performance, decorative coatings are expected to preserve both their visual appeal and functional properties throughout their lifetime. Found in applications such as jewelry, watches, designer accessories, and other high-value products, these coatings are subjected to daily contact, friction, and harsh environmental condition. Over time, these factors can lead to visible degradation, including color fading, surface dullness, or even complete coating removal, thereby diminishing both visual appearance and product value.

To preserve their quality and ensure long-term durability, decorative coatings must adhere strongly to the underlying substrate and resist mechanical damage. Therefore, characterizing their adhesion and scratch resistance is a critical step in evaluating their overall performance. This application report demonstrates how Anton Paar scratch testers provide precise and reproducible measurements, enabling manufacturers to reliably assess the mechanical performance of decorative coatings

2 Scratch testing principle

In scratch testing, a diamond spherical indenter is drawn across a coated surface under either a progressive,

incremental or constant load while the sample moves at a constant velocity. During this process, real-time data is collected through various integrated sensors that measure parameters such as normal force, penetration depth and frictional force. After the test, these data are directly correlated with the optical analysis of critical loads (Lc) at which scratch-induced failures, such as cracking or delamination, occur. The higher the critical loads the stronger the adhesion and scratch resistance [1]. The principle of this testing method is illustrated in the following images, showing a scratch made on a TiN on steel sample.

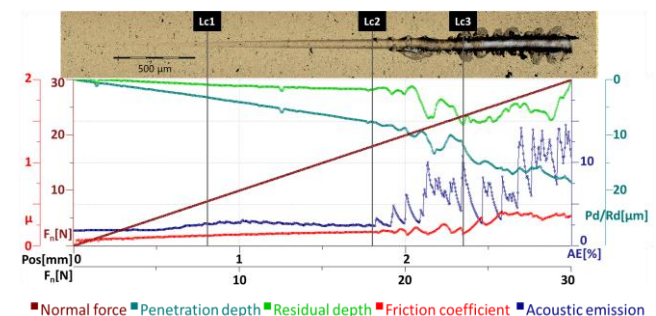
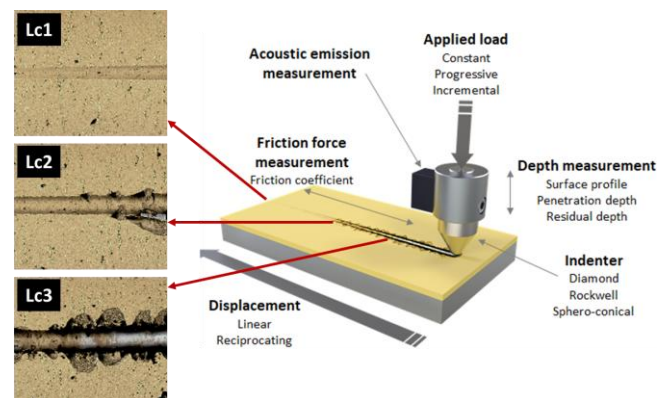


Figure 2 - Scratch measurement results on TiN coating

3 Results

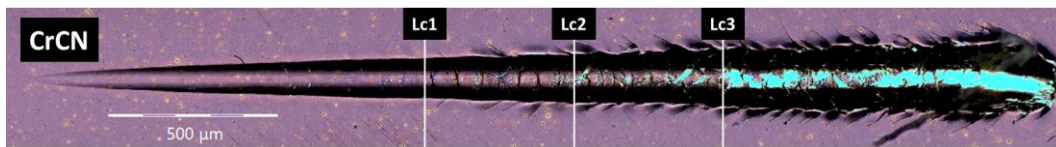
In this report, the adhesion of several decorative coating samples with different properties was evaluated (see table below). The coating properties listed in the table include thickness, measured using a Calotest [2], and hardness, determined by nanoindentation techniques [3].

	CrCn	Pink TiN	TiN	DLC	Au
Thickness [μm]	0.6	0.4	0.5	2	0.3
Hardness [GPa]	8	24	24	25	4

All samples were tested under similar scratch conditions to allow direct comparison of the coatings. Except for the gold (Au) coated sample, tests were conducted with a scratch length of 3 mm, a speed of 6 mm/min, a 100 μm radius

diamond indenter and an end load of 30 N. The gold coating was evaluated at a higher load of 100 N to better visualize its scratch failures.

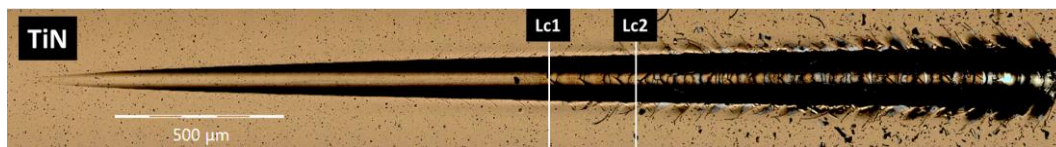
The results are presented below as panoramic scratch images alongside the corresponding critical load values for each sample, providing a clear overview of coating performance and allowing assessment of both adhesion and scratch resistance.



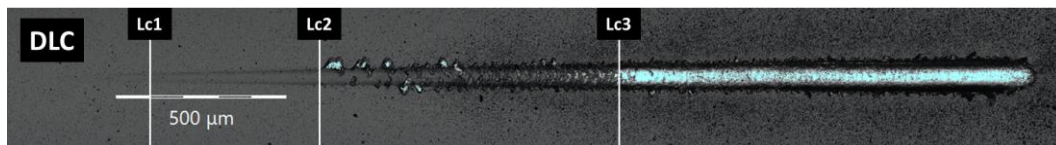
Lc1	12 N
Lc2	17 N
Lc3	21 N



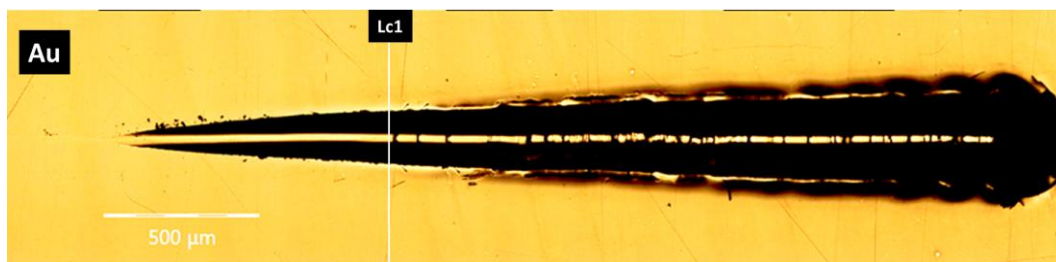
Lc1	13 N
Lc2	21 N
Lc3	28 N



Lc1	16 N
Lc2	19 N



Lc1	6 N
Lc2	9 N
Lc3	18 N



Lc1	37 N
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4 Conclusions

This report demonstrates the effectiveness of scratch testing as a fast and straightforward method for evaluating the adhesion and scratch resistance of decorative coatings. In particular, the use of panoramic imaging is valuable during the analysis for identifying the critical load. Overall, this approach offers a practical tool not only for coating development but also for quality control during production processes.

5 References

- [1] ISO 20502 -Determination of adhesion of ceramic coatings by scratch testing, (2005).
- [2] J. Nohava, XCSIA078EN-Characterization of coefficient of friction and thickness of hard coatings on cutting tools.pdf, (2020).
- [3] I. Thévenaz, J. Nohava, XCSIA095EN-A Comparison of nanoindentation with conventional hardness, (2023).

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