Nano-Impact & Fatigue

Nano-Impact & Fatigue module with the NanoTest Vantage

Repetitive contact through impact allows investigation of fatigue and fracture processes. As an "in situ" wear test it is possible to detect the onset of damage and obtain mechanistic information that can be much more beneficial in intelligent coatings design than merely reporting an average wear rate. Nano-Impact was developed and has been patented by Micro Materials (EU Patent 1095254) and is fast becoming a vital research tool in the very best worldwide research institutions. Operating at high strain rates, nano-impact provides valuable additional information to nanoindentation.

How it works

Two distinct impact/fatigue modes are included as standard in the Nano-Impact & Fatigue module in which any indenter type or material can be used, and both modes can be used on the NanoTest and MicroTest loading heads. The indenter starts away from the sample before accelerating towards it as high strain rates are achieved.

Probe Impact mode for low cycle fatigue:

- Popular testing approach for investigating low cycling fatigue, work hardening, yield stress and dynamic hardness.
- Using solenoid activation the impact probe is accelerated rapidly over a precisely chosen distance (e.g. 10 µm above the sample) to impact the surface at very high strain rate. Single and repetitive impacts are possible,
- Applied load, impact angle, acceleration distance, indenter geometry are user-definable.

Sample Oscillation mode for high cycle fatigue:

- Piezoelectric oscillation system, signal generator, amplifier and software for control and data analysis.
- High cycle fatigue tests with oscillation frequencies up to 500 Hz and amplitudes up to 5 µm
- Enables both impact and contact fatigue tests to be performed depending on the magnitude of the static load.

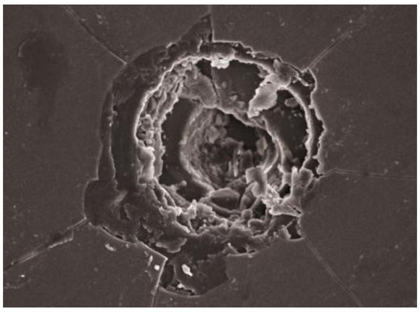

***Figure 1** shows the Nano-impact fracture of a thick brittle coating on polycarbonate. Image courtesy of Dr J Moghal, Oxford Advanced Surfaces*

Real-Time Nano-Impact damage

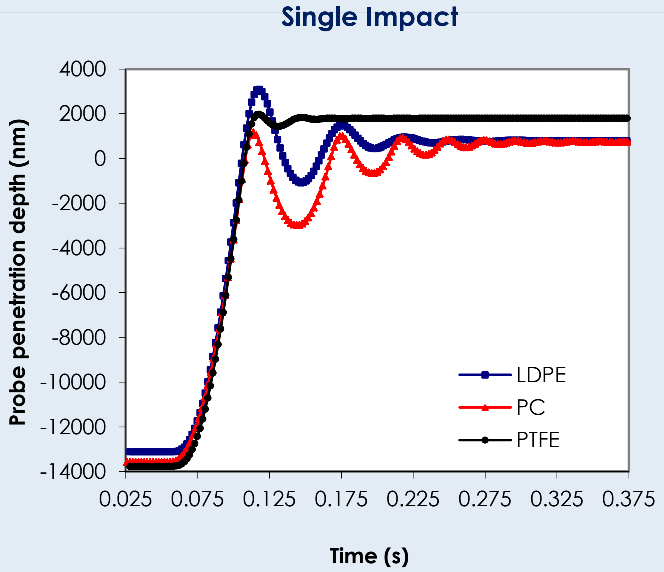

Figure 2 shows single impacts on a range of polymeric materials. The enhanced damping of PTFE is shown clearly.

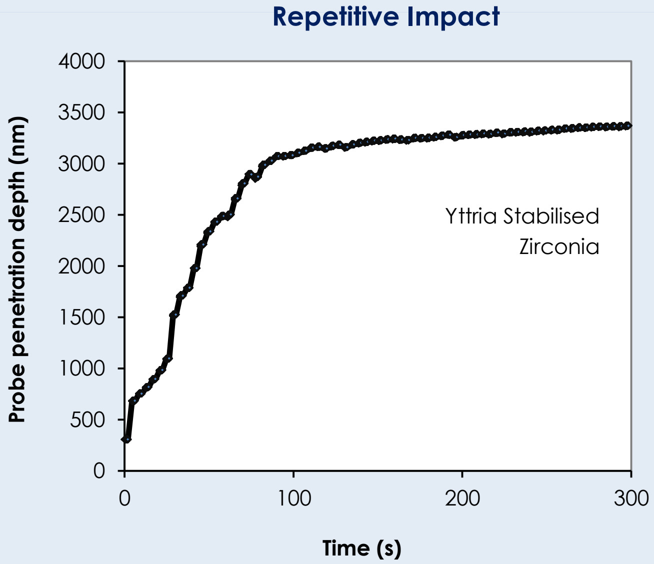

Figure 3 shows repetitive nano-impact tests on a 7-8% Yttria Stabilised Zirconia (thermal barrier coating) that was previously aged for 24 hr at 1500 °C. The rapid nano-impact test shows the decreased resistance to multiple impacts after thermal ageing of the TBC consistent with results from erosion tests.

Optimising advanced high speed cutting tool coatings

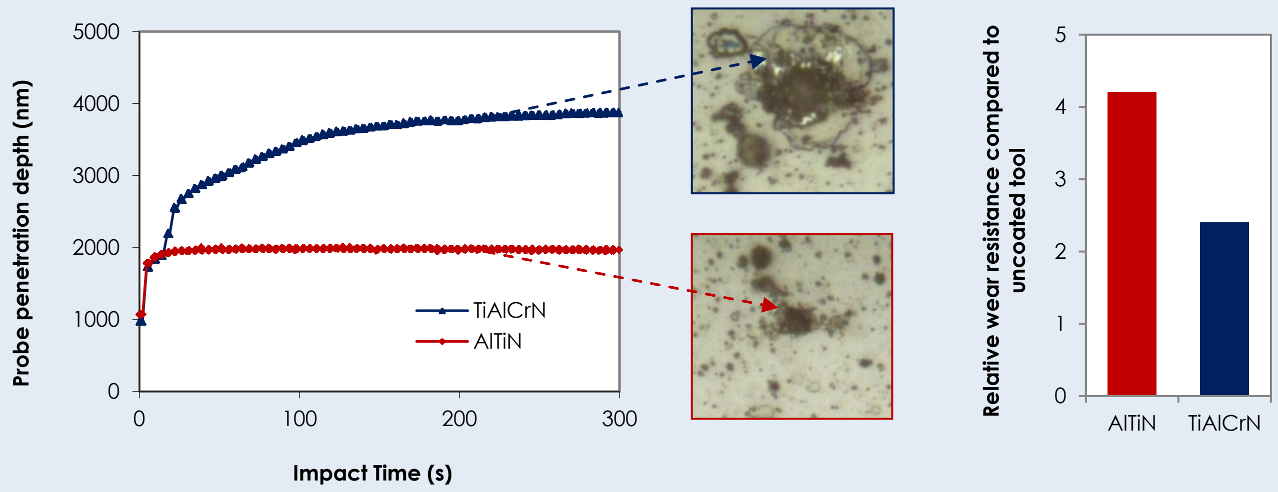

Figure 4 shows the rapid and simple to use Nano-Impact test shows the improved crack resistance of AlTiN, consistent with its longer lifetime in cutting tool tests on aerospace alloys. Impact with the NanoTest has shown to be an effective accelerated wear test capable of accurately simulating interrupted contacts such as erosive wear or milling or in engine operation. The results correlate with field trials of coating performance but the Nano-Impact tests are much quicker so the pace of coating development can be increased dramatically *[...see also GS Fox-Rabinovich et al, Surf Coat Technol 204 (2009)489]*

- **As toughness can be more important than hardness**
- **Clear failure identification is required**
- **Single impacts for work hardening, dynamic hardness and yield stress**
- **Repetitive impact for fatigue**
- **Rapid, automated determination of S-N curves**
- **When nanoindentation alone is insufficient**

Static vs. dynamic techniques

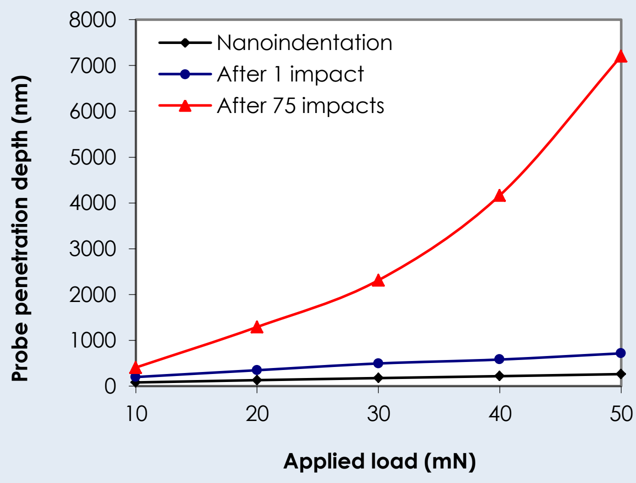

Figure 5 shows a comparison of maximum probe depth after nanoindentation and single and multiple impacts with a 5 μm spherical indenter on thin amorphous hard carbon film on Si shows the penetration depth is much greater in Nano-Impact.

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NanoTest Vantage