# Nano-fretting

## Nano-fretting module with the NanoTest Vantage

In operation, components in a wide variety of applications undergo vibrational wear. Fretting tests are regularly run on the macro-scale in order to examine material behaviour under these conditions. The nano-fretting module allows investigation of fretting and reciprocating wear at the micro/nano scale filling the previous metrology gap.

This capability allows examination of the effect of small oscillatory micro-motion on the durability of complex systems such as hip prostheses where small particles trapped between the ball and socket can slowly damage the contacting surfaces.

## How it works

### Important features of nano-fretting experiments with the NanoTest Vantage

- **Fully programmable experimental conditions**: The nano-fretting hardware allows oscillation frequency and amplitude to be set. This enables customisation of experiments to simulate different wear behaviours.
- **High cycle wear**: The excellent stability of the NanoTest Vantage nano-fretting module allows reliable evaluation of high cycle wear behaviour – up to 1 million cycles in a few hours of testing.
- **Friction measurements**: The Nano-fretting module incorporates friction measurements allowing accurate measurement of frictional forces during fretting providing an indicator of subtle changes in wear behaviour.
- **Range of indenter materials**: Micro Materials Ltd offers a range of indenters for fretting tests from sapphire and diamond to steel balls
- **Flexible indenter geometry**: The NanoTest Vantage gives the flexibility to use either large diameter probes or conventional nanoindentation probes. This allows testing under a wide range of contact pressures enabling more accurate simulation of real world contact conditions.

***Figure 1** shows the nano-fretting stage design*

## High cycle wear behaviour

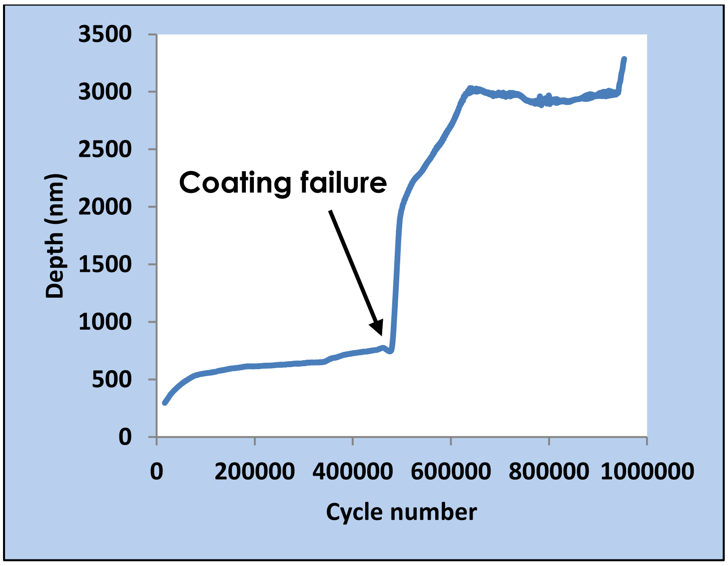


**Figure 2** shows the data from a million cycle nano-fretting experiment on a DLC coating on a silicon substrate.

The coating fails after around 450,000 cycles. The full experiment duration in this case was around 5 hours.

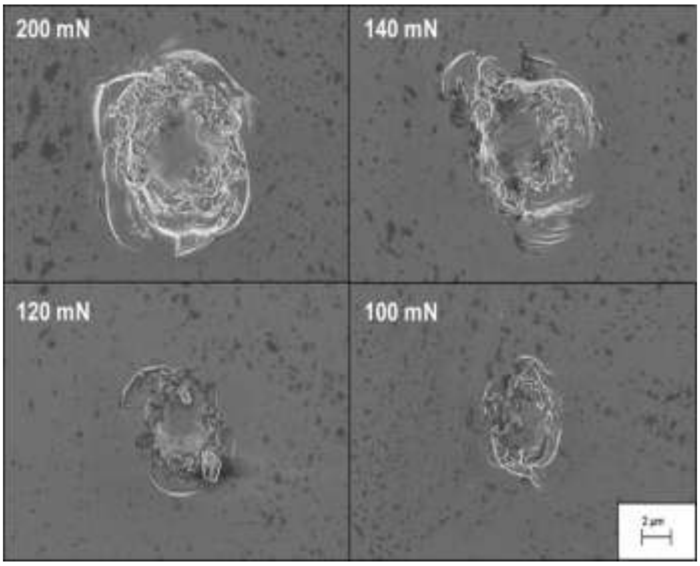


**Figure 3** shows fretting scars from experiments on uncoated silicon. An increased wear rate is seen in experiments above 120 mN fretting load

# Nano-fretting tests on biomedical materials

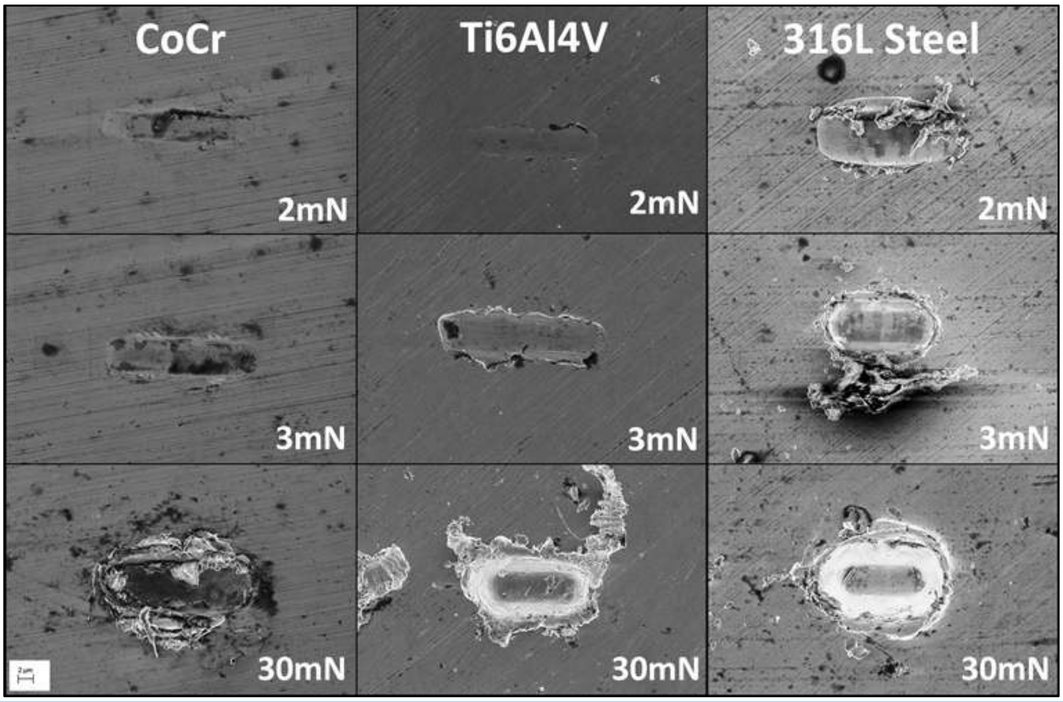


**Figure 4** shows the load dependence of fretting tests on alloys for biomedical applications. SEM images show increased surface damage with increasing load and highlight the weakness of 316L steel to this kind of wear.

For more information see BD Beake and TW Liskiewicz, Tribology international (2012) (http://dx.doi.org/10.1016/j.triboint.2012.08.007)

- **High cycle wear behaviour**
- **True fretting behaviour on the nano-scale**
- **Reciprocating sliding wear.**
- **Integrated friction sensing for improved data interpretation**
- **Flexibility to simulate in-service conditions**


## Nano-fretting of DLC coating

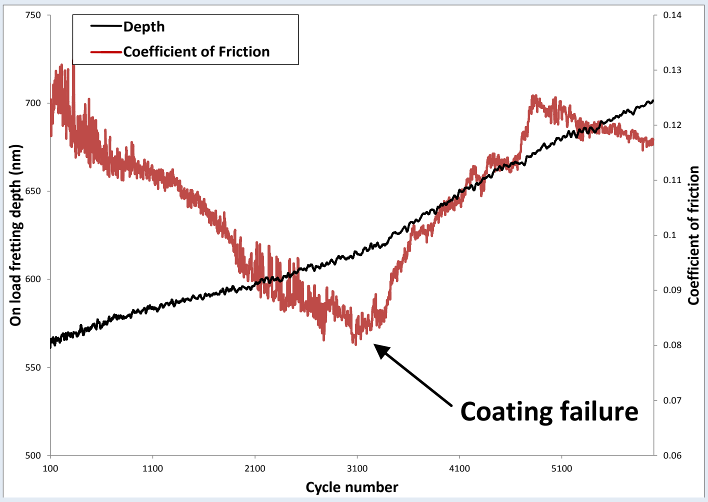


**Figure 5** shows typical depth and friction data for a fretting test on a thin DLC coating. The friction dramatically increases after coating failure corresponding to a change in wear rate observed in the depth signal.

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NanoTest Vantage