

# SCRATCH TEST MODULE

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## Scratch Tester Introduction

The scratch tester accessory is an optional attachment that can be fitted to the IBIS or UMIS nanoindentation instrument for scratch testing operations. The accessory comprises a spring loaded table with a force sensor LVDT that allows the coefficient of friction to be measured during a scratch. The instrument can be used to perform a ramped increasing or steady load along a scratch path. The scratch may be repeated (wear test) many times or offset by a small distance (raster). During a scratch, the specimen is translated beneath the indenter by the X axis stage.

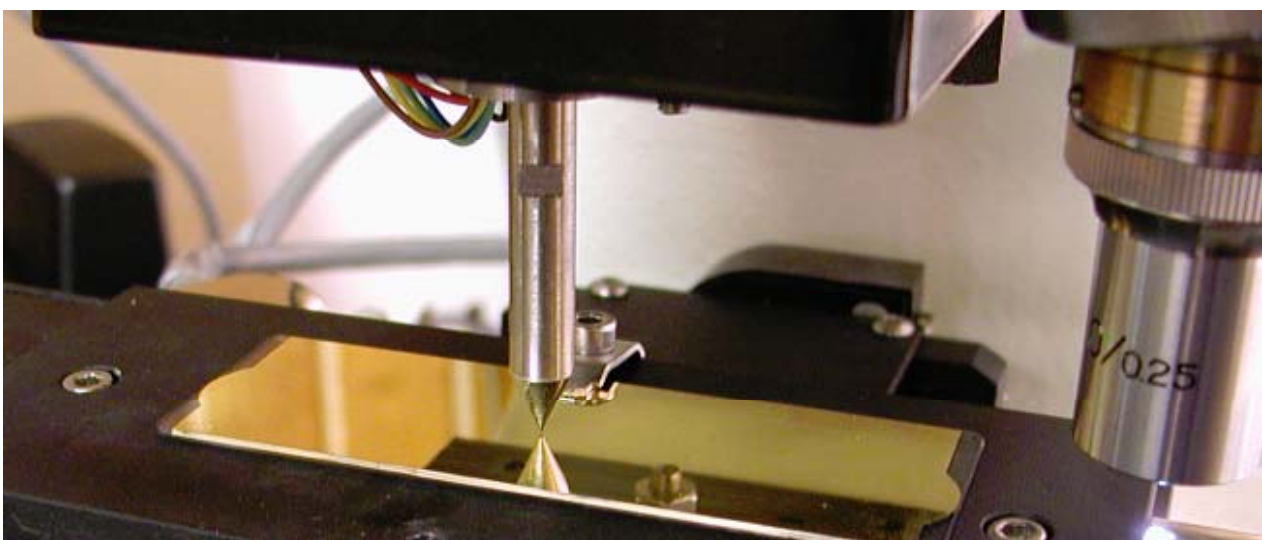
The size or length of the scratch is limited only by the specifications of the X sample stage.

### Features:

- Sensitive and linear dual range LVDT lateral force sensor.
- Closed loop PZT direct acting normal force sensor maintains load for curved or sloping surfaces.
- Pre-scan for slope correction.
- Wear tests.
- Constant load or ramped load.
- Variety of indenter geometries.
- Maximum scratch length up to 136 mm.
- Full length of scratch can be scanned visually without removing or resetting specimen.
- Wide clearance for bulky specimens.
- Traceable calibration.
- Benefits from dual range normal force sensor in IBIS for use on hard materials.

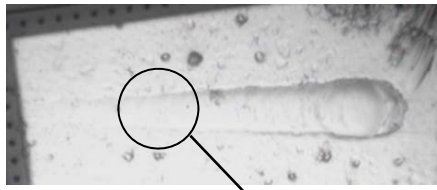
### Specifications

Lateral force range	±20 mN/ ±200 mN dual range. Higher ranges available to order to ±1 N.
Theoretical resolution	0.0006 mN/ 0.006 mN
Actual noise floor	0.005 mN/ 0.01 mN
Maximum scratch length	66 mm standard, 136 mm option
Maximum scratch speed	2000 µm/sec



# Scratch Tester Results

Scratch testing can be done by moving the sample relative to the indenter tip while load is applied (either ramped or steady) to the indenter. At the same time, the lateral force needed to move the sample is typically measured. The ratio of the lateral force to the normal force is the coefficient of friction at the contact.



The results for a scratch test depend very much on the test variables and the sample. Typically, it may take several tests (perhaps 10 or more) to establish a suitable test regime. The AFM scan across the scratch above shows piling-up of material at the edge and characteristic tensile cracking as arcs opening in the direction of travel of the indenter.

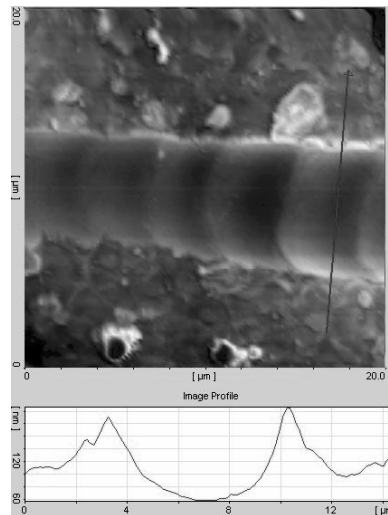
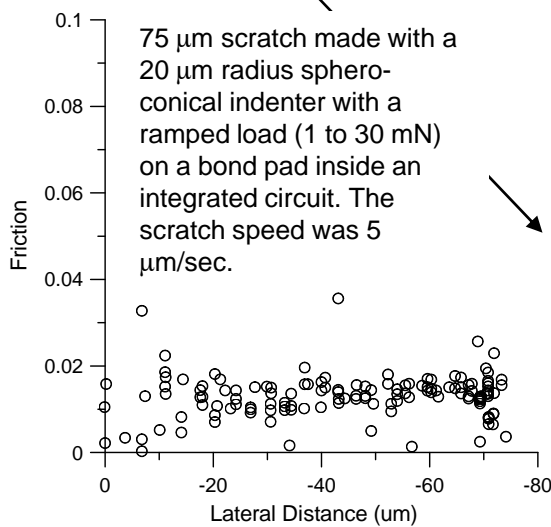


Image from DME Dualscope AFM .

A constant load scratch test may be done as a series of scratches at ever-increasing loads at regularly spaced intervals.

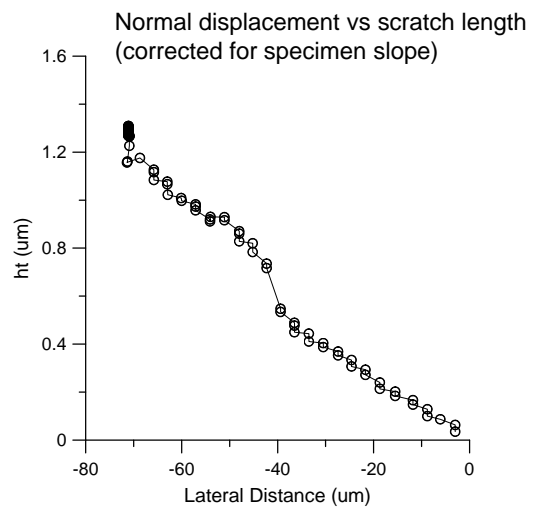
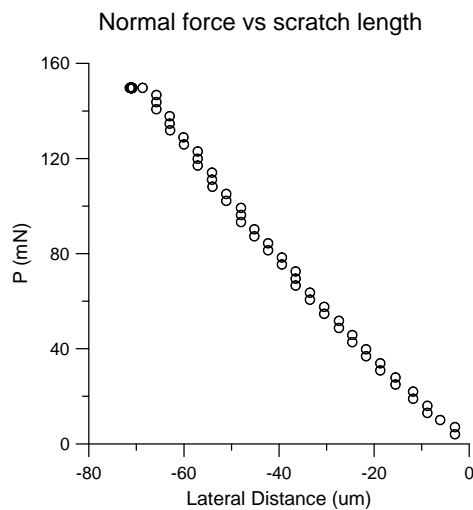
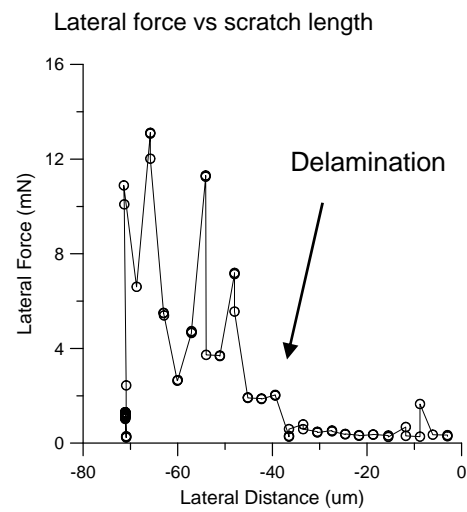
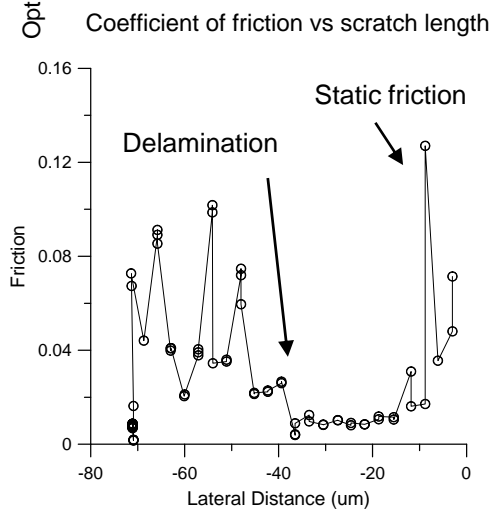
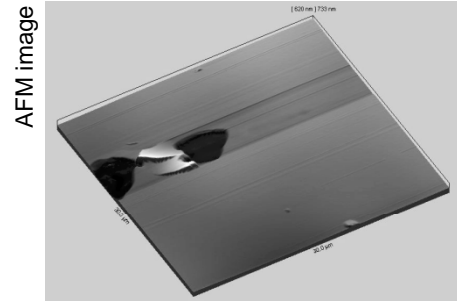
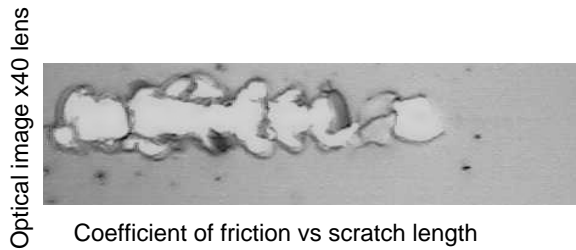


Parallel scratches on gold film on glass with 5  $\mu\text{m}$  spherical indenter with loads 5, 10, 15, 20... mN at 5  $\mu\text{m}$  intervals.

When the scratch is repeated along the same path, then it is a wear test. For scratches on thin films, delamination can be observed by visual inspection and the load at that position along the scratch is the critical load for failure of the film. This is a form of adhesion testing. The scratch resistance or scratch hardness of a surface is a measure of its ability to resist permanent deformation by a moving indenter (as opposed to a stationary indenter in indentation hardness).

# Scratch Tester Results

Friction coefficient, Lateral Force, Normal Force and vertical displacement for a 70  $\mu\text{m}$  scratch with ramped load, 5  $\mu\text{m}$  spherical indenter, on a 300 nm thick DLC film on silicon.



70  $\mu\text{m}$  scratch, ramped load from 1 to 150 mN. Scratch goes from right to left in figures.  
5  $\mu\text{m}$  radius, 60 degree sphero-conical indenter