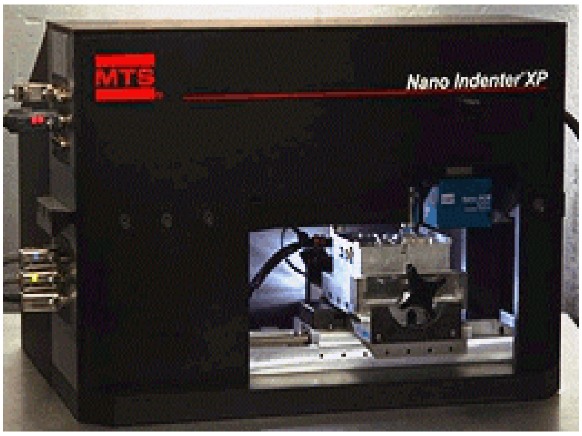
Nanoindentation

The University of Manchester

STRESS & DAMAGE CHARACTERISATION UNIT

Nanoindentation can be used to determine the hardness and elastic modulus of materials, including layers and coatings <100 nm thick. Nanoscratch tests can be performed to measure lateral forces during the scratch process. The direct measurment of friction between fibre and matrix in fibre-reinforced composites can also be measured by performing a push-out test.

FACILITIES



The MTS Nano Indenter XP combines ultra-low load indentation and microhardness testing in the same system. With Continual Stiffness Measurement (CSM) and Lateral Force Measurement (LFM) options it is capable of:

- Displacement resolution < 0.02 nm
- Maximum indentation depth 500 mm
- Maximum load 500 mN (50.8 grams)
- Maximum load with high load system 10 N (1 kg)
- Load resolution 50 nN (5.1 mgm)
- Load resolution with high load 50 nN
- Fully automated position control

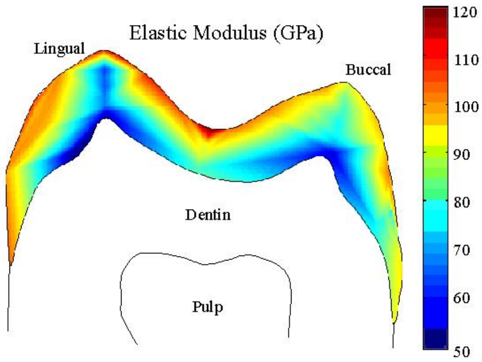
CSM Options:

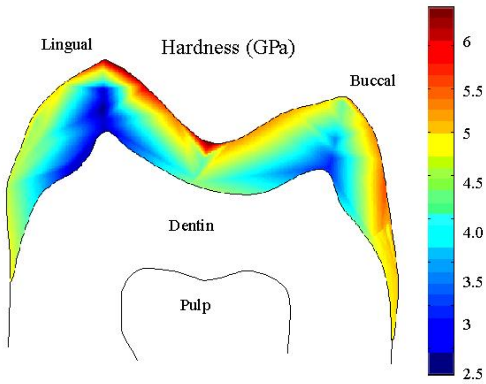
- Force oscillation frequencies 0.5 – 300 Hz
- Force Amplitudes 0.1 – 500 mN
- Software modelling for response in the frequency range 0.1 – 2000 Hz.
- Contact stiffness measurement with amplitudes of 1 Å.

LFM OPTION:

- Scratch, friction, surface profiling and wear testing
- Friction measurement with loads as low as 1 mN
- Cross-profilometry enabling quantification of visco-plastic relaxation in polymers.

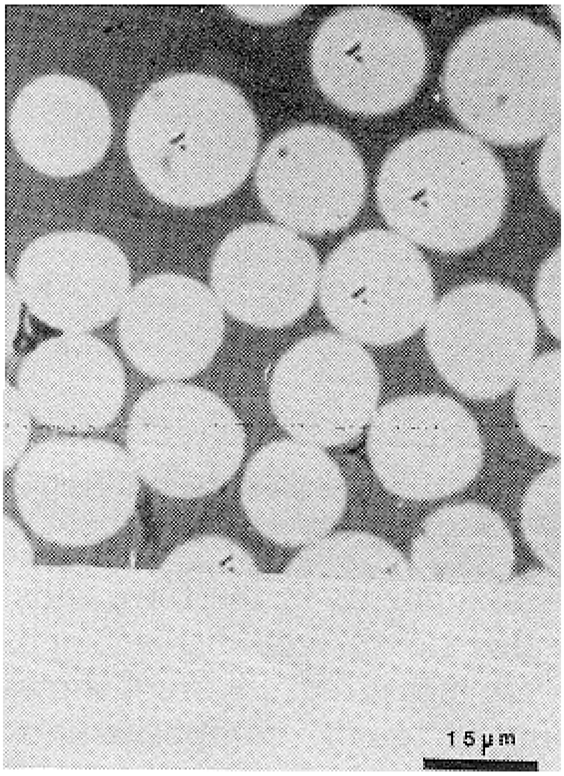
CASE STUDY (1) – MECHANICAL PROPERTIES OF A SECTIONED MOLAR TOOTH.



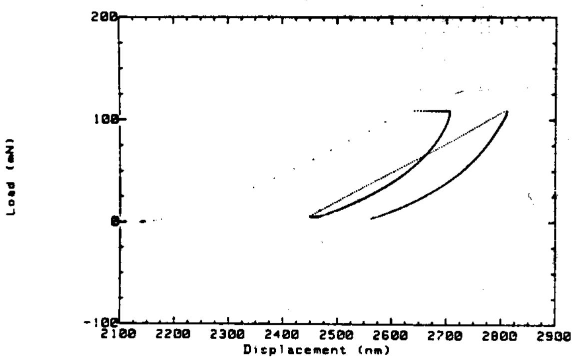


Approximately 3000 nanoindentations were performed across the sectioned tooth, providing the detailed maps shown above of elastic modulus and hardness.

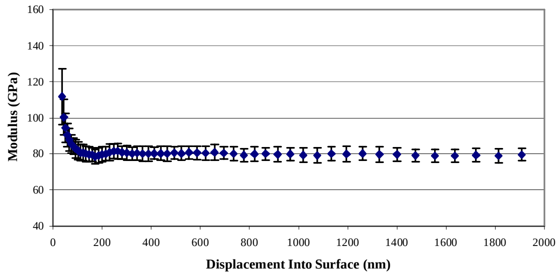
Case Study 2 – The measurement of fibre/ matrix adhesion in composite materials.



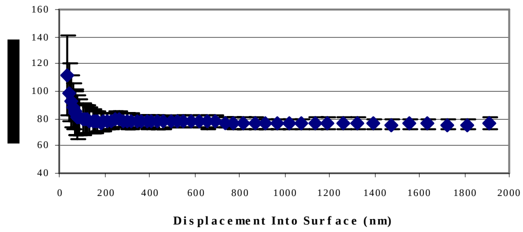
Nanoindentation on the ends of silicon carbide fibres on a cut and polished specimen of a fibre reinforced glass ceramic matrix composite. The subsequent debonding between fibre and matrix can be seen on the following graph of load plotted against displacement.



Case Study 3 – Determination of Young's Modulus of float glass.



Variation of Young's Modulus with penetration depth into the air surface of a 4 mm thick float glass sample.



Variation of Young's Modulus with penetration depth into the tin surface of a 4 mm thick float glass sample.

From the above graphs it can be seen that the value of Young's modulus is slightly lower (an approximate difference of 3 GPa throughout) for the tin surface of the float glass than for the air surface. This observation may be attributed to the presence of tin ions within the tin surface of the glass.

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