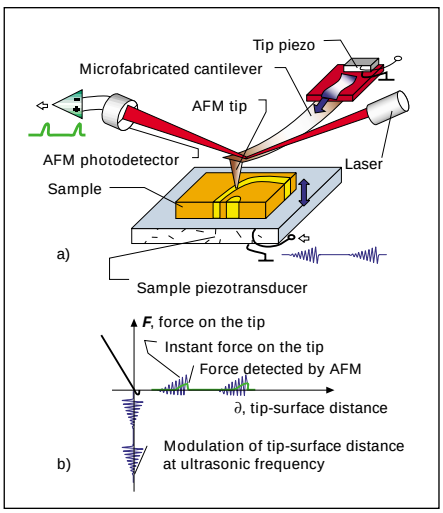
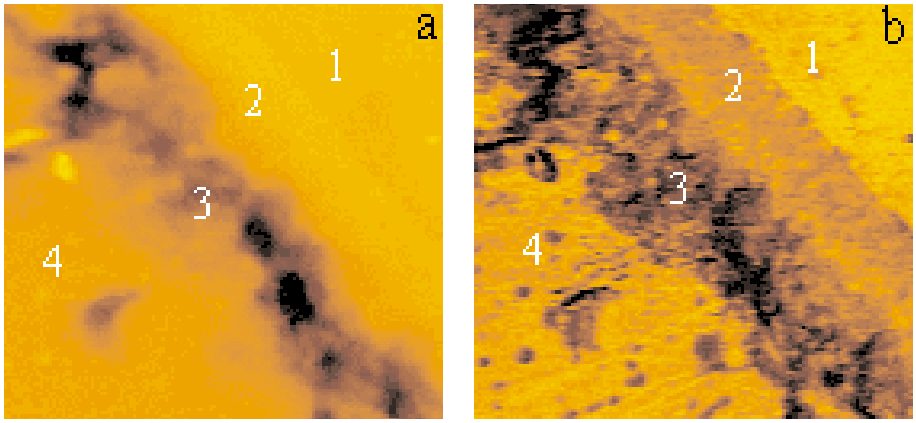
Department's material gains

High rankings at the Metrology for World Class Manufacturing Awards

The Department of Materials had two successes at the Metrology For World Class Manufacturing Awards for 1999. Hongbiao Dong and John Hunt were commended for their recent work in The Development of a Novel Scanning Calorimeter for Accurate Measurements of Thermophysical Properties. This technique improves the resolution, sensitivity and accuracy of calorimetry to measure transition temperatures and enthalpy changes in a wide range of phase transformations. Oleg Kolosov and Andrew Briggs were category winners for their work on Ultrasonic Force Microscopy, described below.



a) Design of Ultrasonic Force Microscope (UFM), b) principle of nonlinear detection of ultrasonic vibration in UFM.



Topography a) and UFM b) images of a sample made of a carbon coated SiC fibre embedded in a mullite matrix (Al_2O_3-SiO_2) (image width 10 μm). UFM reveals the detailed structure of four regions of 1 SiC fibre, 2 the carbon layer, 3 the reaction region with reduced elastic modulus and 4 the mullite matrix.

Ultrasonic Force Microscopy

The scanning tunnelling microscope (STM) developed in 1981 is able to trace the contours of individual atoms on a material's surface. Over the past few years, the Department of Materials has been developing the ultrasonic force microscope (invented in the early 1990s), and a family of related instruments that provide an insight into the nanometre scale elastic properties of materials.

The ultrasonic force microscope (UFM) marries acoustic microscopy (and its sensitivity to elastic properties) to atomic force microscopy, which gives nanoscale resolution imaging of various materials. Current research aims to expand the advances in UFM to the measurement of absolute values of elastic properties on the nano-metre scale.

Applications

UFM offers mapping of various materials from soft polymers to hard ceramics, as well as evaluation of the absolute values of contact stiffness, therefore paving the way for the metrology of materials' elastic moduli on the length scale of a few nm. Kolosov and Briggs forecast future needs in the semiconductor and recording media industries, as well as in the area of ultrathin coatings and surface modification.

The commercial exploitation of UFM was established with the support of ISIS Innovation Ltd, Oxford University's technology transfer company. The National Institute of Standards and Technology, Colorado, USA is pursuing the UFM approach as a basis for the measurement and standardisation of thin coatings and nanostructured materials. In another development, UFM has been assisted by SUNY at Albany, USA and Sematech Corporation of Semiconductor Manufacturers for quality control of interconnects in advanced metal-polymer interconnects.