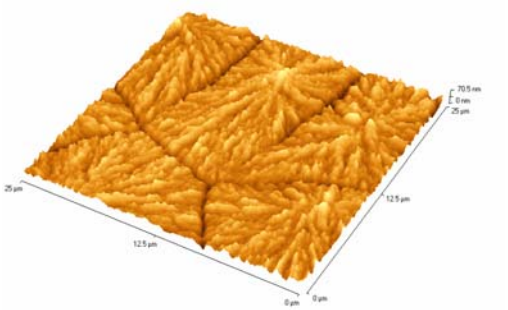
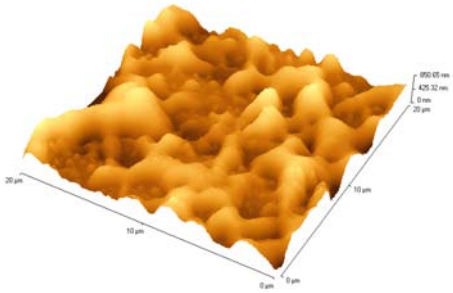
Scanning Probe Microscopy Applications for Industry

Scanning Probe Microscopy (SPM) is increasingly employed in research and development, engineering and manufacturing departments across a broad spectrum of industries from biotechnology to semiconductor sectors. Both established multinational companies and start-up companies in emerging technologies utilize SPM techniques. Today, SPM can characterize a wide range of properties at the nanoscale including electrical, mechanical and thermal whilst simultaneously mapping surface topography. The examples below highlight just a few of the areas where SPM can provide answers to important industrial issues.

Surface Characterisation of Biomaterials: Bioactivity of Implants

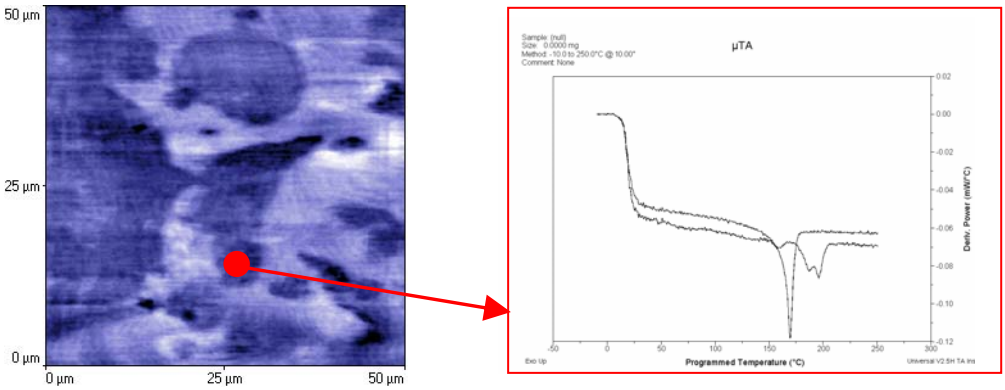
When medical devices are implanted in the body, water attaches to the surface then proteins bind followed by attachment and proliferation of cells. Changing the surface chemistry and / or the surface topography of the device can affect this series of events; consequently, surface properties of implants are an important consideration. AFM is a powerful tool for characterising surface morphology, mechanical properties and surface chemistry. The two images shown here are topographic maps of biomedical polymer surfaces with identical underlying chemistry but different topography, showing how nano- and micro-topography can affect protein and cell adhesion.



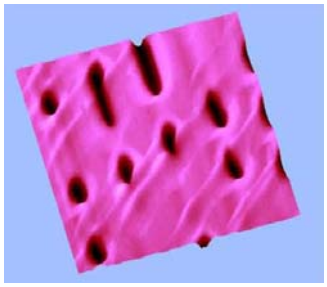


Characterisation of Resorbable Polymers

The image here shows a micro-thermal conductivity image of a blend of rersorbable polymers (PLA and PGA). The degree of mixing affects the degradation properties in the human body. The contrast arises due to differences in thermal conductivity of the components of the blend. Using this technique it is also possible to carry out local differential scanning calorimetry (DSC) which can be used to identify the components of a mixture based upon their phase transition temperatures.



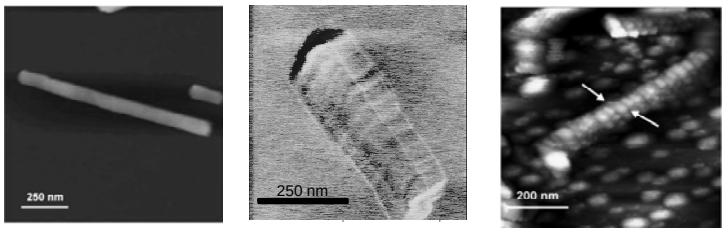
Identifying Manufacturing Problems in Optical Disk Industry



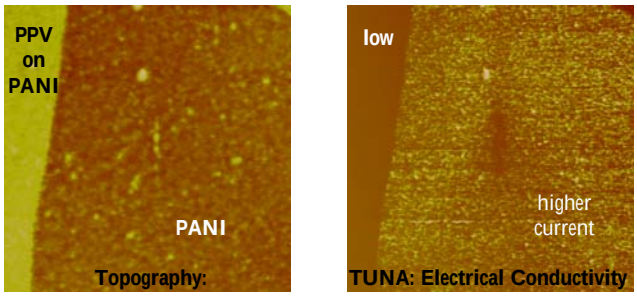
SPM can be used to identify a range of defects in CD and DVD maufactuiering processes. These can occur from defects in the original polycarbon ate moulds, errors in the stamping process and mastering mastering errors. SPM software can automatically calculate the pit depth, pitch and surface roughness and use pass/fail criteria to automatically identify defecvtive disks in a batch. In the image below, pit smearing ona CD is the cause of errors in audio playback.

Mapping Surface Chemical Properties to investigate bone osteoporosis

"Chemical force microscopy" (CFM) employs modified tips to map chemical or biological heterogeneity over a sample surface. The example below shows natural skeletal tissue mineral - hydroxyapatite. The left panel shows a standard tapping mode AFM image of the smooth surface of a mature stage mineral crystal. The centre panel shows a lateral force (friction image) using a carboxylic acid modified tip. At pH8 the tip is negatively charged and therefore the striped contrast in the image identifies alternating charged regions on the mineral surface. The subsequent addition of the matrix protein amelogenin to the crystal surface indicates that the proteins bind in a manner which coincides with this surface charge patterning (right panel) indicating that the electrostatic interaction is driving the binding. These proteins control the dissolution and growth of mineral and their action is implicated in pathologies such as osteoporosis.



Characterising Light Emitting Display Materials (OLEDS)



SPM can simultaneously record surface topography and a range of electrical properties including conductivity, surface potential and capacitance. In the example below, a layer of the light emitting polymer poly-phenylene vinylene (PPV) is spun cast on a 200 nm thick poly-aniline layer (PANI) to facilitate transport of charge carriers. Tunnelling AFM (TUNA) reveals that the inhomogeneous PANI conductive buffer layer has high but non-uniform conductivity. The spun cast PPV coating exhibits much lower but largely uniform electrical conductivity. SPM techniques such as Near Field scanning Optical Microscopy can be used to spatially map the light emission from micro and nano structures.

Avacta

Avacta Analytical Ltd is a specialist analytical service provider and subsidiary of the biotechnology innovator Avacta Ltd. Avacta Analytical has extensive expertise in surface characterisation using atomic force microscopy, electron microscopy, optical spectroscopy and vacuum analytical techniques such as Auger and X-ray photoelectron spectroscopy. We have broad experience of materials analysis from plastics, metals and ceramics, to biomaterials, healthcare products and pharmaceutical formulations.

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Veeco Instruments Ltd

Veeco is a leading provider of Metrology and Process Equipment solutions. Veeco products are critical enabling instruments used in the advancement of scientific research and nanotechnology. Veeco is the leading supplier of Scanning Probe Microscopes to industry and academia. Veeco Surface Profilers are used for 3-dimensional characterisation of surface areas up to 200 x 200 mm in size.

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