Scanning Thermal Microscope (SThM)

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Scanning Thermal Microscope (SThM)

- Scanning Thermal Microscope is a specialized variant of Atomic Force Microscopy

- simultaneous, high-resolution topographic and thermal conductivity or temperature imaging
Operating Principle

- resistive element or thermocouple incorporated into the tip for thermal conductivity and temperature mapping: thermal feedback
- topography feedback is commonly ensured by using optical or electrical methods
- our SThM uses tuning fork feedback to control topography (Nanonics technology)

Scheme of a SThM from C. Blanco et. al., J. Microscopy 205(1) 21, 2002.
SThM Probes

Thermoresistive probe
- Pt-wire
- Glass

Thermal probe
- Pt-core
- Glass
- Au-coating

Image of a Nanonics SThM probe: the tuning fork is glued to the cantilever (pipette) directly above the tip.
Specifications

• 200 nm thermospatial resolution
• Full atomic force microscope functionality
• 10 K to 300 K
• 5x10^-8 Torr high vacuum chamber
• Scan range: 25 µm Z-range, 70 µm XY-range (step size < 1 nm)
• Rough x, y sample positioning using motorized stage: 5 mm.
• 16 mm diameter sample size with a maximum load of 75 g
• Measures conducting and insulating materials
Applications

SThM has potential applications in: fundamental investigations of heat transport, polymer science, nanotechnology, pharmaceuticals, surface science, thin films, biology, microelectronics, forensics, and quality control.

Some specific capabilities:

• Mapping material distribution in composites
• Differentiation between bulk and surface properties
• Failure analysis
• Determination of phase miscibility
• Identification of contaminants
Applications

Comparison of topographic (a; d) and thermal (b; e) images (concurrently recorded) of an untreated SWCNT film on: a silicon substrate (a-c) and a glass substrate (d-f).

The tip scanned the surface near a scratch such that it stepped from the substrate to the film.

The increase in probe voltage, $V$, at the silicon:SWCNT film junction, shown in (c), indicates reduced heat dissipation from the tip by the SWCNT film. No increase is observed at the glass:SWCNT film junction, (f), indicating that the heat dissipation ability of the SWCNT film is similar to the glass substrate.

Applications

The SThM can also perform microscale versions of thermo-mechanical analysis (µ-TMA) and differential thermal analysis (µ-DTA).

Analysis of an acetaminophen tablet (from M. Reading et. al., Am. Lab., Jan. 1999.)
Unique Capability

• SThM is the ONLY current technique capable of sub-micron thermo-spatial resolution!

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• Our SThM is the only instrument of its kind in Canada