

Scanning Thermal Microscope (SThM)

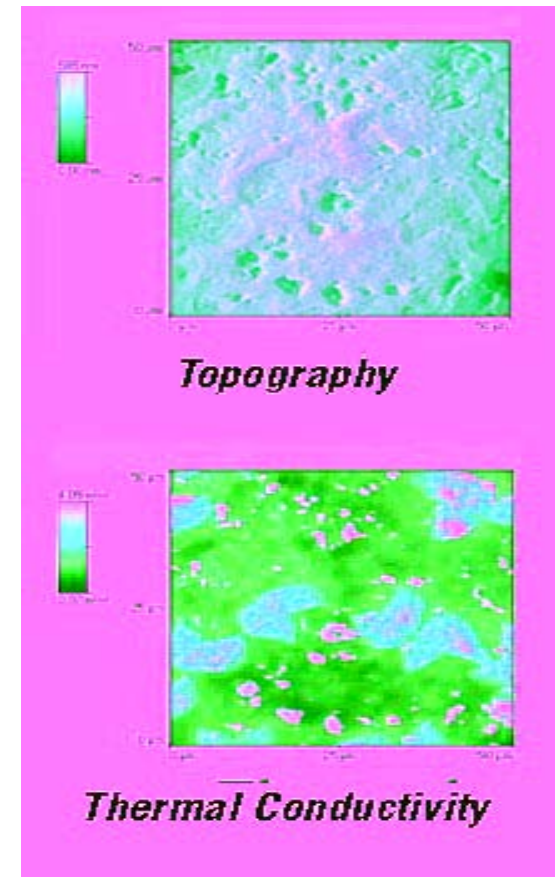
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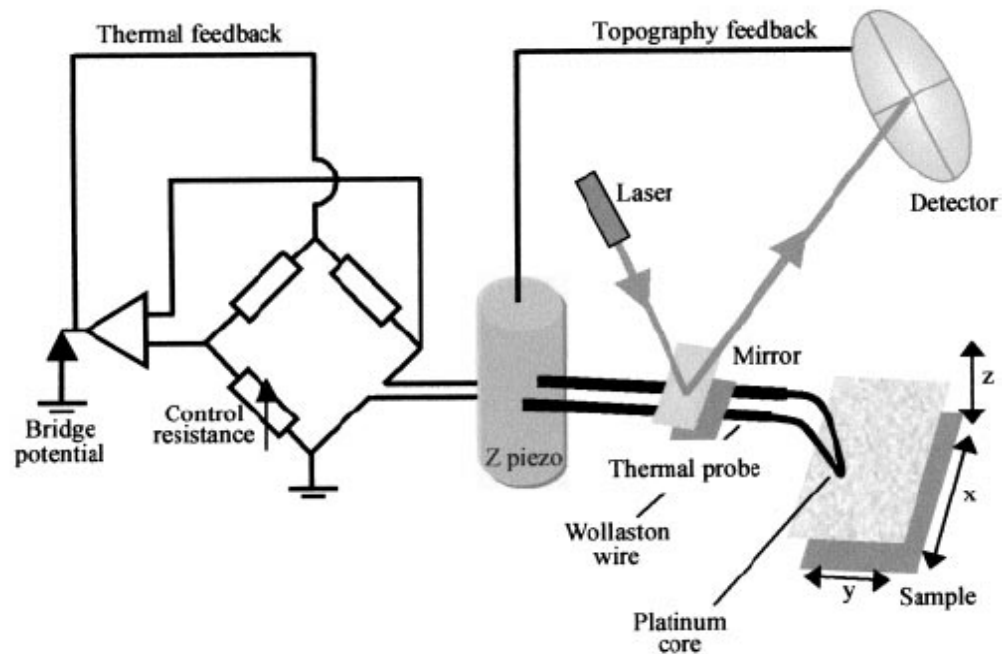
Scanning Thermal Microscope (SThM)

- Scanning Thermal Microscope is a specialized variant of Atomic Force Microscopy
- simultaneous, high-resolution topographic and thermal conductivity or temperature imaging



Operating Principle

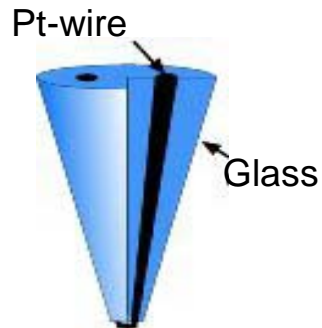
- resistive element or thermocouple incorporated into the tip for thermal conductivity and temperature mapping: thermal feedback
- topography feedback is commonly ensured by using optical or electrical methods
- our SThM uses tuning fork feedback to control topography (Nanonics technology)



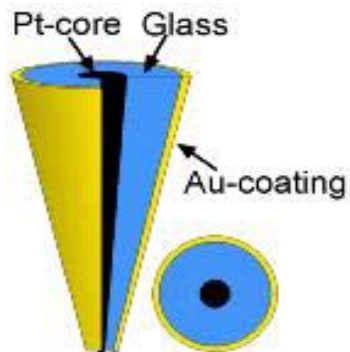
Scheme of a SThM from C. Blanco *et. al.*, *J. Microscopy* **205**(1) 21, 2002.

SThM Probes

Thermoresistive probe

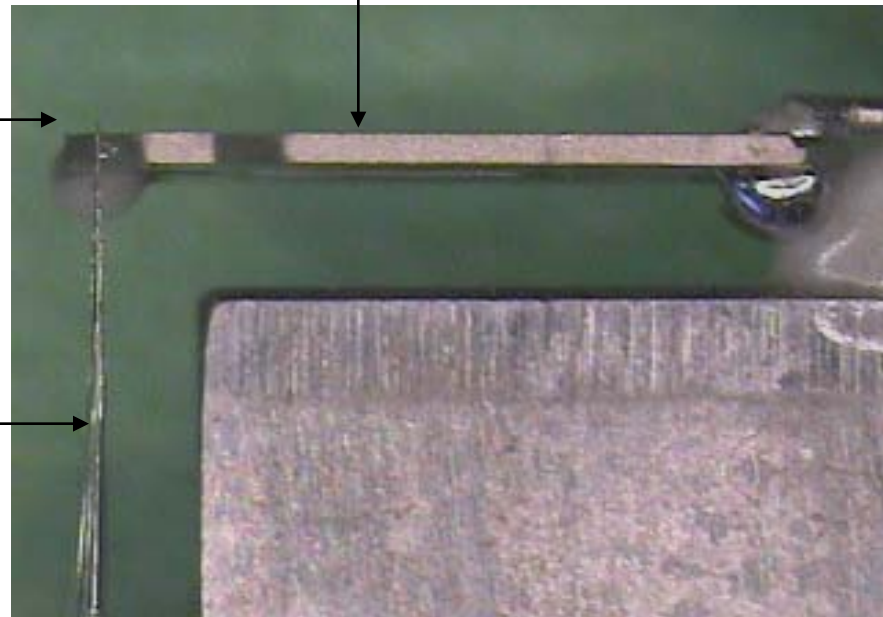


Thermal probe



Tuning fork

tip

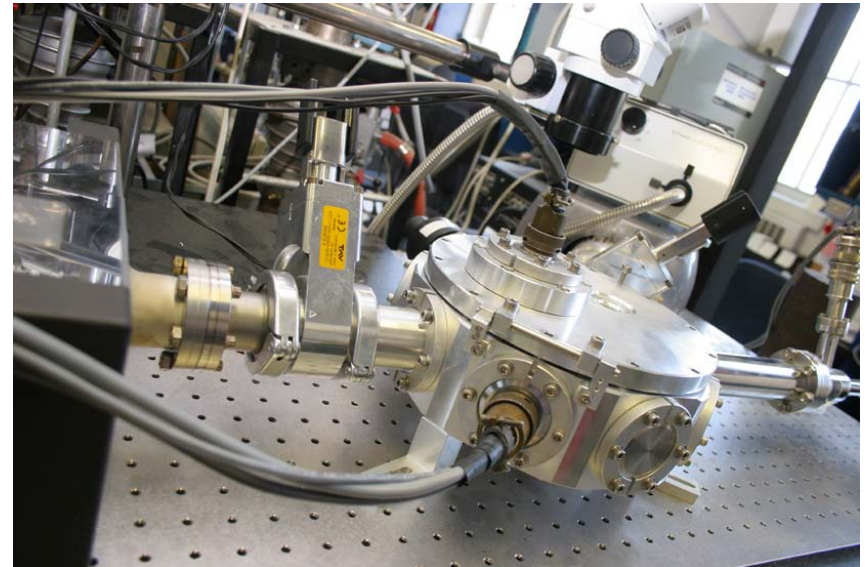


pipette

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
- 5×10^{-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:

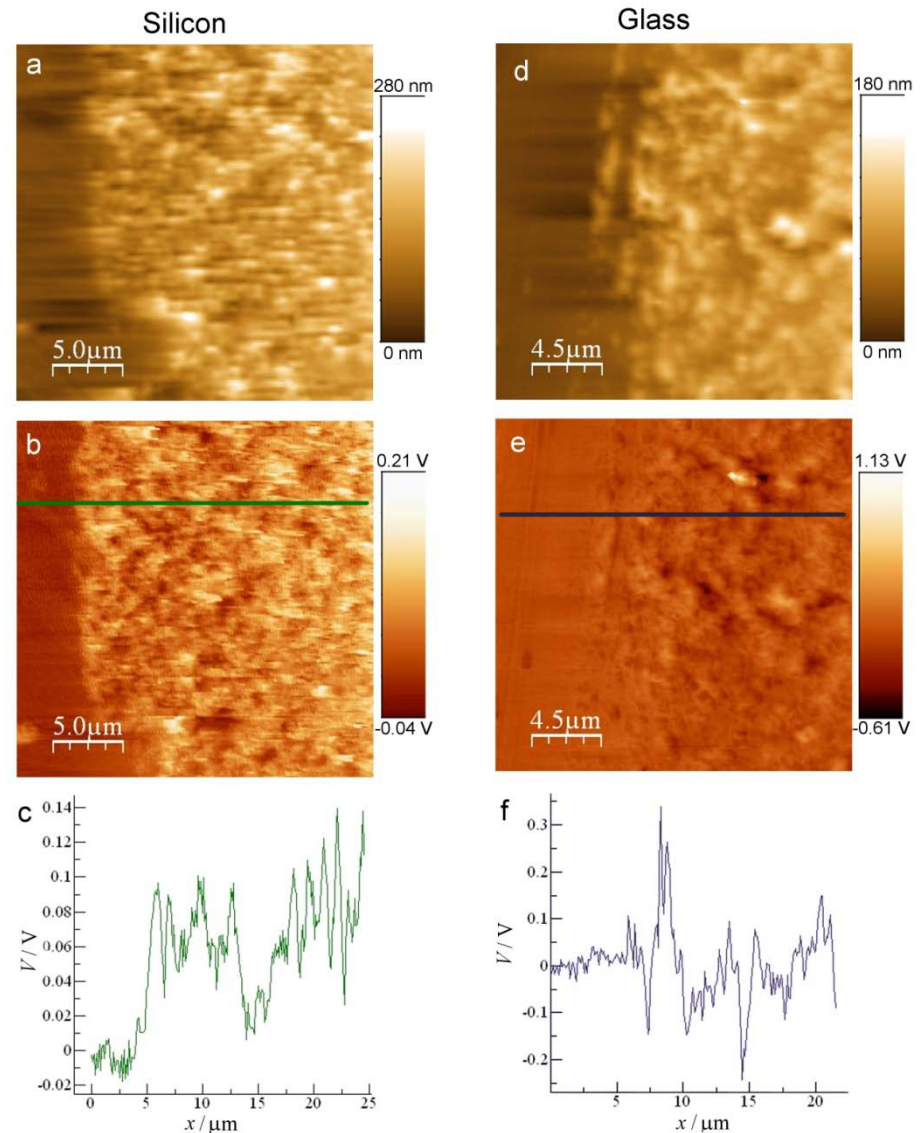
- Mapping material distribution in composites
- Differentiation between bulk and surface properties
- Failure analysis
- Determination of phase miscibility
- Identification of contaminants

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.

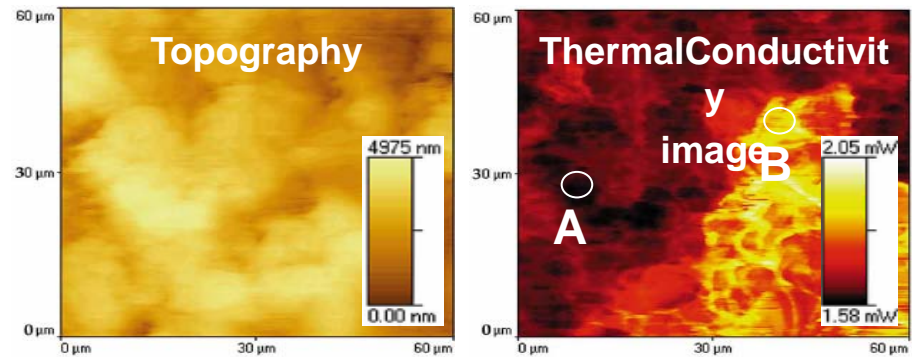
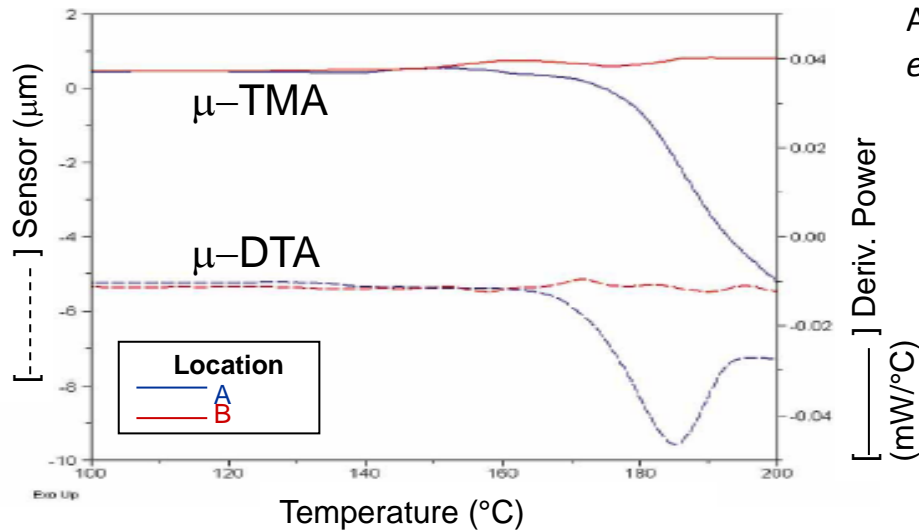
The increase in probe voltage, V , at the silicon:SWCNT film junction, shown in (c), indicates reduced heat dissipation from the tip by the SWCNT film. No increase is observed at the glass:SWCNT film junction, (f), indicating that the heat dissipation ability of the SWCNT film is similar to the glass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



M.B. Jakubinek, M.B. Johnson, M.A. White, J. Guan and B. Simard. *J. Nanosci. Nanotechnol.* **10**, 8151 (2010).

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!
- SThM is the ONLY current technique capable of sub-micron thermo-spatial resolution!
- Our SThM is the only instrument of its kind in Canada