The Scanning Thermal Microscopy (SThm) module from Anasys Instruments enables a number of commercially available Atomic Force Microscopes to generate nanoscale thermal images while simultaneously obtaining contact mode images of the topography. It includes hardware, software and probes and optionally a cantilever holder designed for your AFM. The SThM capability is a subset of the full suite of thermal analysis methods available, and can be easily upgraded to the full NanoTA2 system if your applications require that capability.

The SThM mode works by replacing the standard contact mode AFM probe with a specialized probe that incorporates a resistor near the apex of the probe tip. This resistor is incorporated into a Wheatstone bridge circuit which allows the system to monitor the resistance. The resistance correlates with the temperature at the end of the probe, which can be used to both monitor the temperature of a sample as well as map out the thermal conductivity of the sample in a qualitative manner. Sample temperatures are typically measured on active device structures, such as magnetic recording heads, laser diodes or electrical circuits. Conversely, thermal conductivity is more typically measured on composite samples. In this measurement, a higher voltage is applied to the probe increasing it further above room temperature. The thermal conductivity of the sample will affect the temperature of the probe by draining more or less heat away from the tip. Shown to the left is an image from a fiberglass sample showing the epoxy between three glass fibers. The sample has been sectioned and polished so the surface is flat. Planarization improves the performance of the SThM mode, whereas, significant topography can induce artifacts in the SThM image. The scan size is 3 µm with the topography on the left and thermal image on the right.
definition of the epoxy clearly shows the sub 100 nm lateral resolution capable with this system.

Anasys Instruments provides batch fabricated thermal probes which provide better than 100 nm resolution for both the topography and thermal images. Shown to the right are SEM images of one of these probes. The cantilever is made of SiN with a thin metal wire deposited so that the highest resistance portion of the wire is near the apex of the tip. These tips are premounted on supports and electrically connected for minimal handling and ease of use. Anasys Instruments has developed specialized cantilever holders for all of the major AFM manufacturers.

The Anasys Instruments electronics have been developed to be flexible and allow a range of resistive thermal probes to be used with the system. The system includes a simple software interface connected via USB to the electronics. This interface is capable of outputting a low noise, high resolution voltage to the probe. The voltage can be varied over a wide range depending on the probe type and the desired temperature of the probe. The other components in the bridge circuit are easily changed if required for custom experiments, and the system includes an input connection to apply AC voltages to the probe. Also adjustable through the software is a variable gain which makes balancing the bridge simple and quick. Once the system is adjusted using the Anasys software, the resistance of the probe is output on a BNC which is connected to a spare input channel on the AFM.

Shown to the left are SThM images from a magnetic recording head, showing the area around the read portion of the head. The read portion senses the magnetic bits by monitoring the resistance of a thin conductive film embedded in the head. In order to monitor the resistance of this film, a current is applied which causes heating of the film and surrounding material. The three images are SThM images showing the increased temperature (i.e. lighter colors) caused by increasing amounts of current flowing through the film.

SThM images of a magnetic recording head showing localized heating due to 3.5 mA (top) 5 mA (middle) and 6 mA (bottom) of current flowing thru the magnetoresistive element. Scan size = 25 x 6 µm

SEM Images of the entire cantilever (top) and the tip (bottom)
Features:

- System includes software, power supply, controller, CAL box, bridge cable and five SThM probes
- Probes come premounted for easy exchange and allow high resolution thermal imaging (<0.1°C) and heating up to 160°C
- Can be used to measure the temperature distribution on active devices such as electrical circuits, magnetic recording heads or laser diodes and waveguides
- Characterize the thermal conductivity of composite samples by monitoring the temperature change of the probe.
- Currently compatible with a number of commercially available AFMs, contact Anasys Instruments to see if your system is compatible with the SThM system

Requirements:

- AFM system must have available a spare analog input channel and a spare USB connection
- The operating system for the AFM must be Windows 7, 2000 or XP
System Specifications:
Controller:
Measurement Mode: Temperature contrast
Temp. Resolution: <0.1 °C (dependent on probe)
Output (Probe): 0-10V (16 bit resolution)
Output (AFM): +/-4.2 V (equivalent to probe resistance)
Input Signal: 16 bit ADC 1.2 Msps
Input Gain: 10X, 100X or 1000X (software controlled)
Controller: 67XX DSP with FGPA
Connection to PC: USB
AC Input: BNC connector on the CAL box allowing up to 50 kHz sine waves to be summed onto the output to the probe

Probe:
Max. Temperature: 160°C (dependent on probe)
Spring Constant: ~0.3 N/m
Resonant Frequency: ~50 kHz
Tip Radius: <100 nm
Tip Height: ~10 microns
Cantilever Length: 150 microns