Agilent Temperature Control

Data Sheet

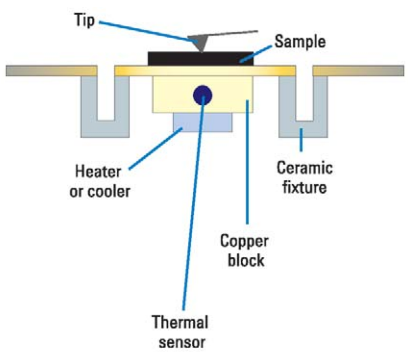

Figure 1. Patented design Ceramic fixtures insulate the stage from the sample plate and are symmetrically designed to compensate for thermal expansion and/or contraction. The Peltier device quickly heats or cools the stage to create a temperature gradient across the element.

Features and Benefits

- Precise temperature control from -30° C to 250° C with accuracy up to ±0.025° C offers lowest thermal drift available
- Open-access, modular design provides ease of use and quicker setup
- Simultaneous electrochemical and temperature control ensures full support of a broad range of applications
- Eliminates condensation with environmental control so there is no need to heat the AFM/SPM tip
- Works in air, liquid, and controlled environment to afford excellent versatility
- Patented design enables high-resolution imaging at extreme temperatures
- Rapid settling time helps yield results faster
- Three temperature ranges available to best meet application needs
- Heating: ambient to 250° C
- Single Peltier: 0° C to 40° C
- Triple Peltier: -30° C to ambient

Overview

Agilent's temperature controller uses a patented thermal insulation and compensation design to deliver precise temperature control for high-resolution scanning probe microscopy (SPM). It allows imaging during temperature changes and is fully compatible with all imaging modes.

The unique sample plate has built-in temperature control and offers excellent thermal stability for SPM imaging. The temperature controller provides a rapid settling time, thereby allowing the sample plate to reach temperature quickly and hold constant temperature for long periods of time.

Agilent's temperature control design isolates the sample plate from the rest of the SPM system. An insulated ceramic fixture protects the surrounding apparatus from the effects of heating or cooling, thus providing the most precise, stable temperature control available for SPM. (Figure 1.)

Temperature	Drift Rate in X-Y	Drift Rate in Z
Room Temp.	< 5 Å/min	<0.2 Å/min
100° C, 30-60 min. setting time	< 30Å/min	<2 Å/min
230° C, 30-60 min. setting time	<45 Å/min	<4 Å/min

Extremely low drift rate demonstrated at various temperatures.

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Three Plates Available

Three temperature control plates are available. These plates can heat, cool, and precisely maintain extreme temperatures (from -30° C to 250° C; ±0.1° C or ±0.025° C for the 5100 & 5500 and 5° C to 250° C for the 5400) during SPM imaging and spectroscopy. (Figure 2.)

The Agilent temperature plates are easily added to any member of the AFM/SPM product lines. The plates are seamlessly integrated with the compact, rigid design of the microscope and top-down multipurpose scanners in order to provide exceptional flexibility and ensure high-resolution results.

These three plates are also compatible with Agilent's environmental chambers, so vapor condensation can virtually be eliminated — even at extreme temperatures. The plates are compatible with Agilent's fluid cells as well.

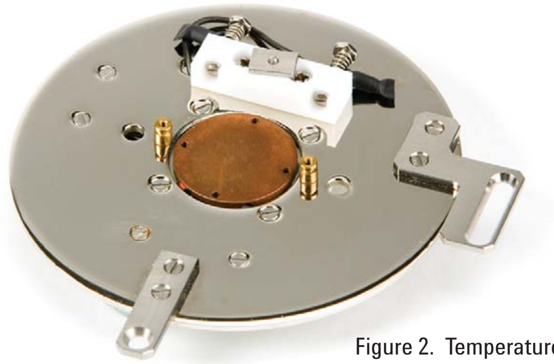


Figure 2. Temperature control sample plates.

Figure 3. Industry leading environmental control for the 5500 AFM system.

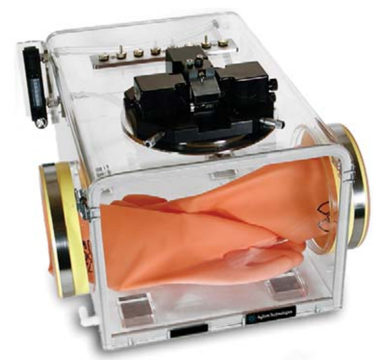


Figure 4. Miniature glove box for the 5500 AFM system.

Temperature and Environmental Control

Agilent offers a complete solution for AFM and SPM imaging in ambient air or fluids under controlled temperature and environmental conditions. When used with our environmental isolation chamber or glove box, the Agilent temperature controller provides unparalleled capability for high-resolution imaging. Sample contamination and water condensation are eliminated.

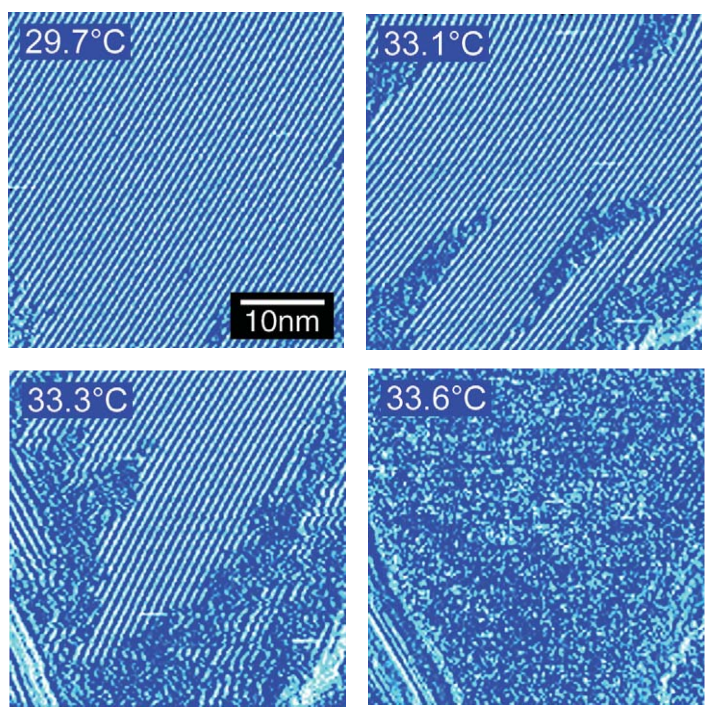


Figure 5. *In situ* images of 2,2'-bipyridine molecules on Au(111) in 50 mM H_2SO_4 under electrochemical and temperature control.

Application Suitability

Temperature control plays a critical role in SPM research. Temperature can be used to modify molecular structures and accelerate, inhibit, and control the rates of many chemical reactions. In material sciences, temperature is used to control phase transition of materials such as co-polymer and crystal growth. Temperature also plays a very important role in life sciences. For example, physiological processes can be accelerated or decelerated, the structures of many biological molecules can be altered, and biomolecular binding events can be controlled all by heating or cooling.

Applications

- Biomolecular studies: decrease temperature to stabilize or anneal molecules; increase temperature to induce melting transition or denature molecules; perform experiments at physiological temperature
- Surface chemistry and polymer studies: control reaction rates; induce phase transitions; induce thermal degradation
- Corrosion studies: accelerate oxidation reactions; mimic corrosion conditions
- Studies of mechanical or electrical temperature-dependent properties in all applications

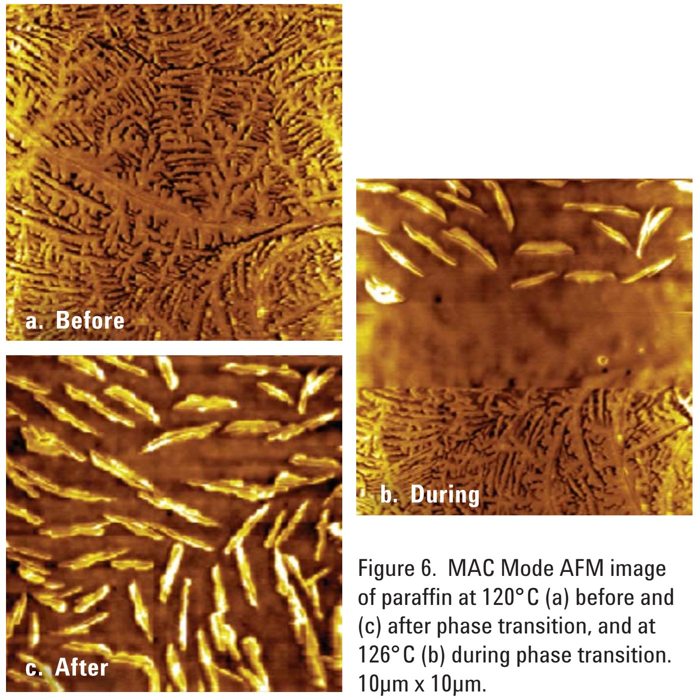
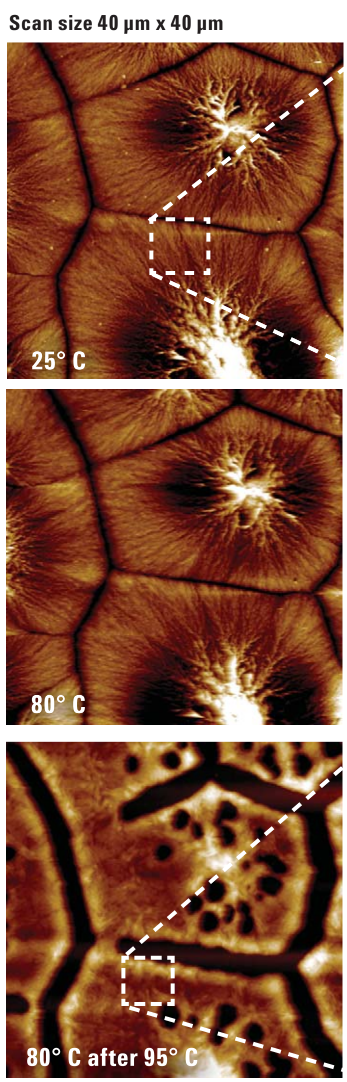


Figure 6. MAC Mode AFM image of paraffin at 120° C (a) before and (c) after phase transition, and at 126° C (b) during phase transition. 10µm x 10µm.



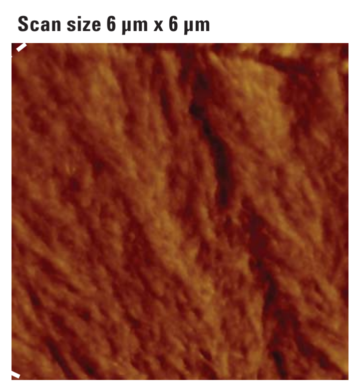
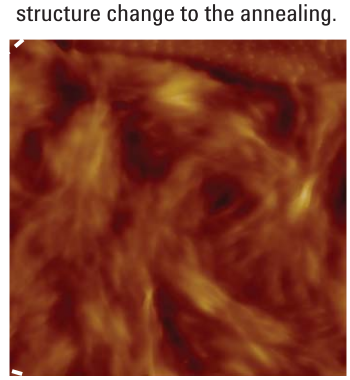


Figure 7. *In situ* and temperature-dependent AFM studies of polymer low density polyethylene (LDPE). The images on the left are acquired at 25° C (top), 80° C (middle) and 80° C after heating over 95°C (bottom), respectively. It shows that LDPE can withstand a temperatures of 80° C for a long time, but heating above 95° C will lead to a structure transition. The two images on the right are *in situ* zoom-in demonstrate the structure change to the annealing.



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