

Atomic Resolution Imaging in STM using attocube Positioners

Since its invention (1983) and Nobel prize (1986), Scanning Tunneling Microscopy (STM) and related Scanning Probe Microscopies have become some of the most important new laboratory techniques for studying sub-nanoscale surface phenomena.

STM works by scanning a sharp conductive tip over a surface. A bias voltage is applied between the tip and a conductive sample. When the sample is approached within a few Å from the tip, a tunneling current can be established indicating the proximity of the tip to the sample with very high accuracy. Most of the tunneling current can flow through a single protruding atom on the tip and sub-Å resolution in z can be achieved on a clean surface with a sharp tip.

There are two different modes in STM:

In constant height mode, the tip is moved only in plane. Thus, the current between the tip and the sample surface visualizes the sample relief. In this mode, adjustment of the surface height is not required and a higher scan speed can be obtained. Anyway, constant height mode is only applicable if the sample surface is very flat, because surface corrugations higher than 5-10 Å will cause the tip to crash. In this case, maintaining a constant tunneling current by adjusting the height with a piezo element and monitoring the piezo voltage while scanning, allows to image the surface. This mode is called constant current mode (see Fig. 1).

STM gives true atomic resolution on selected samples even at ambient conditions. This technology can be applied to study conductive surfaces or thin nonconductive films and small objects deposited on conductive substrates.

Dr. Amakusa (JEOL, Japan) is currently building a STM operating at low temperatures and high vacuum conditions. The scan head has been fabricated using attocube system's ANPz100 (Fig. 2) for the tip approach. This ultra-stable linear positioner provides atomic resolution over a travel range of 6 mm.

The image shown in Fig. 3 was acquired at room temperature and high vacuum conditions (2×10^{-8} mbar) on a Si(111) surface in constant current mode (tunneling current: 0.2 nA, bias voltage 2.0V, scan range 38 nm x 38 nm). Atomic resolution can be achieved!

Reference:

(1) The data was generously provided by Mr. Amakusa, JEOL, Japan and Dr. Hosoi, Hokkaido University, Japan.

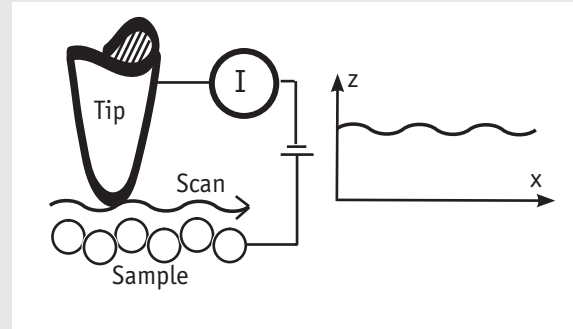


Fig. 1: Schematic illustration of the constant current mode.



Fig. 2: The ultra-stable ANPz100.

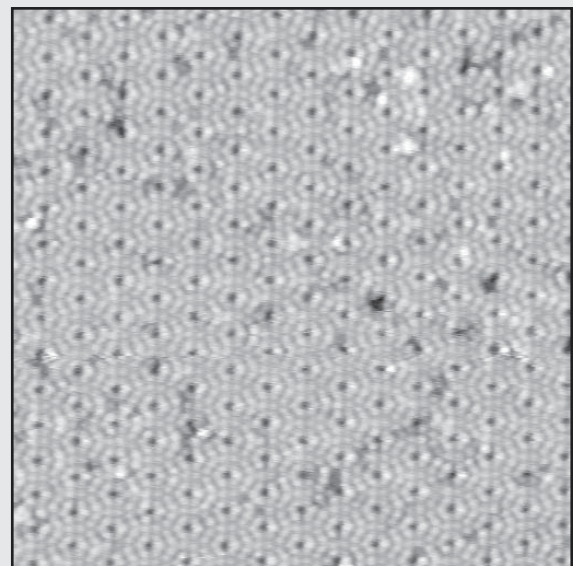


Fig. 3: Atomic resolution image of a Si(111) surface recorded at room temperature and high vacuum conditions. The scan area was 38 nm x 38 nm. Image by courtesy of Mr. Amakusa, JEOL, Japan and Dr. Hosoi, Hokkaido University, Japan.

RELATED PRODUCTS

ANPz100	high precision, piezo electric, inertial positioner
ANC150	electronic controller