High Precision local electrical Probing:
A New Low Temperature 4-Tip STM with Gemini UHV-SEM Navigation

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Abstract

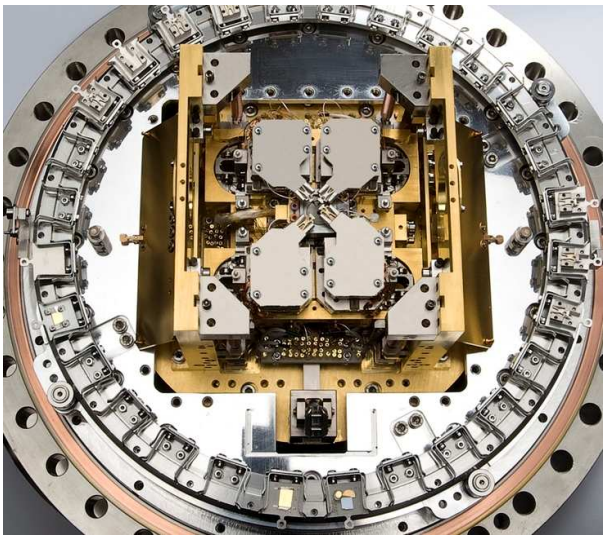
Developments in commercial surface science instrumentation regularly follow the major trends in science. The variety of instrumental approaches is as wide-ranged as science itself. Therefore, the identification of relevant analysis techniques and their advancement towards ease-of-use and a routinely accessible performance level represent a major challenge for enterprises. Beside *OMICRON´s* major activities in conventional SPM, electron spectroscopy and thin film techniques, the class of "multi-technique" instruments represents another important R&D line that is in the focus of this presentation.

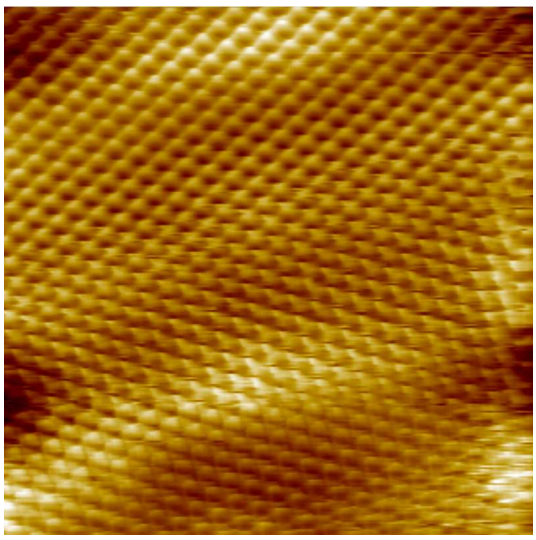
One prominent example in nanotechnology is the development of individual nano-scale devices. A tremendous variety of approaches exist and fundamental questions arise. Comprehensive concepts towards electrically integrated and therefore functional devices are however rare. Individual (metallic) nano-scale contacts represent one of the main challenges. High precision local electrical probing has the potential to increase efficiency in evaluating different approaches.

The OMICRON *UHV NANOPROBE* already meets the involved requirements: (1) Rapid and simultaneous SEM navigation of four local STM probes; (2) Localization of nanostructures by sub-4nm *UHV Gemini* SEM resolution; (3) Individual probe fine positioning by atomic scale STM imaging; (4) STM based probe approach for "soft-landing" of sharp and fragile probes and controlled electrical contact; (5) suitable low noise signal re-routing for transport measurements; (6) chemical/magnetic analysis by complementary analysis techniques such as SAM, SEMPA, CL and others.

And although the UHV NANOPROBE represents a flexible solution, especially in combination with complementary techniques, it´s concept is fundamentally limited in terms of lowest temperature and SPM resolution. Together with the Forschungszentrum Jülich, we thus have been developing a completely new design, the Low Temperature UHV NANOPROBE. It represents the evolution from a high performance probing system towards 4 simultaneously operating and high performing low temperature SPMs, navigated by SEM. The major R&D targets have been (1) equilibrium temperature of sample and probes at temperatures T<5K; (2) simultaneous SEM for probe navigation close to base temperatures; and (3) high STM performance of all four probes, truly suitable for manipulation and spectroscopy. First evaluation measurements will be presented: STM on Au(111) with pm stability, STS revealing the supeconducting gab of a Nb tip with approx. 3meV gap size, and first transport measurement at T<5K.

Figures





Left: Image of the LT NANOPROBE stage.

Right: STM on Au(111) at a temperature of below 5 K. The atomic structure and the herringbone reconstruction are clearly visible.