Editorial

This issue of CHIMIA commemorates the 30th anniversary of the invention of scanning tunneling microscopy (STM). The main inventors at IBM Research – Zurich in Rüschlikon, Gerd Binnig and Heinrich Rohrer received just five years later the Nobel Prize in Physics, which shows the extreme importance of this technique. Actually, STM can be considered as *the* method that initiated Nanotechnology.

STM is based on electron tunneling between a sharp tip and a surface. Based on the tunneling current the distance is controlled by clever electronics with an accuracy of picometers. An STM image results by scanning the tip over the surface (Fig. 1).

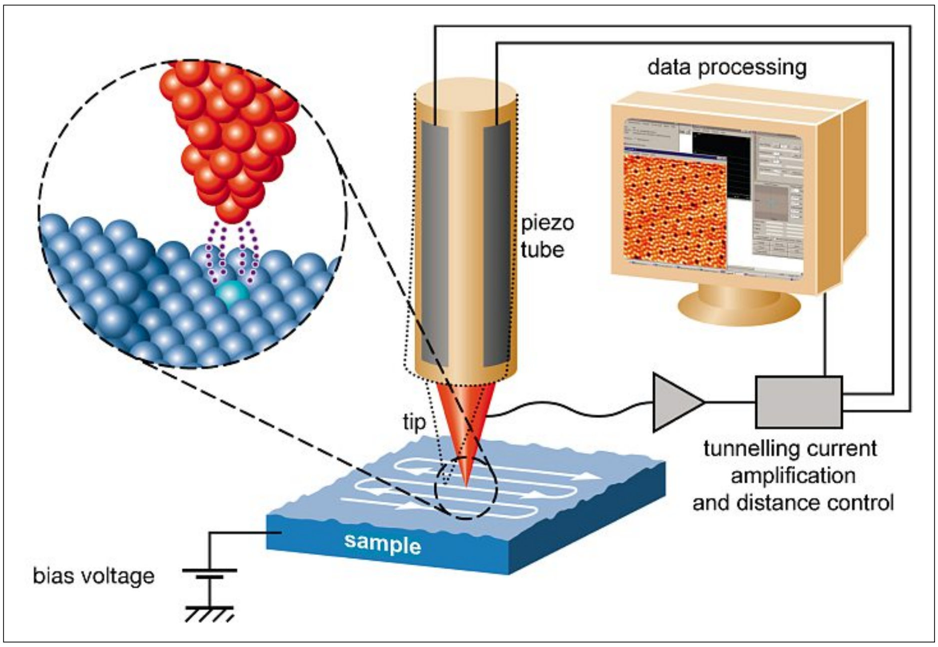

Fig. 1. Schematic set-up of standard STM as performed today. A piezo tube moves the tip in x, y and z direction. The tunneling current, highly sensitive to the actual distance to the conducting sample, is used for distance control.

This technique has become the most powerful tool in surface science, unraveling long-standing problems in the field. However, this method is not merely limited to imaging, but can be used to manipulate atoms and molecules. It goes far beyond repositioning of molecules into motifs, as presented on the cover, and allows excitation of molecules and atoms at surfaces *via* inelastically tunneling electrons. This excites electronic transitions or vibrations in single molecules (or both, see Swiss Science Concentrates, p. 64 in this issue for example) and may cause spin excitation in magnetic atoms. Besides a brief retrospect into the times of invention, this issue presents eight scientific contributions that show the large value of STM as research tool for different fields.

The first article of this issue is written by an 'eye witness'. In his personal account, ***Karl-Heinz Rieder***, staff scientist at IBM Rüschlikon at the time of the invention and later a leading figure in the STM community, recalls Binnig's and Rohrer's first steps to atomic resolution.

At the time he received the Nobel Prize, Gerd Binnig had co-invented another method that has had an even higher impact than STM today, the atomic force microscope (AFM). ***Gerhard Meyer et al.*** from the founder's laboratory at IBM Rüschlikon present how powerful STM and AFM are nowadays. Although depending on electrical conductivity, STM can also be used on very thin insulators. This allows a better imaging of electronic density in molecules, charging of single gold atoms and formation of chemical bonds between metals and molecules. Using single carbon monoxide molecules as part of the probe, their high-resolution AFM image of pentacene will certainly make it into the chemistry text books of generations to come.

In the last two decades, STM has proved its paramount importance for studying self-assembly of molecules at surfaces. ***Wolf-Dieter Schneider*** from the EPFL in Lausanne reviews aspects like chirality at surfaces, hierarchical self-assembly, tiling a surface simultaneously with molecular pentagons, hexagons and heptagons, and electron-tunneling-induced light emission from molecules.

The article by ***Christian Bobisch*** and ***Rolf Möller*** from the University of Duisburg-Essen (D) describes ballistic electron transport through different atomic and molecular layers and electron transport parallel to the surface plane. Therefore, they upgraded STM to ballistic electron emission microscopy (BEEM) and scanning tunneling potentiometry (STP).

The contribution by ***Ye-liang Wang, Hong-jun Gao et al.*** from the Institute of Physics of the Chinese Academy of Sciences in Beijing focuses on the importance of modification of the tip for the contrast. By using the Si(111) (7×7) surface, a system which had been studied with STM already by Binnig and Rohrer, they show that a sharper tip reveals more surface atoms than normally observed. In addition, they show how chemical modification with organic molecules or oxygen impacts the imaging.

That STM is not limited to vacuum tunneling is shown in two contributions concerned with STM performed at the solid/liquid interface. ***Steven De Feyter et al.*** from KU Leuven (B) describe self-assembly of molecules adsorbed from solution at the graphite surface. This approach allows insight of adsorption-desorption and conformational dynamics in flexible molecules.

Adding potential control in aqueous solutions, ***Knud Gentz*** and ***Klaus Wandelt*** from University of Bonn (D) describe the electrochemical-STM and their results of adsorption and self-assembly of ionic species.

Molecular electronics is a hot topic of Nanotechnology. The electrical conductance through single molecules is either measured in break junctions or with the STM. ***Harold Zandvliet*** from the MESA+ Institute of University of Twente (NL) presents two examples in which the molecule is either trapped between the STM tip and the surface or between nanowires on the surface.

The everlasting desire for smaller-sized magnetic storage devices required investigation tools with ultimate lateral resolution. The final article of this themed issue comes from the pioneer of spin-polarized STM, ***Matthias Bode***, now at University of Würzburg (D). He delivers two examples how magnetic domains and magnetic phenomena in thin films are resolved with the SP-STM.

Although certainly incomplete, this collection of articles gives the reader of CHIMIA a good overview of the power and the impact the STM provides for our understanding of surface phenomena and molecular sciences.

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The Editorial Board of CHIMIA would like to express its gratitude to Prof. Dr. Karl-Heinz Ernst for organizing this very interesting special issue marking the 30th anniversary of the invention of Scanning Tunneling Microscopy.

Cover Picture

The cover image (5 nm × 5 nm) shows twelve propene molecules that have been arranged into the Swiss Cross on a single crystalline copper surface. © Manfred Parschau, Empa.