THE KAVLI PRIZE

KAVLI PRIZE IN NANOSCIENCE 2016

The Norwegian Academy of Science and Letters has decided to award the Kavli Prize in Nanoscience for 2016 to

GERD BINNIG
Former Member of IBM Zurich Research Laboratory, Switzerland

CHRISTOPH GERBER
University of Basel, Switzerland

CALVIN QUATE
Stanford University, USA

" for the invention and realization of atomic force microscopy, a breakthrough in measurement technology and nanosculpting that continues to have a transformative impact on nanoscience and technology"

Sculpting and analysing nanoscale structures are at the core of nanoscience. An ultimate dream had been to position atoms on any surface, one by one, to enable the design and creation of revolutionary new structures. Imaging atomic structures in a wide range of material systems was another visionary concept. The invention of atomic force microscopy has turned these dreams into reality. Atomic force microscopy is now widely used in the fields of physics, chemistry, biology, and materials science.

In atomic force microscopy, a nanoscale tip scans across a sample surface at atomically close range. At the same time, the tiny forces between the sample and the tip are detected. These forces reveal many properties of the sample, such as the arrangement of its individual atoms, now with subatomic resolution. Electric and magnetic interactions, friction, and chemical bonding can induce these forces. The technique is applicable over a wide temperature range and in magnetic fields. Unlike scanning tunnelling microscopy, atomic force microscopy can also be applied to insulating materials.

Nanosculpting refers to adding, arranging, and removing atoms to produce desired phenomena and functions. The tip provides a versatile tool for accomplishing such control. Being able to manipulate conductors and insulators at the nanoscale has applications comparable to those of nanoscale 3D printing. Nanostructures created by force microscopy-based techniques include devices in nanoelectronics, nanophotonics, and nanomagnetism.

The advantages of atomic force microscopy include experimenting in liquids such as water, which opens the possibility of exploring biological systems. A single molecule, such as a DNA or a protein molecule, can be suspended between the tip and surface. Lifting the tip stretches and unfolds the molecule. The measured restoring force reveals the molecule's elastic properties and functionality. Biochemical sensors are utilizing the in-situ detection of chemical reactions by temperature-sensitive cantilevers, opening new doors for medical applications. In life sciences, explorations of molecular processes with high resolution advance drug design.

The invention of atomic force microscopy has spawned a wide variety of measurement and manipulation techniques invaluable for many purposes. These range from magnetic force and chemical force microscopy to magnetic resonance spectroscopy, and scanning capacitance microscopy. Another example is friction force microscopy that deepens our understanding of lubrication at the atomic level.

Atomic force microscopy is a powerful and versatile scientific technique that continues to advance nanoscience for the benefit of society.

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See also:

The Kavli Prize
www.kavliprize.org

The Kavli Foundation
www.kavlifoundation.org