The first tests in the INA project will relate to the surface structure of glass, its composition and production methods.

Atom optics for non-destructive nanoscale surface microscopy

Using advances in nanotechnology, a European research team proposes to improve on an imaging technique they pioneered. A microscope will be built, suitable for surface studies down to 20 nm, and will be tested to study the topography of glass. Although the experiments are primarily for scientific interest, if successful they will prove very useful to industry. The instrument is likely to have a tremendous impact on science since it will open novel opportunities for study – such as fragile biological probes or metastable materials – since samples will not require pre-treatment and will remain undamaged during analysis.

The team of engineers and scientists working on the 'imaging with neutral atoms' (INA) project proposes to develop a scanning helium-atom microscope which will make non-destructive and non-invasive surface investigations at the nanoscale a possibility. Their first tests will be to relate the surface structure of glass to its composition and production methods. But if they are successful, their microscope will help researchers working with a wide range of materials.

Atom-optics improvements

In the scanning helium-atom microscope the beam, composed of low-energy uncharged helium atoms, is brought to a focus on the sample by an atom optical element. In previous experiments, signal intensity was limited by the focusing technique, which used transmission lenses. The same limits will not apply in the new microscope, in which silicon-wafer atom-focusing mirrors will be used. The larger apertures these permit will allow greater signal intensity and, thus, make scanning helium microscopy possible for the first time.

The ideal mirror

The first atom-focusing mirrors were pioneered by two INA partners and basically consist of a chemically-prepared silicon wafer sandwiched between two alumina discs and suspended above an electrode structure. Applying an electric potential between the wafer and the electrode controls the deflection of the mirror into an aperture on one of the discs.

The production of the mirror surface for the current project will be challenging, as the partners will have to develop the necessary technology themselves. But it will be important too. The team includes pioneers in the field of scanning atom microscopy as well as experts in the preparation of ultra-thin wafers and optical equipment. To achieve the resolution they are aiming for, namely 20 nm, they plan to make various improvements to the mirror at both the macroscopic and atomic levels. These

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With its increased resolution, it is expected that the scanning helium-atom microscope will have applications in the study of fragile biological samples, for example.

INA

NEST ADVENTURE

AT A GLANCE

Official title

Imaging with neutral atoms

Coordinator

Austria: Institute of Experimental Physics, Graz University of Technology

Partners

- *United Kingdom: Surface Physics Group, Cavendish Laboratory, Cambridge University*
- *Poland: 1. Institute of Electronics Materials Technology; 2. Institute of Applied Optics*
- *Spain: Surface Science Lab, Universidad Autónoma de Madrid*
- *France: Saint Gobain Recherche*

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include reducing the error in the angle at which the crystals are cut, thereby minimising their warp; improving polishing techniques to ensure uniform crystal thinness; increasing the reflectivity of the mirror; and optimising the electrode structure.

Glass-surface topography

To test the equipment, once it is operational at the nanoscale level, the researchers plan to study the surfaces of different types of melt glass to identify a characteristic 'signature' for each type of glass. Glass surfaces look very similar when coming out of the melt, and atomic-force microscopy, which is also used to study glass surfaces, only reveals small differences in topography over a wide range. However, it is expected that the scanning helium-atom microscope used in the diffraction mode will be sensitive to both the topography and the chemical composition of the glass surface. These tests of the microscope on glass will, nonetheless, prove useful in themselves, in the preparation of glass formulations, where such a method is currently unavailable.

> By increasing the resolution to allow observation at the nano-scale, it is expected that the scanning helium-atom microscope will have widespread applications in both research and industry.

Microscope applications

With its increased resolution, it is expected that the scanning helium-atom microscope will have applications both in scientific research and industry. For example, it would be useful in the study of fragile biological samples, in companies involved in surface coating and for quality control in the semiconductor industry. As it has the potential to appeal to a wide market, the team anticipates that the microscope will eventually be manufactured.

SIXTH FRAMEWORK PROGRAMME