

Neutral helium atom microscopy

B. Holst, S. Eder, T. Reisinger and G. Bracco

Department of Physics and Technology

University of Bergen

Allegaten 55, 5007 Bergen, Norway

e-mail: bodil.holst@uib.no

Abstract

Surface science has been revolutionized in recent years by nano-resolution imaging techniques such as scanning tunneling microscopy (STM) and atomic force microscopy (AFM). It is often said that the field of nano-technology was born with the invention of the STM in the early 1980s.

In 2008 we presented results using a focussed beam of neutral helium atoms as a microscopy tool[2],[3], creating the first 2D image of an object obtained with neutral matter waves. The imaged object was a hexagonal Cu-grating, and the image was obtained in transmission by scanning across the object. The resolution was about 2 micron, determined by the size of the focussed beam.

Helium atom scattering is already known as a powerful probe for investigating the structural and dynamical properties of surfaces[1]. The two major advantages of using neutral helium atoms in microscopy are 1) the low energy of the helium beam (less than 100 meV for a de Broglie wavelength of 1 Å) and 2) the fact that the atoms are uncharged. This means that a scanning helium atom microscope can be applied with no sample damage and without additional sample preparation such as conductive coating. Hence it should be possible to investigate insulators, biological materials and all fragile samples which are difficult to examine by other methods.

In this paper we present new results demonstrating the first sub-micron focus of a neutral helium beam. The small spot size was created using a free standing Fresnel zone plate as optical element. Furthermore we present our design for a new neutral helium beam reflection scanning microscope, which we are currently in the process of constructing.

Keywords: Molecular Beams, Fresnel Zone Plate, De Broglie Atom Optics, Microscopy

References

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