SFB616
Energiedissipation an Oberflächen
UNIVERSITÄT DUISBURG ESSEN

4 November 2003 / 15:30 p.m., Room S 05 V 07 E 04

AFM Nanolithography Studied by Spectromicroscopy

Dr. Stefan Heun, Sincrotrone Trieste, Elettra, Italien

The fabrication of state-of-the-art semiconductor nanostructures is of great interest both for basic research and device applications. Besides the traditional lithography techniques, scanning probe microscopy (SPM) has attracted attention as a tool for nanofabrication because of its demonstrated ability to manipulate matter at the atomic level [1]. Among the various approaches to nanolithography by SPM, atomic force microscope (AFM) induced local oxidation is of particular interest, because working nanodevices have already been demonstrated by direct oxidation of the semiconductor surface [2]. In spite of the ease and the effectiveness of the AFM induced oxidation, little information is available on the chemical nature of the patterned oxide, mainly due to the lack of reliable techniques in order to perform a chemical analysis on such small structures. We addressed this open issue by a series of spatially resolved photoemission spectroscopy studies. As a model system we have studied AFM induced oxide lines on Si [3]. Oxide patterns of different widths and thickness were produced on n-type silicon by scanning an AFM tip, biased up to 15V negative with respect to the Si surface. The morphology of the structures was studied by AFM and low energy electron microscopy (LEEM). Spatially resolved chemical information is derived using synchrotron radiation with the spectroscopic photoemission and low energy electron microscope (SPELEEM) at the Sincrotrone Trieste. We monitored the binding energy of the Si 2p peak to study the different levels of oxidation of the AFM induced oxide patterns and of the native oxide on the unpatterned surface. The AFM induced oxidation produces a chemically uniform, stoichiometric silicon dioxide, independent of the oxidation bias. The observed charging effects allow to estimate the electrical properties of the AFM induced oxide. Also using SPELEEM, we studied the properties of AFM induced oxide patterns on GaAs. This material has a greater technological interest because most of the devices so far fabricated with AFM induced oxidation have been made on GaAs based heterostructures. Here the interpretation of the data is more complicated because a strong photodesorption of the oxide was observed. In spite of this difficulty we were able to monitor in a time-resolved fashion the chemical changes on the AFM induced oxide patterns during the desorption process.

REFERENCES

[1] D. M. Eigler and E. K. Schweizer, Nature **344** (1990) 524.
[2] A. Fuhrer, S. Lüscher, T. Ihn, T. Heinzel, K. Ensslin, W. Wegscheider, and M. Bichler, Nature 413 (2001) 822, and references therein.
[3] M. Lazzarino, S. Heun, B. Ressel, K. C. Prince, P. Pingue, and C. Ascoli, Appl. Phys. Lett. **81** (2002) 2842; Nucl. Instr. and Meth. in Phys. Res. B **200** (2003) 46.