Electron Beam Induced Modification of Organic Monolayers on Si(111).

E. Balaur[1], T. Djenizian[1], R. Boukherroub[2], and P. Schmuki[1]

[1] *Dept. of Materials Science, LKO, University of Erlangen-Nuremberg, Martensstr. 7, D-91058 Erlangen, Germany.*

[2] *Electrochemistry and thin films Materials Science Department Physique de la Matière Condensée Ecole Polytechnique 91128 Palaiseau Cedex, France*

Over past decades, strategies for high resolution patterning of chemically modified Si surfaces have attracted a large community of scientists. A particular field of interest is driven by the potential applications of functional molecules attached on silicon surfaces [1, 2]. Recently, electron-beam (e-beam) induced C-mask effect for electrochemical reactions has opened new perspectives for the patterning of semiconductor surfaces in the sub-100 nm range [3, 4].

During this work, interaction between e-beam and attached organic monolayers on Si surfaces is investigated using electrochemical reactions and electroless process.

Experiments were consisted of attaching various organic monolayers (e.g. C10 molecules) on Si(111). Subsequently, e-beam patterning was carried out on these so-called chemically modified surfaces using different electron doses.

It is clearly demonstrated that such organic molecules are strongly modified by the e-beam. As it is shown in Fig. 1 and 2, it has been found that e-beam patterns can activate or block completely deposition of copper.

The effect of e-beam on modified Si surfaces as well as copper deposits were characterized by scanning electron microscopy (SEM), atomic force microscopy (AFM) and Auger electron spectroscopy (AES). We demonstrate that the process is in the sub-100 nm range.

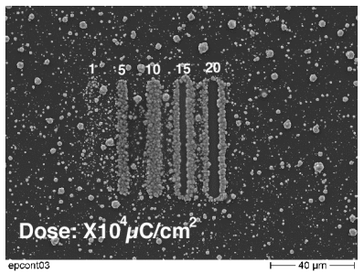

Fig. 1: Organic monolayers on Si (111) after e-beam induced modification followed by electrochemical deposition of Cu (V = – 600 mV *vs.* Ag/AgCl for 30 min in 0.1 M $CuSO_4$ + 1 M H_2SO_4). Irradiated areas consisted of five rectangles of 50x5 µm written with increasing electron doses.

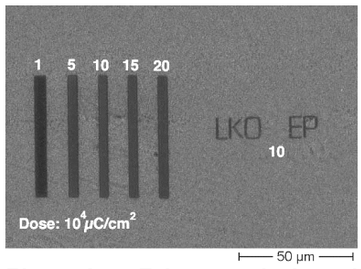

Fig. 2: E-beam induced modification of organic monolayers attached on Si(111) after deposition of Cu. The surface was patterned as described in Fig. 1. Deposition of Cu was carried out by electroless process in 0.1 M $CuSO_4$ + 0,5% HF for 30 s.

References:

[1] R. Boukherroub, F. Bensebaa, S. Morin, and D. D. M. Wayner, *Langmuir,* **15** (1999) 3831.

[2] R. Boukherroub and D. D. M. Wayner, *J. Am. Chem. Soc*., **121** (1999) 11513**.**

[3] T. Djenizian, L. Santinacci, and P. Schmuki, *Appl. Phys., Lett*. **78** (2001) 2940.

[4] T. Djenizian, L. Santinacci, H. Hildebrand, and P. Schmuki, *Surf. Sci*., in press (2002).