Electron-Beam Induced Carbon Nanomasking for Plating of Copper on Semiconductors

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Except for UV lithography, electron beam (e-beam) lithography is one of the most employed approaches to obtain high resolution patterning of surfaces. This technique is currently used to fabricate photolithographic masks as well as to produce a wide range of very small devices.

More recently, electron beam induced deposition technique has been investigated. The principle of the technique is based on the fact that e-beam can activate precursor vapor species adsorbed at the surface leading to a solid deposit at the point of impact of the beam. It has been observed that carbon based material can be grown if precursor species are the residual hydrocarbon molecules issued from the pump oil of the e-beam instrument.

In previous work, it has been demonstrated that such e-beam induced carbon deposition (EBICD) can act as a negative resist for electrodeposition of gold [1, 2] and for the formation of selective porous Si [3]. This EBICD technique has been used to produce structures in the sub-100 nm range as it is shown in Fig. 1.

The present work explores possibilities to extend the use of C-masks to suppress copper deposition at C-treated surface locations (see Fig. 2). Carbon patterns were written at different electron doses on n-type Si surfaces. Subsequently, copper was plated on e-beam patterned surfaces using both potentiostatic experiments and electroless deposition process.

The C-masks as well as the copper deposits were characterized by scanning electron microscopy (SEM), atomic force microscopy (AFM) and Auger electron spectroscopy (AES). We demonstrate that the lateral resolution of the process is in the sub-100 nm range.

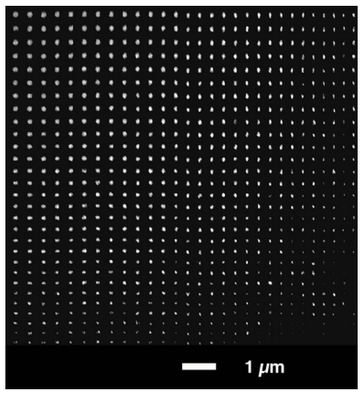

Fig. 1: SEM image of gold dots electrochemically deposited between two arrays of C-lines. Clusters were obtained by decreasing the distance between the C-patterns.

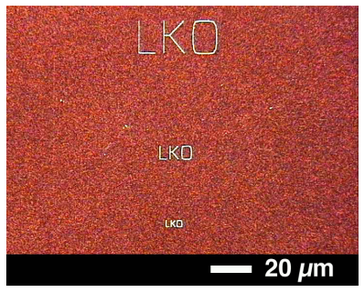

Fig. 2: Optical image of copper electrochemically deposited on Si surface carrying "LKO" as e-beam C-patterns. The C-treated locations can block completely the deposition of copper.

References:

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[2] T. Djenizian, L. Santinacci and P. Schmuki, *J. Electrochem. Soc.*, **148**, 197 (2001).
[3] T. Djenizian, L. Santinacci, H. Hildebrand, and P. Schmuki, *Surf. Sci.*, in press, (2002).