Electron Beam Induced Carbon Deposition Used for Nanostructures Fabrication

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Nanomachining and nanofabrication are rapidly finding applications in many areas from microelectronic components to biomedical devices. Due to new behavior of materials dominated by unique properties, nanoscale is not only just another step towards miniaturization but it is also a qualitatively new scale. That is the reason why nanoscience is at the center of an intense international competition in different fields including physics, chemistry, materials science and biology.

Lithography is the key technology that has driven the ever-shrinking dimensions in the sub-μm range. To date, even if optical lithography is the main technique employed to produce highly-accurate patterns, a range of techniques bearing the potential to achieve nanometer scale have been studied and established. In this context, lithography based on particles beam such as e-beam lithography as well as e-beam induced deposition reactions have been explored. In the latter case, the precursor molecules present or introduced into the vacuum chamber of an e-beam instrument decompose under the direct electron bombardment and form a solid deposit on the substrate surface. A specific case of e-beam induced patterning is the formation of carbon rich contamination layers in scanning electron microscopes (SEMs). The e-beam activates reactions of the residual hydrocarbons molecules issued from the pump oil to form a deposit with mechanical and electrical properties close to diamond (*i.e*: the deposits are electrically insulating).

Previous results have demonstrated that such e-beam induced C-deposit can act as a mask for electrochemical reactions [1-3]. In other words, e-beam C-based material of nanometer scale in thickness can block completely and selectively electrochemical reactions. During this work e-beam induced C-deposition conditions as well as electrochemical parameters have been widely investigated in order to produce various structures such as very small metal linewidth or selective porous Si in the sub-100 nm range as it is shown in Fig. 1 and 2.

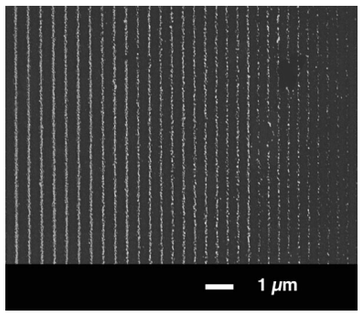

Fig. 1: SEM image of ultrasmall gold lines electrochemically deposited between C-lines. The distance between C-lines was reduced from the left to the right.

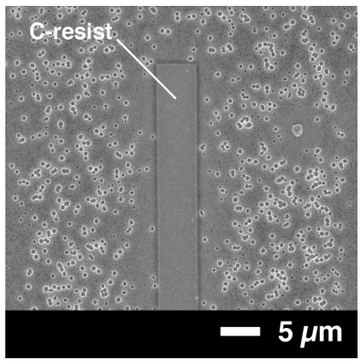

Fig. 2: SEM image of a Si sample carrying a C-pattern after porosification experiment. Absolutely no signs of pitting or etching are visible within the C-protected area.

References:

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