Electron Beam Induced Carbon Masking for Selective Porous Silicon Formation

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Due to its photo- and electroluminescence properties [1, 2], porous silicon has been widely studied in view of developing silicon-based optoelectronic devices. Previous works have produced light emitting porous silicon patterns using photolithography process [3], doping-induced selectivity [4] and amorphization-controlled selectivity [5]. It has been also demonstrated that selective porous silicon growth can electrochemically be initiated preferentially at surface defects created in a n-type Si substrate by Si^{2+} focussed ion beam bombardement [6].

E-beam induced deposition reactions have also been studied to create 3D nanostructures in the 1-100 nm range. In this approach, the e-beam activates gaseous precursor species introduced into the vacuum chamber of the e-beam instrument leading to solid deposits at the irradiated surface. Typically the precursor vapor species that are used are metallorganic compounds or, more simply, the residual hydrocarbons from the pump oil. In the latter case, (so called contamination writing), the hydrocarbon molecules adsorbed on the surface react under e-beam to form an amorphous structure of carbon, more specifically a layer of diamond-like carbon (DLC) that confers to the carbonaceous deposit electrical properties comparable to diamond. Such contamination writing has been successfully applied to achieve high definition patterning of semiconductor surfaces for subsequent metal electrodeposition [7, 8].

The present work explores possibilities to use C-masks for porous silicon patterning, *i.e*: to use e-beam C-deposits to suppress completely the pore formation process at e-beam treated locations. Characterization of the pores was carried out by SEM, atomic force microscopy (AFM) and photoluminescence measurements. We demonstrate that selective pore formation can be obtained. The high degree of selectivity of the process that can be achieved depends strongly on e-beam exposure and electrochemical parameters.

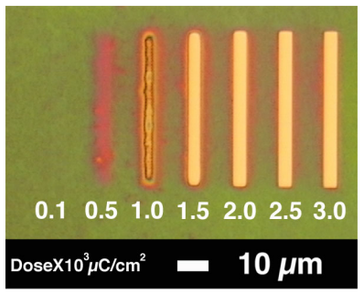

Fig. 1: Optical image of p-Si sample carrying rectangle C-mask patterns after anodization in 20 % HF solution). The surface is modified except at the e-beam C-treated locations.

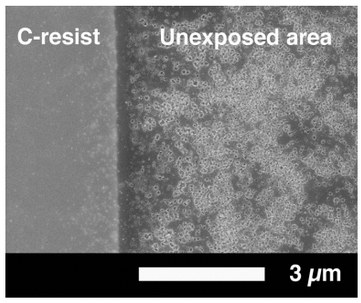

Fig. 2: SEM image of the interface C-masked area/porosified surface taken at the edge of the highest electron dose exposed pattern. Two distinct structures separated by a well-defined boundary are observed; the smooth part is attributed to the C-covered area.

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