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].

Previous own work has demonstrated that electron-beam (e-beam) induced carbon deposition acts as a negative resist for electrodeposition of metals on semiconductor surfaces. It has been shown that the e-beam activates the reaction of the residual hydrocarbon molecules issued from the pump oil in scanning electron microspe (SEM) chambers to form a deposit with mechanical and electrical properties close to diamond (*i.e*: the deposits are electrically insulating). Even carbon deposits in the order of 1 nm thickness are sufficient to block an electrodeposition reaction of materials completely selectively and thus can be used for high definition patterning of semiconductor surfaces in the 1-100 nm range [7-9].

The present work explores possibilities to use C-masks for porous silicon patterning, *i.e*: to use contamination writing in a SEM to suppress selectively the pore formation process at treated locations. p-type silicon (100) surfaces were patterned with different electron doses and anodized in a 20% HF electrolyte. We demonstrate that selective pore formation can be obtained. Characterization of the pores was carried out by SEM, atomic force microscopy (AFM) and photoluminescence measurement. Auger Electron Spectroscopy and cathodoluminescence experiment confirmed the high degree of selectivity of the process that depends strongly on e-beam exposure and electrochemical parameters.

References:

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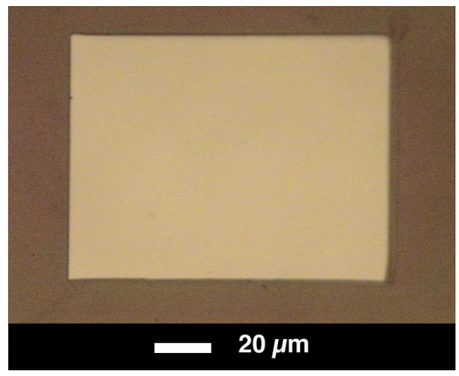

Fig.1: Optical image of sample carrying C-mask pattern as in Fig.1 after anodization in 20 % HF solution. The C-masked area contains absolutely no pores and acts as a negative resist.

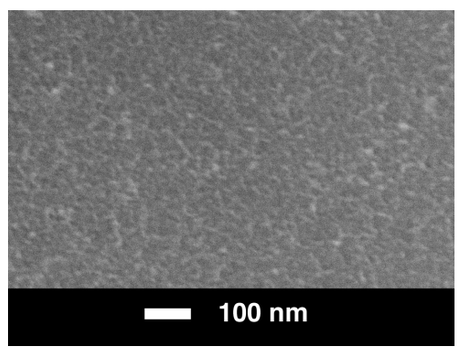

Fig.2: SEM image of porous silicon surroundind the C-patterned.