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Morphological and structural effect of aluminum on Macroporous silicon layers

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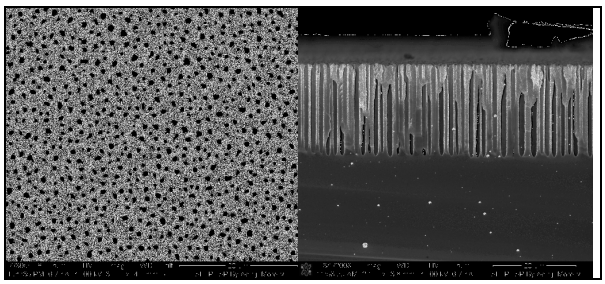
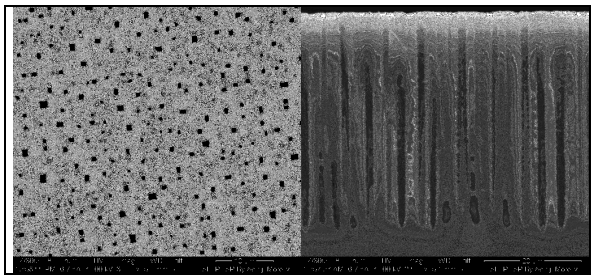
Abstract – Macroporous silicon with rectangular and squares pores were obtained by electrochemical anodization process of the p-type silicon substrate, before anodization process the Aluminioum thin film was deposited on the pulishized surface side of silicon wafer and follow by annealin process at N_2 emviroment. In this work, the aluminum thin film anneling time effect on the pores size and density were studied and disussed.

The macro porous silicon (MPS) structures conventionally are obtained in HF-based aqueous solution using n-type silicon or in p-type silicon using HF-based organic solution [1]. The silicon substrate type and the electrolyte solution used in the MPS formation determine its structural, physical and chemical features [1,2]. In general, the MPSs were obtained at the cleaned front side of polished silicon wafer which results in, almost circular pores in despite of the type of the organic solvent used in electrolyte solution (Figure 1) [2]. The present work reports the MPS fabrication with the square or rectangular shapes pores. These structures were obtained by electrochemical anodization process in the HF-based solution mixture with two types of organic solvent (DMF or ACN). Previous to electrochemical process the front polished side of silicon wafer had been metallized with aluminum follow the annealing process in the N_2 environment at temperature of the 500 ^{o}C. In order to identify the annealing effect on the pores size distribution and density, the different samples were obtained corresponding to different annealing times of the 0.5, 1.0, 1.5 and 3.0 hours. In despite of the organic solvent used, the MPs obtained in this way showed rectangular pores with high aspect ratio, some of them showed to have trench features also with high aspect ratio (Figure 2). These pores or trenches showed to have a preferential crystallographic orientation at it can be seen in the 2a. The annealing time increasing, of samples before the anodization process, increase on the thickness of the formed layer. The relationship between the annealing time and the thickness of the layers showed to have approximately a linear relation. The present works discuss the possible mechanism of rectangular pores formation as well as its etching rate dependence from the annealing time in the sense of Al diffusion into silicon substrate after annealing process. As far we know the high aspect rectangular pores formation is reported at the first time in the present work.



a) b)

Figure 1: The SEM image of the MPS structures obtained at non Al metallized on the front polished side of the silicon substrate showing: **a)** Surface features with characteristic pores. **b)** The SEM image of the cleaved sample.



a) b)

Figure 2: a) The SEM image of surface and **b)** The cleaved sample of the MP structure obtained from the silicon wafer with previously metallized the front side with Al follow the annealing process.

[1] H. Föll, M. Christophersen, J. Cartensen, G. Hasse, Mat. Sci. Eng. R. **39**, 93 (2002).
[2] V. Kochergin, H. Foell, . Sci. Eng. R. 52, 93 (2006).