Characterizations of Porous Silicon Layers Formed on Modified Silicon Surfaces

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Porous silicon has been the interest of scientific research after the discovery of its strong visible photoluminescence at room temperature. Although porous silicon is readily formed by anodic polarization of silicon in HF-based solutions, the surface and optical properties of such microstructures are not well controlled. It is recognized that surface chemistry plays an important role in the formation of porous silicon microstructures. Surface products generated during wafer etching processes can significantly influence the growth of porous silicon.

In this work, a 3-electrode flat cell was used to fabricate porous silicon. The cell was made of Teflon. The working, auxiliary and reference electrodes were p(100) silicon wafers, platinum foil, and saturated calomel electrode, respectively. Chemical and electrochemical methods were employed to modify wafer surfaces before or during the formation of porous silicon microstructures. In chemical pre-treatment, the silicon surfaces were exposed to 1:1 (by volume) 20% HF and ethanol solutions for different periods of time before applying a constant anodic potential of 6V for 10min. In periodic polarizations, both anodic and cathodic potentials of 6V and 3V were repeatedly applied to silicon surfaces with intervals of 30s and 15s, respectively, for total time of 10min (as illustrated in Fig. 1). The surface and optical properties of porous silicon microstructures formed on modified wafer surfaces were examined by scanning electron microscopy and Raman spectrometer.

The cross-sectional morphologies of porous silicon formed by pre-treated the silicon wafers for different periods of time are shown in Fig. 2. It is interesting to note that the thickness of porous silicon microstructures slightly decreased with the increase of pre-treatment time ranging from 0.5h to 4h. However, more uniformly distributed pores were observed when the pre-treatment of wafer surfaces was 2h.

The surface and cross-sectional morphologies of porous silicon formed at the center and at the edge of samples by constant potential application and by periodic potential application are compared in Fig. 3. It is evident that the porous silicon formed by periodic potential application displayed more uniform and thicker microstructures. In addition, the pores formed by periodic potential application were better defined and filled almost no products within the pores.

Acknowledgement

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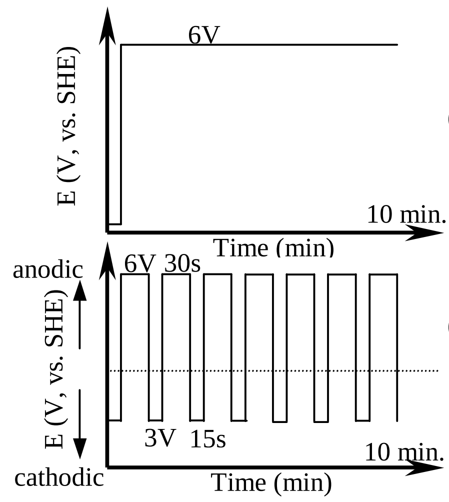

Fig. 1 A schematic representation of potential applications (a) constant potential application (b) periodic potential application

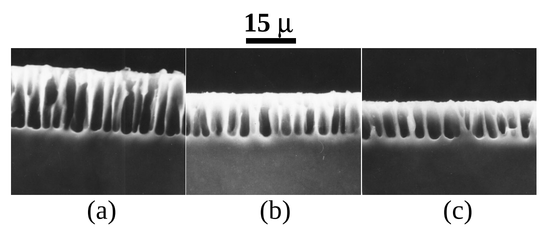

Fig. 2 Cross-sectional morphologies of porous silicon formed on modified wafer surfaces by pre-treatment for (a) 0.5h (b) 2h and (c) 4h

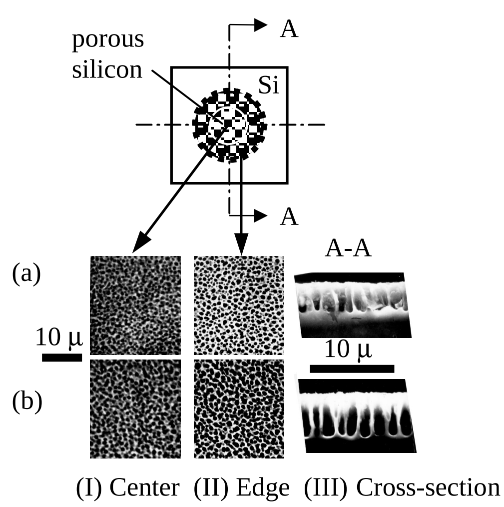

Fig. 3 Surface and cross-sectional morphologies of porous silicon formed by (a) constant potential application (b) periodic potential application