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Simple way of SiO2/Si ion-track templates parameters characterization

The use of porous templates for controlled formation of nanostructures and nanosystems requires reliable method of pore size, shape, quantity per unit area (porosity), distance to nearest neighbors and porous matrix thickness monitoring. The scanning electron microscopy method allows to estimate these parameters, however, manual processing of obtained images is a very time-consuming task. Taking into account that the use of ImageJ software makes it possible to significantly simplify the process of detailed statistical information about templates surface obtaining, the work describes in detail the methodology for analyzing of scanning electron microscopy images of SiO2/Si ion-track templates surface to control pore size, shape, unit area and distance to the nearest neighbors. The method for estimating thickness of SiO2/Si ion-track template based on processing of data about surface is also proposed.

Amorphous SiO2 layers were thermally grown on (100) n-type (P-doped) silicon wafers of 524 nm thickness in a pyrogenic environment at 1050 ℃. Irradiation of the SiO2/Si substrate was carried out at the DC-60 accelerator (Astana, Kazakhstan). Samples were irradiated at normal incidence with Bi ion of energy of 1.75 MeV/nucleon, at fluence 2 × 107 cm2. Low fluences were chosen in order to minimize the spatial overlap of the individual conical pores appearing after etching of latent tracks in SiO2. Transformation of ion tracks into pores was carried out by etching in hydrofluoric acid at a concentration of 1% for 58 minutes. Morphology of the porous samples was characterized by field emission scanning electron microscopy (SEM), using a JEOL JSM-7000F microscope and processed using ImageJ software. The average diameter of a single pore was determined, which was 0.39 μm. The total area of the image was 371.84 μm2, which allowed calculating the number of pores per unit surface, which was 1.85 × 107 cm2. The results of measurements of the thickness of SiO2 using the ellipsometry method showed l = 0.255 ± 0.001 μm.

It is important to note, that the techniques described not only allow to effectively control SiO2/Si ion-track template pore parameters, but also suitable for other types of porous templates.

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