INFLUENCE OF ANODIZATION PERIOD ON THE PHOTOACOUSTIC SPECTRA OF POROUS SILICON

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The discovery of efficient photoluminescence (PL) from electrochemically anodized porous silicon (PS) in 1990 initiated a strong research effort to understand PS properties. Optical absorption is the first step of the complex processes leading to PL. However, there are few results on optical absorption in PS on a silicon (Si) substrate in spite of the wealth of experimental PL data because of the strong scattering in the highly porous structure. However, these scattering effects can be minimized by employing photoacoustic (PA) method which is less sensitive to light scattering effects. In the PA method, one can detects an acoustic energy proportional to the thermal energy induced by nonradiative relaxation processes. In the present paper, we report the influence of anodization period on the PA spectra of PS layers.

The PS layers were formed on p-type Si(100) oriented wafers by anodization in HF electrolyte at a current density of 4 mA/cm^2 from 15 to 60 minutes in the dark at room temperature. After the anodization, the samples were etched in a solution of $HF:H_2O:C_2H_5OH=1:8:3$ for 5 minutes. PA measurements were carried out by the normal gas-microphone method. Measurements were carried out in the wavelength range of 320 to 1200 nm with the modulation frequency of 333 Hz.

Figure 1 shows the PA intensity spectra for PS layers with different anodization period. They show broad peaks centered around at 3.0 – 3.5 eV.[1] It shows the optical absorption character of PS layers because there are no constant contributions by Si substrate to the PA intensity. Hence, we can measure the optical absorption characteristics of the PS layers without removing the substrate. The PA intensity increases with the increase of the anodization period. It increases rapidly over an anodization period of 30 minutes, indicating the abrupt growth of the PS layers. Also, the PA phase spectra for PS layers with different anodization period show abrupt changes above the photon energy of 1.7 eV. The fundamental absorption edge of the PS layers derived from the assumption of indirect allowed transition of the PS layers is shown in Fig. 2 as a function of anodization period. Figure 2 shows a shift of fundamental absorption edge to higher energy region with the increase of anodization period, indicating that the quantum confinement effect is enhancing with the increase of anodization period. However, our preliminary PL measurements showed that the peak position of the PL (~2.0 eV) does not shift with the increase of anodization period, indicating that the PL of PS layers were dominated by small crystallites in the various size distribution.

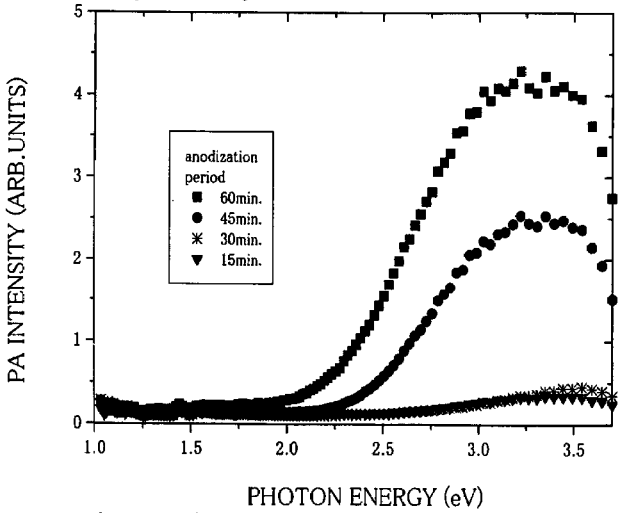

Fig. 1 PA intensity spectra of PS layers as a function of anodization period.

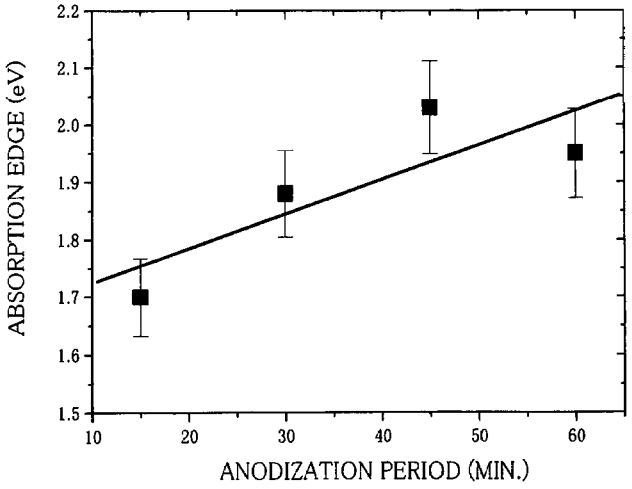

Fig. 2 The fundamental absorption edge of PS layers as a funtion of anodization period.

1) T. Toyoda, T. Takahashi, and Q. Shen, J. Appl. Phys. **88**, 6444 (2000).