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Thermal oxide effect on the photoluminescence of porous silicon

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The Photoluminescence (PL) in the visible spectral range at room temperature of porous silicon (PSi) discovered Canham in 1990 was explained by the size quantization effect of electron states in silicon nanocrystals [1]; since then the PL of PSi has been continuously studied, discovering that it may have different origins, besides the quantum effects. We report on the effect of thermal oxide grown on the PL of mesoporous PSi layers. The oxidation temperature is the main varied parameter. A set of PSi layers was prepared by electrochemical etching under the same anodizing conditions. The etched substrates were single side polished p-type Si (100) wafers with 0.01-0.02 Ω·cm resistivity. The etchant contained Ethanol:HF:Glycerol (60:30:10) in volume proportion. The produced pores have a diameter of about 15 nm. The set of samples were divided in two. Set 1 of PSi layers were thermally oxidized at 300°C under 10 ml/min O_2 gas flux for 3, 30 and 60 min. The PSi layers of set 2 were oxidized at 800 °C for 3, 30 and 60 min under the same oxygen flux. The PL of all the samples was recorded at room temperature, including an as grown PSi layer, to use it as a reference. Fig. 1 shows PL spectra of both sets of samples.

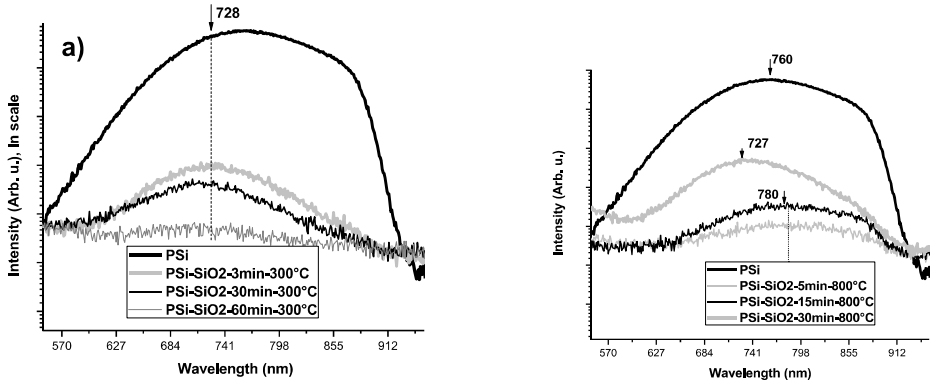

Fig. 1. PL spectra of PSi layers with thermal oxidation carried out at (a) 300°C and (b) at 800°C for different processing times. The PL spectrum of an as grown PSi layer is included for comparison.

From Fig 1(a) it is seen that as the oxidation time increases from 3, 30 to 60 min, the PL intensity of PSi diminishes drastically. We infer that in this case SiO_2 passivates the radiative surface states of PSi. In Fig. 1(b) the reverse effect occurs, that is, the longer the oxidation time is, the more intense the PL spectrum gets, probably due to a quantum confinement effect (the thickness of the pore walls is in the range of Si Bohr radius).

References

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