The effect of thermal oxide on the photoluminescent properties of porous silicon and of porous silicon impregnated with rhodamine 6G

E. Gómez-Barojas[(1)], V. Aca-López[(1)], R. Silva-González[(2)], E. Quiroga-González[(2)], E. Sánchez-Mora[(2)], F. Flores-Gracia[(1)], M. Aceves-Mijares[(3)], and J.A. Luna-López[(1)]

(1) CIDS-IC, Benemérita Universidad Autónoma de Puebla (BUAP). Apdo. Postal 196, Puebla, 72000, Pue. México.
(2) Instituto de Física, BUAP. Apdo. Postal J-48, Puebla 72570, Pue. México.
(3) Instituto Nacional de Astrofísica Óptica y Electrónica. Apdos. Postales 51 and 216 Puebla 72000, Pue. México.

email: egomez@ifuap.buap.mx

In the present work, the effect of SiO_2 thermally grown on PSi and PSi infiltrated with rhodamine 6G on the photoluminescent properties of these materials has been studied. PSi films have been synthesized by electrochemical etching of single side polished p-type (100) Si wafers with resistivity of 0.01-0.02 Ω·cm, applying a current density of 20 mA/cm^2 for 20 min. The etching solution contained ethanol (purity 99.5%), hydrofluoric acid (45%) and glycerol (99%), at volume proportions 60:30:10. The samples exhibit 61 % porosity and thickness of 21 μm. The PSi samples were thermally oxidized (PSi-OX). Afterwards, the samples were silanized by dipping them into a solution containing 2:5 v/v of 3-mercaptopropyltrimethoxysilane (MPTS) and 2-propanol for 15 min. Finally, the samples were infiltrated with a solution 1.2 M of rhodamine 6G (RD) in ethanol, by dipping them in that solution for 1 h. SEM micrographs of as etched samples present pores with diameter of about 19.6 nm and average pore wall thickness of 12 nm. PL spectra of as prepared samples present an intense broad peak centered at 707 nm. This PL emission quenches in PSi-OX sample (see Fig. 1). Nevertheless, when RD is incorporated in the PSi-OX films previously silanized with MPTS (PSi-OX-MPTS samples) the PL spectra present shapes similar to the ones of RD solutions. From this, it can be inferred that RD is well absorbed in the hydrophilic PSi-OX-MPTS films since RD preferentially interacts with oxygen terminated rather than with H terminated surfaces [1,2]. Interestingly, it has been observed that the intensity of PL spectra show a nonlinear relation with respect to the RD concentration. On the other hand, the PL spectra of PSi samples that were not oxidized, but silanized with MPTS and infiltrated with RD show a PL emission peak with similar shape to the one of as prepared PSi samples, but the intensity varies in a nonlinear relation as the RD concentration is increased.

According to the pore diameter and the average wall thickness of PSi layers it is inferred that the PL of PSi films is originated by surface defects rather than by quantum confinement effects.

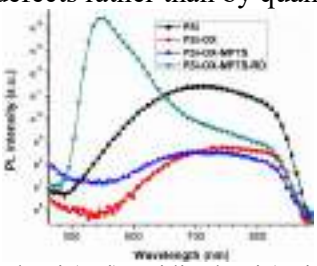

Fig. 1. PL spectra recorded from: as anodized PSi (PSi), oxidized PSi (PSi-OX), oxidized and silanized PSi with MPTS (PSi-OX-MPTS) and oxidized and silanized PSi, infiltrated with a 1.2 mM RD solution (PSi-OX-MPTS-RD).

Acknowledgement

This work has been partially supported by CONACYT through a scholarship and by SEP- IFUAP-CA190.

[1] Chouket, A. et al. *J. Thin Solid Films*, **518** (2010) 212-216.
[2] Kontkiewicz, A. et al. *J. Appl. Phys Lett.* **65**, 11 (1994) 1436-1438.