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Photosensitive Devices Structures Based on Low Porosity Porous Silicon

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Abstract – The photosensitive properties of porous silicon (PS) layers on p-type silicon were studied in Au/PS/p-Si/Al structure with two HF etching times. The optical characteristics of the photodiode were compared under different light sources: a cold white lamp with an IR filter and LEDs in a wavelength range from 465 nm (blue) to 945 nm (IR); and in the PS photoluminescence study two peak emission at 1,14 eV and 2,11 eV are presented for the sample with lower HF etching time. Gold thin films have been deposited on the PS surface to form metal-semiconductor junctions and the linear dependence between the measured photocurrent and the illumination power are obtained.

Porous silicon (PS) presents a large area-to-volume ratio, high resistivity and direct bandgap energy [1]. These intrinsic properties make the PS a suitable material for photodetectors [2,3]. The optical property depends on the PS layer thickness and morphology. The minimization of the optical losses has been obtained by controlling the electrochemical etching for the formation of thin PS layers on p-type silicon and by improvements in the photodetector fabrication [4,5].

Preliminary work with samples of PS made highly doped substrates has shown poor quantum efficiency. The sensitivities reported 0.3 A/W in near UV range and about to 0.5 A/W in near to IR range [3] and greater than 3 A/W at wavelength region in the near UV [6,7] and IR [7]. The effects of fabrication parameters on the photoluminescence of PS have been the subject of study in recent years, especially in the visible [8] and near UV [9,10] regions. The PS photodevices have attracted because of the easy fabrication, uniform and reproducible porous layer across the wafer, their simplicity and responsivity. Thus they represent a potential candidate for low cost monitoring, such as photodiode based on a Metal/PS/p-Si/Metal structure [7,11] and Metal/PS/Metal photodiode [6,7,12].

Several authors have presented conduction mechanisms that explain the electrical transport in the PS photodiodes such as Schottky barrier with aluminium contact [2,3,9] and another rectifying effect that may be due to the carrier diffusion with another metal such as gold contact [7,11].

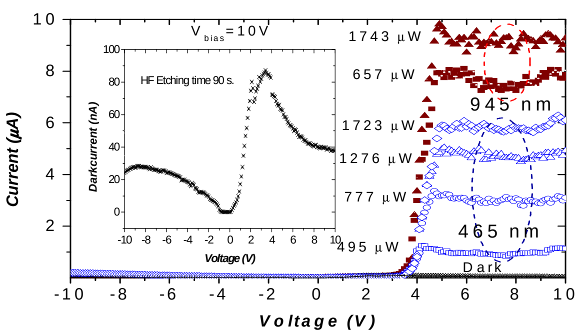

Figure 1: The photoresponse characteristics of sample A measured for a blue LED (open symbols, 465 nm) and a IR LED (filled symbols, 945 nm). The dark current is shown in the inset.

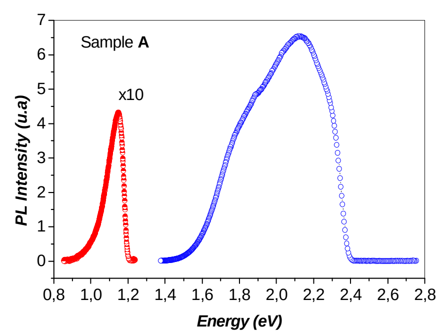

Figure 2: Photoluminescence spectra of PS layer with two peak emission in the regions of near UV and IR.

References

[1] V. Parkhutik, Solid-State Elect., 43 (1999) pp 1121 – 1141.
[2] L. Pavesi et al, J. Appl. Phys., 75 (1994) pp 1118 – 1126.
[3] M.K. Lee, C.H. Chu, Y.H. Wang, S.M. Sze, Optics Lett., 26 (2001) pp 160 – 162.
[4] M. Ohmukai, Y Nishinori, Y. Tsutsumi, Sci. Tech. Adv. Mat., 2 (2001) pp 455 – 457.
[5] D.A. Kim, J.H. Shim, N.H. Cho, Appl. Surf. Sci., 234 (2004) pp 256 – 261.
[6] A.M Rossi, H.G. Bohn, Phys. Stat. Sol. A, 202 (2005) pp 1644 – 1647.
[7] F. Fonthal et al, AIP Conference Proceeding RIAO/OPTILAS 2007, 992 (2008) pp 780 – 785.
[8] M. Naddaf, H. Hamadeh, Mat. Sci. & Eng. C, Accepted Manuscript (2009).
[9] T.V. Torchynska et al, Thin Solid Films, 492 (2005) pp 327 – 331.
[10] H. Song et al, Appl. Surf. Sci., 254 (2008) pp 5655 – 5659.
[11] T. Hadjersi, N. Gabouze, Optical Materials, 30 (2008) pp 865 – 869.
[12] G. Gacía Salgado et al, Microelectronics J., 39 (2008) pp 489 – 493.