Virtual Instrumentation for Multilayered Porous Silicon Formation

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Porous silicon (PS) obtained by anodic electrochemical etching of monocrystalline silicon (Si) in HF solution has shown efficient visible photoluminescence at room temperature [1] and has demonstrated good perspectives for optoelectronic applications [2]. Although multilayers can be easily obtained by alterning current densities, important questions have been raised concerning PS multilayer structures, such as the quality of surface roughness depending on layer formation and thickness, for instance [3]. Here we address the question of obtaining precise and reproducible multilayer structures by means of an automatically controled apparatus with the use of virtual instrumentation.

Multilayered PS was obtained by anodization of (100)-oriented p-type substrates (400 mΩcm resistivity) by using HF (48%wt) as electrolyte. We developed a virtual instrument (VI) in LabVIEW 5.0 (National Instruments) in order to control a current source and to simultaneously measure current and voltage drop between electrodes. Moreover, acquisition, graphical presentation and storage of experimental data are performed on line within the system, composed by a personal computer, GPIB board and low-cost laboratory equipment.

Through the designed graphical user interface one can choose current densities, intervals for each density and number of periods for current steps. Control of other process variables such as various waveform generation are being implemented. In this work PS multilayers were formed applying 10mA/cm^2 for 5min, 100mA/cm^2 for 2min and 10mA/cm^2 for 5min, subsequently. The VI automatically controls and switches current density for the predefined periods of time.

The obtained PS multilayers have been measured and characterized by Raman spectroscopy and scanning electron microscopy. Main variables analysed were porosity, layer formation, reproducibility and precision in layer formation depending on time and current density.

[1] Canham, L.T. “Silicon quantum wire array fabrication by electrochemical and chemical dissolution of wafers”. *Applied Physics Letters*, v.57, p.1046-1048, 1990.

[2] Loni, A; Canham, L.T., Berger, M.G.; Arens-Fischer, R.; Munder, H., Luth, H.; Arrand, H.F.; Benson, T.M. “Porous silicon multilayer optical waveguides”. *Thin Solid Films*, v. 276, p. 143-146, 1996.

[3] Setzu, S., Ferrand, P., Romestain, R. "Optical properties of multilayered porous silicon", *Materials Science and Engineering*, v. B69-70, p. 34-42, 2000.