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Macroporous Silicon: Efficient Antireflective Layer on Crystalline Silicon

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Abstract – A macroporous silicon (ma-PS) layer electrochemically grown on crystalline silicon surface can be used as an efficient antireflective layer for the optical devices as antireflection coating and photodiode. In this work, we presented the ma-PS layers on n-type and p^+-type crystalline silicon (c-Si) obtained by electrochemical HF etching. The morphology, porosity, thickness of ma-PS layer can be adjusted by controlling the electrochemical formation conditions. The optical behavior of the antireflective layers under the UV-Vis-NIR spectrum is determined; the reflectivity measurements were evaluated at 45º in the wavelength range of 200 to 1100 nm in five zone on the silicon wafer (Centre, North, South, East and West) for different samples of the ma-PS/c-Si and how the etching time used influences the formation of the ma-PS layer; resulting in very low values of normalized reflectivity coefficient (below~1%).

Since the discovery of the porous silicon (PS) photoluminescence at room-temperature [1], the interest of scientists in this material has grown considerably. Macroporous silicon (ma-PS) has continued drawing the attention in the last decade because of its potential for creating visible radiation sources and for integrating optoelectronic and microelectronics elements based on silicon technology [2]. The ma-PS layer is formed by electrochemical etching with aqueous hydrofluoric (HF) solution on the crystalline silicon (c-Si) surface [3].

The first application of photo-electrochemically formed macroporous silicon (oxide) ARC on polycrystalline Si solar cells was reported in 1981 [4]. This defines the starting point in the search for a simple macroporous etch to obtain an ARC and a selective emitter structure, where they have been obtained low values of normalized reflectivity bellow 10% [4]. The advanced optic devices incorporate surface texturization to reduce the reflection and consequently to reinforce the optic absorption. The ma-PS can be used as antireflective coating for solar cells and photodetectors [5-7]. The PS optics layers have early drown a lot of interest because of their simplicity and responsivity, and as potential candidates for low cost monitoring, but PS/c-Si diodes show different optic behavior in the absorption and reflectance properties, depending on the manufacturing conditions [2].

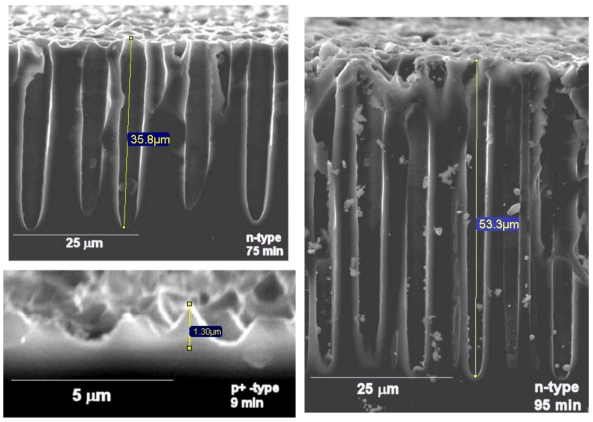

Figure 1: SEM micrographs the cross-section of the ma-PS layers for 75, 95 min. (n-type) and 9 min. (p^+-type).

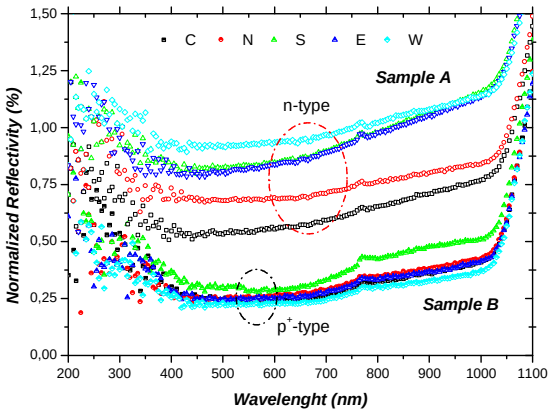

Figure 2: Normalized reflectivity spectrum compared between the samples n-Si (95 min.) and p^+-Si (9 min.). For both samples, values below of 1%, (Solid symbol ma-PS/n-Si and open symbol ma-PS/ p^+-Si) were obtained.

References

[1] L.T. Canham, Appl. Phys. Lett., 57 (1990) 1046-1048.
[2] L.T. Canham, Properties of Porous Silicon, IEE INSPEC, London, 1997.
[3] S. Strehlke, S. Bastide, J. Guillet, C. Levy-Clément, Mater. Sci. and Eng. B, 69-70 (2000) 81-86.
[4] A. Prasad, S. Balakrishnan, S.K. Jain, G.C. Jain, J. Electrochem. Soc., 129 (1982) 596-599.
[5] U. Gangopadhyay et al, Solar Energy Matt. and Solar Cells, 91 (2007) 285-289.
[6] B.C. Chakravarty et al, Solar Energy Matt. and Solar Cells, 91 (2007) 701-706.
[7] F. Fonthal, et al, AIP Conference Proceeding RIAO/OPTILAS 2007, 992 (2008) 780-785.