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Title of the thesis : **Fabrication and Investigation of Nanocrystalline Semiconductors films for use with silicon solar cell**

Abstract of Thesis

Solar cells exploit a virtually infinite source of energy and generate electrical current directly from sunlight in a one-step conversion process. The solar energy that hits the earth's surface in one hour is comparable to the amount consumed by all human activities in a year. Most silicon solar cells are based on n^+p-p^+ (or p^+n-n^+) structure in which the front heavily doped n^+ (or p^+) region is generally made by diffusion of dopant impurities. Because of high recombination of minority carriers in this region, a front illuminated silicon solar cell generally has a poor spectral response in 300-450 nm wavelength range. A photoluminescent porous silicon (PS) layer can be formed on the front surface of a silicon solar cell which is compatible with the silicon solar cell and has ability of absorbing and converting 300-500 nm solar radiation into longer wavelength photons (covering wavelength as large as 850 nm). Thus they can work as down shifter layers. The emitted longer wavelength photons if absorbed in silicon solar cell can result in higher quantum efficiency in 300-500 nm range. Since porous silicon is a nanocrystalline material it may give rise to down conversion whereby an incident photon of 300-500 nm wavelength as it has energy $h\nu > 2 E_g$ of silicon, may create two sub band gap photons, each of $h\nu > E_g$. These sub band gap photons, if absorbed again in silicon solar cell, can further increase quantum efficiency of the cell in 300-500 nm range. Therefore, a poor response in short wavelength region may be improved by the utilization of a photoluminescent layer on the top surface.

We have developed a phenomenological model of growth of pores of porous silicon during anodic etching of p and n-Si. It is primarily based on the assumption that the rate of anodic etching depends on the magnitude of J_p in that direction. The model shows that the morphologies at the surface of porous layers formed on p and n-Si wafers can be quite different. This is because during formation of n-PS layer under illumination the space charge layer does not offer any resistance to the flow of hole current as J_p is the minority carrier current and can easily flow across the reverse biased n-Si-electrolyte junction. The effect of application of a PL layer on the front surface of a silicon solar cell was theoretically investigated based on the realistic values of (i) PL spectra of PS and ZnO-PS layers, and (ii) spectral responses of n^+p-p^+ silicon solar cells. We find that the depending of the photoluminescent spectra of the PL layer and the spectral response of the solar cell there exists a critical value of photoluminescent conversion efficiency η_{PLC} below which the layer is not useful even under ideal conditions to enhance the spectral response and thereby the conversion efficiency of the cell on which it may be applied. The critical value of η_{PL} depends on the values of spectral response SR_0 of the cell and is smaller for a smaller value of SR_0 . Thus a photoluminescent PL layer is likely to be more beneficial for a cell with otherwise poor response in the short wavelength region than a cell with rather good spectral response.

PS layers with $\eta_{PL} \sim 10\%$ at excitation wavelength of 325 nm have been made by Gelloz et al. Such layers may be useful for enhancing the spectral response of some silicon solar cells at and around 325 nm. It will be desirable to make PS or ZnO-PS photoluminescent layers with still higher η_{PL} than of Gelloz et al to be useful for a practical silicon solar cell (e. g. Cell B studied in present work).