In-situ diagnostics in VHF PECVD process : A crucial aspect for fast fabrication of thin film silicon solar cells

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For thin film silicon solar cells to compete with c-Si and other types of thin film materials such as CdTe and CIS, the deposition rate has to be increased substantially compared to the present status at the industries. Several deposition techniques promise to deliver that, however, the thin film Si, especially nanocrystalline Si, made by VHF PECVD has so far shown the best results, in terms of efficiency as well as deposition rate. This can be attributed to the available ion energy that can be tuned by pressure, coupled power, process temperature, plasma frequency [1] and external applied voltage bias to the RF electrode. We present here how to find a suitable combination of these parameters to attain high growth rates (> 5 nm/s). The second optimization step is the identification of the so called crystalline to amorphous transition regime which in a plasma process can be achieved by varying delivered power and/or hydrogen dilution. The third optimization step is the gas distribution in the plasma zone, which is achieved by a suitable showerhead design. The fourth optimization step involves a deposition process that avoids the progress toward the dusty plasma regime. Use of smaller inter-electrode distance and Amplitude modulation of the RF plasma are proposed as candidates to achieve this. This step also has a consequence on homogeneity of the film. We will show how various diagnostic tools, such as optical emission spectroscopy, V-I plasma probe and ion energy analyzer can be used in the optimization process to obtain state of the art nc-Si solar cells with high deposition rates.

Keywords: Nanocrystalline silicon, PECVD, Thin films, Solar cells

References

[1] J.K.Rath, Solar Energy Material and Solar Cell, **76** (2003)431-487;

Topic: Thin films