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Interface Control to get Higher Efficiency in a-Si:H Solar Cell

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In thin film silicon solar cells, p-i-n structure is adopted instead of p/n junction structure as in wafer-based Si solar cells. PECVD is the most widely used thin film deposition process for a-Si:H or μc-Si:H solar cells. Single-chamber PECVD system for a-Si:H solar cell manufacturing has the advantage of lower initial investment and maintenance cost for the equipment. However, in single-chamber PECVD system, doped and intrinsic layers are deposited in one plasma chamber, which inevitably impedes sharp dopant profiles at the interfaces due to the contamination from previous deposition process. The cross-contamination between layers is a serious drawback of single-chamber PECVD system.

In this study, a new plasma process to solve the cross-contamination problem in a single-chamber PECVD system was suggested. In order to remove the deposited B inside of the plasma chamber during p-layer deposition, a high RF power was applied right after p-layer deposition with SiH4 gas off, which is then followed by i-layer, n-layer, and Ag top-electrode deposition without vacuum break.

In addition to the p-i interface control, various interface control techniques such as FTO-glass pre-annealing in O2 environment to further reduce sheet resistance of FTO-glass, thin layer of TiO2 deposition to prevent H2 plasma reduction of FTO layer, and hydrogen plasma treatment prior to n-layer deposition, etc. were developed. The best initial solar cell efficiency using single-chamber PECVD system of 10.5% for test cell area of 0.2 cm^2 could be achieved by adopting various interface control methods.

Keywords: Thin film silicon solar cell, PECVD, Cross-contamination, Interface control