E-006

High-Efficiency a-Si:H Solar Cell Using In-Situ Plasma Treatment

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In amorphous or microcrystalline thin-film silicon solar cells, p-i-n structure is used instead of p/n junction structure as in wafer-based Si solar cells. Hence, these p-i-n structured solar cells inevitably consist of many interfaces and the cell efficiency critically depends on the effective control of these interfaces. In this study, in-situ plasma treatment process of the interfaces was developed to improve the efficiency of a-Si:H solar cell. The p-i-n cell was deposited using a single-chamber VHF-PECVD system, which was driven by a pulsed-RF generator at 80 MHz. In order to solve the cross-contamination problem of p-i layer, high RF power was applied without supplying SiH4 gas after p-layer deposition, which effectively cleaned B contamination inside chamber wall from p-layer deposition. In addition to the p-i interface control, various interface control techniques such as thin layer of TiO2 deposition to prevent H2 plasma reduction of FTO layer, multiple applications of thin i-layer deposition and H2 plasma treatment, H2 plasma treatment of i-layer prior to n-layer deposition, etc. were developed. In order to reduce the reflection at the air-glass interface, anti-reflective SiO2 coating was also adopted. The initial solar cell efficiency over 11% could be achieved for test cell area of 0.2 cm^2.

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