

Prevention of P-i Interface Contamination Using In-situ Plasma Process in Single-chamber VHF-PECVD Process for a-Si:H Solar Cells

Seung-Hee Han¹, Jun-Hong Jeon^{1,2}, Jin-Young Choi^{1,2}, Won-Woong Park^{1,2}

¹Solar Cell Center, Energy Division, Korea Institute of Science and Technology, Seoul 136-791, Republic of Korea, ²Department of Materials Science and Engineering, Korea University, Seoul 136-701, Republic of Korea

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 a most widely used thin film deposition process for a-Si:H or μ c-Si:H solar cells. For best performance of thin film silicon solar cell, the dopant profiles at p/i and i/n interfaces need to be as sharp as possible. The sharpness of dopant profiles can easily achieved when using multi-chamber PECVD equipment, in which each layer is deposited in separate chamber. However, in a 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 a single-chamber PECVD system in spite of the advantage of lower initial investment cost for the equipment. In order to resolve the cross-contamination problem in single-chamber PECVD systems, flushing method of the chamber with NH₃ gas or water vapor after doped layer deposition process has been used.

In this study, a new plasma process to solve the cross-contamination problem in a single-chamber PECVD system was suggested. A single-chamber VHF-PECVD system was used for superstrate type p-i-n a-Si:H solar cell manufacturing on Asahi-type U FTO glass. A 80 MHz and 20 watts of pulsed RF power was applied to the parallel plate RF cathode at the frequency of 10 kHz and 80% duty ratio. A mixture gas of Ar, H₂ and SiH₄ was used for i-layer deposition and the deposition pressure was 0.4 Torr. For p and n layer deposition, B₂H₆ and PH₃ was used as doping gas, respectively. The deposition temperature was 250°C and the total p-i-n layer thickness was about 3500 Å. In order to remove the deposited B inside of the vacuum chamber during p-layer deposition, a high pulsed RF power of about 80 W was applied right after p-layer deposition without SiH₄ gas, which is followed by i-layer and n-layer deposition. Finally, Ag was deposited as top electrode. The best initial solar cell efficiency of 9.5 % for test cell area of 0.2 cm² could be achieved by ap-

plying the in-situ plasma cleaning method. The dependence on RF power and treatment time was investigated along with the SIMS analysis of the p-i interface for boron profiles.

Keywords: Thin film silicon solar cell, PECVD, cross-contamination