DEPOSITION MECHANISM OF AMORPHOUS SILICON THIN FILM ON SILICON WAFER WITH <100> AND <111> ORIENTATION

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Silicon hetero-junction (SHJ) solar cell attracts more attentions due to its high efficiency of >26% and potential for mass-area production in the application of photovoltaic devices\textsuperscript{[1, 2]}. Hydrogenated amorphous silicon thin film is an excellent passivation layer for crystalline silicon (c-Si) due to its low fabrication temperature and low defect density. In this research, we focus on the growth evolution of a-Si:H deposited by PE and CAT CVD on the silicon wafer with <100> and <111> orientation, respectively. The growth mechanism of a-Si:H and microstructure evolution can be derived by using PE and CAT CVD methods. The prevalent techniques to deposit a-Si:H are plasma enhanced (PE) and catalytic (CAT) chemical vapor deposition (CVD). In the former, ion bombardment frequently occurs in the subsequent deposition, which can lead to damage in the subjacent a-Si:H layer or interface. The advantage of the latter is rich in Atomic hydrogen generated by cracking H\textsubscript{2} around a heated catalyzer. However, possible thermal-radiation frequently occurs on the deposition surface of samples. It is necessary to discern which technique is more competitive by researching the deposition mechanism.

n-type textured czechralski (CZ) silicon wafers with a resistivity of ~3 Ω·cm, which were used as the substrates of heterojunction passivation and SHJ solar cells, were cleaned by a standard RCA process and then dipped in 2% HF for 2 min. Subsequently, two series of i-a-Si:H thin films were prepared at low substrate temperatures of less than 200 °C by using a radio frequency PE and CAT CVD, respectively. In the case of PE method, power density and deposition pressure are 30 mW/cm\textsuperscript{2} and 200 Pa, individually. The electrode distance and [H\textsubscript{2}]/[SiH\textsubscript{4}] flow ratio are 25 mm and 10, respectively. As for CAT method, [SiH\textsubscript{4}]/[H\textsubscript{2}] flow ratio is 2 in the few pascal of pressure.

Figure 1 is the FTIR spectrum of the intrinsic a-Si:H films with different thicknesses by using PE technique. It is apparent that the initial growth is totally different when the thickness is less than 10 nm. High stretch mode of films on <111> substrates is more higher than that of films on <100> substrates, which means the epitaxial grown prone to present on <100> substrates in the initial stage of a-Si:H deposition. In the case of CAT deposition, same tendency with the increasing thickness has been found in the initial deposition. The details of microstructure differentiation between PE and CAT can be seen in the manuscript.

References


![Figure 1: Hydrogen contents as a function of f\textsubscript{CO2} for a-SiO\textsubscript{2}H thin films deposited with varied R\textsubscript{H} at specific T\textsubscript{sub} and P\textsubscript{g}](image-url)