Simulation studies on crystalline silicon based back heterojunction solar cells

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Abstract

Back heterojunction (BHJ) solar cell is a combination of c-Si based (i) front heterojunction cell, and (ii) back junction cell. BHJ solar cell was designed by combining the advantages of the above two cells. Absence of front grids, interdigitated point contact structure at the rear side (from back junction cell), and low processing temperature around 250°C, passivation by intrinsic a-Si:H on both sides of c-Si (from front heterojunction cell) were combined to form BHJ cell. In this design, shadowing losses due to front grid structure, and atrade-off between series resistance and reflection can be completely eliminated. Also, in the rear side, sufficient contact metal can be used to avoid resistive losses. In our simulation study, a low doped (1.0 x 1015/cm3), textured, n-type c-Si with a very high lifetime of 2-3 ms was used. Silicon nitride was used as an antireflection layer and intrinsic a-Si:H was used as passivation layer on both sides of c-Si. At the rear side of the cell, both emitter (p+-a-Si:H) and back surface field (n+-a-Si:H) were formed as an array of an interdigitated pattern with their respective contacts. Doped a-Si:H (emitter and BSF) circular region diameters were fixed as 20 µm and 10 µm respectively and space between emitter and BSF was fixed as 10 µm. Using optimized parameters [1,2], and Silvaco Atlas tools, simulation was carried out as a function of pyramid base width and height. For an optimized BHJ design, an efficiency as high as 26.6% have been achieved.