Limiting-Efficiency Assessment on Advanced Crystalline Silicon Solar Cells with Auger Ideality Factor and Wafer Thickness Modifications

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Abstract

With the improvement of surface passivation, bulk recombination is becoming an indispensable and decisive factor to assess the limiting efficiency (η lim) of crystalline silicon (c-Si) solar cells. In simultaneous consideration of surface and bulk recombination, a modified model of η lim evaluation is developed. Surface recombination is directly depicted with contact selectivity while bulk recombination is revised on the aspects of ideality factor and wafer thickness. The η lim of cutting-edge photovoltaic technologies, double-side tunneling-oxide passivating contact (TOPCon) and silicon heterojunction (SHJ) solar cells, are numerically simulated using the new model as 28.73% and 29.00%, respectively. Hybrid solar cells consisting of n-type TOPCon contact and p-type SHJ contact can approach an η lim as high as 29.18% at the optimal wafer thickness (W opt) of 103 μm . Our results are instructive in accurately assessing efficiency potential and accordingly optimizing design strategies of c-Si solar cells.

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