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Fabrication of zinc oxide and phosphorus optical thin films and comparison of their effect on silicon solar cell efficiency

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Abstract

In this study, we investigated the application of the photoluminescence of red phosphorus nanoparticles in increasing solar cell efficiency. Additionally, red phosphorus can also decrease surface reflection in silicon solar cells, thereby further increasing their efficiency. To demonstrate the impact of phosphorus's photoluminescence properties on cell efficiency, a layer of zinc oxide, known for its anti-reflective properties, is first deposited on the cell surface. By minimizing surface reflection and reducing the influence of phosphorus's anti-reflective effects on the efficiency, we can attribute any efficiency gains to the photoluminescence of red phosphorus. Initially, 50 nm zinc oxide was deposited on the silicon solar cell surface using the PVD method. Optical spectroscopy analysis showed that this layer effectively reduced surface reflection. However, subsequent measurement of the cell efficiency under standard AM1.5G radiation demonstrated a decrease in efficiency. Subsequently, 90 nm red phosphorus was deposited onto the zinc oxide layer using the PVD method. Optical spectroscopy results indicated that this new layer actually increased surface reflection. Remarkably, the efficiency measurement showed a significant relative increase of approximately 37%. This efficiency boost can be attributed to the photoluminescence properties of phosphorus nanoparticles, which absorb UV light and emit visible light, making it more efficiently absorbed by silicon solar cells.

Keywords: silicon solar Cell, Efficiency, phosphorus, reflection, zinc oxide

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