

**STUDY OF ELECTRICAL AND OPTICAL PROPERTIES OF ANTI-
REFLECTIVE LAYER IN SILICON SOLAR CELL**

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ABSTRACT

STUDY OF ELECTRICAL AND OPTICAL PROPERTIES OF ANTI-REFLECTIVE LAYER IN SILICON SOLAR CELL

Silicon-based photovoltaic (PV) cell efficiency is greatly constrained by reflective losses since uncoated silicon surfaces reflect over 30% of incident light. This study investigates the impact of anti-reflective coatings (ARCs) in enhancing both the optical and electrical properties of silicon solar cells. Specifically, the research compares single-layer (SLARC), double-layer (DLARC), and triple-layer (TLARC) ARC designs and identifies optimum structures for minimizing reflectance and maximizing energy conversion efficiency. Simulations were carried out with PC1D and PV Lighthouse software tools. PC1D was used to study electrical performance parameters like short-circuit current (I_{sc}), open-circuit voltage (V_{oc}), fill factor (FF), and power conversion efficiency (PCE). PV Lighthouse was used to study optical parameters such as absorption, reflectance, and photogenerated current density (J_G). Different ARC materials including MgF_2 , SiO_2 , Al_2O_3 , and TiO_2 were evaluated in different layer combinations and thicknesses. The result revealed that all the ARC configurations performed better than the uncoated reference cell. Among these, the DLARC made from MgF_2 and TiO_2 realized the highest efficiency of 23.10% compared to the bare cell's 15.70%. Thus, this configuration represents an impressive relative improvement of over 47.13%. However, TLARCs also yielded competitive performance but introduced complexity in design and fabrication. Overall, this study shows how fine-tuning ARC designs can make a real difference in how well solar cells perform. By improved absorption of light and reduced reflection, these coatings offer a practical and cost-effective solution to advancing solar technology and support the global transition to cleaner energy sources.

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