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SIMULATION OF ANTI-REFLECTIVE TIO_2/SIO_2 COATING FOR SILICON PHOTOVOLTAIC APPLICATION BY RAY TRACING

IMRAN AL-HAQEEM BIN JAFFAR

BACHELOR OF SCIENCE (Hons.) PHYSICS

FACULTY OF APPLIED SCIENCES

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ABSTRACT

Simulation of Anti-Reflective TiO2/SiO2 Coating for Silicon Photovoltaic Application by Ray Tracing

In solar systems, anti-reflective coatings are used to reduce reflection and increase efficiency. However, the front surface on the solar cells alone is not effective because most of the light from the sun is reflected and very less energy absorption into the solar cells occur. An anti-reflective coating (ARC) of a sufficient thickness can greatly reduce front surface reflectance. Nanoscale surface texturing, on the other hand, can efficiently capture a higher ratio of incident light to boost optical absorption. In this study, the light trapping scheme within the wavelength of 300nm to 1200nm is used to improve the overall efficiency of silicon solar cells. A thin layer of TiO_2 and SiO_2 anti-reflective coating with different thicknesses is stacked alternatingly due to their different refractive index with TiO_2 having a high refractive index and SiO_2 with a low refractive index. Solar irradiance spectrum AM1.5G is used in this simulation according to the ASTM standard. For the ray-tracing simulation, the front planar with multilayer ARC with different thicknesses are investigated to obtain the optimum value for optical properties and current density. All the four combination arrangements of SiO_2 and TiO_2 were studied and from the data obtained, the value of J_{max} is calculated. The J_{max} value of c-Si (without ARC) is only at 24.93mA/cm^2 but when ARC was used on the front surface, the value of J_{max} increased to 30.28mA/cm^2. This represents an increasement of 21.46% enhancement compared to the J_{max} of the c-Si reference.