OPTIMIZING OF LIGHT-TRAPPING SCHEMES IN SILICON SOLAR CELLS USING RAY TRACING SIMULATION

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work.

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This Final Year Project Report entitled **"Optimizing of Light-Trapping Schemes in Silicon Solar Cells Using Ray Tracing Simulation"** was submitted by Siti Nur Adilah binti Mohd Alzubairi in partial fulfilment of the requirements for the Degree of Bachelor Sciences (Hons.) Physics, in the Faculty of Applied Sciences, and was approved by

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ABSTRACT

OPTIMIZING OF LIGHT-TRAPPING SCHEMES IN SILICON SOLAR CELLS USING RAY TRACING SIMULATION

Thin crystalline silicon (c-Si) had poor light absorption, which made it difficult to generate high photocurrent in photovoltaic (PV) devices. Thus, enhancing absorptivity and optimization of texturing in solar cell manufacturing was very significant in order to overcome this issue, in which surface texturization was one of the factors that influences both absorption and optimization. In this study, ray tracing of inverted random pyramids with different angles, heights, and widths were used to investigate the effects of surface morphology on optical properties and current density through the ray tracing method via the Wafer Ray Tracer from PV Lighthouse. The base angle of the surface geometry that were used in this simulation study as a reference is 54.7°, which is an ideal angle for random pyramids and Lambertian scatterers. In this simulation, the light-trapping effectiveness of the AM1.5G solar spectrum at the angle of incidence is evaluated within the wavelength range of 300-1200 nm and there were five sets of model structures with different height, width, and angle in surface morphology were simulated. Front random inverted pyramidal with SiN_x ARC is used as reference with height of 4 µm, base angle of 54.7° and width of 5.66 µm. From the absorption profile, the maximum potential short-circuits current density, J_{max} is determined for the entire region based on the absorption result, considering unity carrier collection. As a results, Scheme IV has the highest broadband light absorption, due to the surface texturing of inverted random pyramid and anti-reflective coating (ARC) of SiN_x, resulting in J_{max} of 39.49 ma/cm^2 compared to reference scheme which exhibits 39.10 ma/cm^2.