MODELLING AND ANALYSIS OF MGF_2/SIO_2 BILAYER ANTI-REFLECTIVE COATING OF LIGHT TRAPPING IN A SILICON SOLAR CELLS USING WAFER RAY TRACER

NUR IRDINA IWANI BINTI MOHD JAMALUDDIN

**FINAL YEAR PROJECT SUBMITTED IN
PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
DEGREE OF BACHELOR OF SCIENCE (HONS.) PHYSICS
IN THE FACULTY OF APPLIED SCIENCES
UNIVERSITI TEKNOLOGI MARA**

AUGUST 2022

ACKNOWLEDGEMENT

First of all and foremost, I am grateful to Allah for blessing me with such a sound intellect and good health in order to complete my assignment and offered guidance through my assignment preparation journey. I'd also like to thank both of my parents for their continuous encouragement and support as I worked on this assignment. Also, most importantly, the persons who are the guiding pillar for this assignment, I would like to thank Madam Madhiyah Yahaya Bermakai, our beloved lecturer and guidance as well as Dr Zaki bin Mohd Yusoff, our admired co-supervisor for always guiding us through the thick and thin of preparation for this assignment. They provided us invaluable advice and supported us throughout challenging times. Their dedication and assistance made significant contributions to the assignment's success. Last but not least, I'd want to express my appreciation to all of the lecturers and individuals that directly or indirectly participated in the making of this assignment.

ABSTRACT

Anti-reflective coating (ARC) application is continuously being developed extensively and widely for the manufacture of coatings on the surfaces of optical devices which are hugely essential, desirable, and required, particularly on silicon solar cells. Single layer ARC is sufficient, but double layer ARC tremendously enhances solar cell efficiency by covering a wider range of the solar spectrum. Magnesium fluoride, MgF_2 and silicon dioxide, SiO_2 are the AR coatings used in this proposal, with wavelengths in the range from 300 to 1200 nm. The optical properties of bilayer AR coatings were obtained by varying the thickness of the double coatings, which were 75 nm, 100 nm, 115 nm, and 122 nm, and see how the ARC effects Si solar cells and until the optimum current density was obtained. Wafer ray tracer was used in PV LightHouse software to simulate and model MgF_2 and SiO_2 bilayer AR coatings in order to fully understand the performance and impacts of the coatings on Si solar cells. This simulation work contains the analysis of reflection, absorption, transmission, and J_{max}, which have been compared to many other theoretical results gathered from other studies and researches. To conclude, this simulation shows that bilayer anti-reflective coatings with the highest thickness are much more effective in Si solar cells. Hence, based on the simulation ran using the wafer ray tracer, it was found out that the highest value of J_{max} is when the thickness of the anti-reflective coating is at 75 nm (Scheme I), where the value is value is 32.80 mA/cm^2. This indicates that Schemes I, with a value of 27.13%, had the maximum J_{max} enhancement. This outcome suggests that the performance of solar cell applications may be strengthened more effectively by using bilayer anti-reflective coating. The bilayer anti-reflective coating using MgF_2 and SiO_2 discussed in this paper can also be used and modified as a beneficial component for maximizing solar cell efficiency by decreasing optical loss.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Due to current technological advancements, the consumption of solar cells is developing nowadays. This growth has been aided by advancements in materials and manufacturing processes. However, there are other challenges and issues that must be addressed before the photovoltaics (PV) can provide clean, abundant, and affordable energy for people convenience. The issues are particularly with regard to reflection loss. Whenever sunlight shines on the front surface of a solar cells, some of light energy is transmitted into the cell and converted to electrical energy, while the rest is reflected from the front surface. Various methods have been used to reduce the loss caused by reflection on the silicon surface. The most commonly used approaches to minimize the loss due to reflection include light trapping, surface texturing, and anti-reflective coatings (ARC) (Sharma et al., 2017).

Anti-reflective coating (some may use AR and others says ARC) is a technique for reducing reflection and increasing light absorption in solar cells, hence enhancing their efficiency (Rooij, 2012). It is indeed best known for being the fundamental thin films used in optics. The anti-reflective coating has a numerous advantage, including maximum light transmission and thus increased the overall efficiency of the solar cells. The glare from the glass will also be minimized, which is a plus. According on the website, it said that ARC enables the panel to blend in better with its surroundings (Rooij, 2012). Since the reflection of bare silicon solar cells is about 30%, this anti-reflective coating is both necessary and crucial (Rooij, 2012). It seems to be an important component of photovoltaic (PV) systems and has a broad range of applications. Texturing and applying an anti-reflection coating to the surface will lead to low reflection. Solar cells contain anti-reflection coatings similar to those found on camera lenses as well as other optical equipment (Rooij, 2012).