UNIVERSITI TEKNOLOGI MARA

AMORPHOUS CARBON THIN FILMS BY AEROSOL-ASSISTED CHEMICAL VAPOR DEPOSITION FOR CARBON-BASED SOLAR CELL APPLICATIONS

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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 (UiTM). It is original and is the result of my work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification

I, hereby acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Nitrogen doped amorphous carbon (a-C:N) was synthesized using a new custom-made Aerosol-assisted Chemical Vapor Deposition (AACVD) from camphor oil as the precursor. The a-C:N thin films have demonstrated better quality in uniformity, high conductivity, moderate and suitable I_D/I_G ratio from Raman analysis and optical band gap for solar cell applications. The doping process was successful as proven by the Energy Dispersive X-ray analysis (EDX) spectrum with the presence of Nitrogen (N) peak in a-C:N, and thus this AACVD has proven the suitability to undergo the doping process for nitrogen doped a-C:N. The produced thin films have demonstrated high conductivity with photoresponse effect towards the sun light which is very important in solar cell application. Transmittance spectrum of the nitrogen doped a-C:N exhibit a large transmittance value (>85%) and high absorption coefficient value of 10^6 cm^{-1} and the value was higher than undoped a-C (10^3-10^4 cm^{-1}). The optimized optical band gap with the value of 1.4 eV was also close to the optimum optical band gap for the solar cell (1.5 eV) and the thin films yield the smooth surface morphology with very tiny grain size, which has the potential to produce the nanostructured a-C solar cell. The fabrication of new carbon based solar cell by N doped a-C was successfully done by using the AACVD process. The configuration for the fabricated device was Au/a-C:N/p-Si/Au. On the other hand, the rectifying J-V characteristics of Au/a-C:N/p-Si/Au photovoltaic cells resulted from the heterojunction between the n-type a-C film and the p-Si substrate. Since the substrate used was the p-Si substrate, no P-N junction will formed between the undoped a-C with weakly p-type conductivity and p-Si substrate. Thus it was proven that the conductivity of the a-C was tuned from weakly p-type to n-type from the nitrogen doping to form heterojunction with p-Si substrate. The rectifying curve for the device was obvious than the pure a-C, and the efficiency was 0.115% and this value is higher compared to the device fabricated from pure undoped a-C thin film, 0.003%. When the light was incident to the surface of the a-C:N, the photon in the lower wavelength region was strongly absorbed by the Au metal contact which served as the counter electrodes thus giving higher efficiency value. In addition, images captured by the FESEM exhibited small particle size, which is less than 100 nm and in nanostructured scale.

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CHAPTER ONE
INTRODUCTION

1.1 RESEARCH BACKGROUND

1.1.1 Nanotechnology

In the twentieth century, a Japanese engineer, Norio Taniguchi introduced the term "nanotechnology" which originally implied a new technology that went beyond controlling materials and engineering on the micrometer scale. In general nanoscience here is defined as the study of phenomena and the manipulation of physical systems that produce significant information, with critical boundaries that do not exceed 100nm in length at least in one direction. Therefore, the main focus of nanotechnologies includes the design, characterization, production and application of nano-scale system and components.

Recently, the important areas that involved nanotechnology are catalysis, micro/quantum electronics, water treatments, sensors and energy conversions. As for the renewable energy conversion, thin films solar cells in nanotechnology also come to an interest. Until recently, most of the solar cell fabricated from large grain of n–type and p-type semiconductor in order to prevent negative effects of grain boundaries and other defects but as the nanotechnology is developing very rapidly, there is possibility that more efficient solar cell for energy conversion can be build up. For both the n-type and p-type nanomaterial, research is looking forward to achieve an efficient solar absorption in the p-type semiconductor and maximum light transmittance through the n-type material by opening up the band gap in both kinds of semiconductors [1].

Singh et al. [2] reported on the advantages offered from the nanostructured thin film for solar cells applications. First of all, the effective optical path for absorption is much larger than the actual film thickness, which is due to multiple reflections. Secondly, the absorber layer thickness in nanostructured solar cells can be as thin as 150 nm instead of several micrometers in the traditional thin film solar cells. As a result of this, the light generated electrons and holes will only have to travel over