UNIVERSITI TEKNOLOGI MARA

PREPARATION AND OPTIMIZATION OF SILICON NANOWIRES BY SILVER NANOPARTICLE-ASSISTED CHEMICAL ETCHING AS GRAPHENE SYNTHESIS TEMPLATE

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of the requirements for the degree of
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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. This thesis has not been submitted to any other academic institution or non-academic institution for any 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

This research studied the preparation of Silicon Nanowires (SiNWs) arrays on silicon substrate and SiNWs coated with graphene layer. SiNWs was successfully formed on p-type (1 0 0) silicon substrate by depositing Silver (Ag) nanoparticle as metal-catalyst at one minute immersion in room temperature and by using metal-assisted chemical etching (MACE) for growth process at four different parameters which are molarity dependence (0.3 M, 0.4 M, 0.5 M, 0.6 M and 0.7 M), etching time dependence (0.5 h, 1 h, 2 h, 3 h,4 h and 5 h), temperature dependence (room temperature, 30 °C, 40 °C, 50 °C, 65 °C and 80 °C) and angle of formation (0°, 45°, 90°, 135° and 180°). All the samples were immersed in Acid Nitric (HNO_3) solution for 15 minutes to remove Ag nanoparticle from the sample. FESEM cross section images and EDX analysis shows that the SiNWs contains no impurities after the process. The structural properties of SiNWs were observed through Atomic force microscopy (AFM), Field Emission Scanning Electron Microscopy (FESEM) and X-ray Crystallography (XRD) while the optical properties were measured by Uv-Vis spectroscopy. The optimized SiNWs which has formed a very dense SiNWs, align nanostructure, high aspect ratio and has a very low reflectance for solar sensor application obtained was at 0.5 M of Hydrogen Peroxide (H_2O_2), for 4 hours of etching time at 30 °C and 0° angle of formation. The SiNWs optimized diameter is at 58.60 nm average and 14360 nm average length as a result the aspect ratio is a large value at 245.05. XRD analysis for the optimized sample has the high peak intensity, small width and a large crystallize size equivalent to 6.9060 nm. Furthermore, SiNWs coated with few-layer of graphene (FLG) were produced by mechanical exfoliation of Highly Oriented Pyrolytic Graphene (HOPG) for all five sample optimize with 0.5 M, 4 hours of etching time at 30 °C with five different angle of formation (0°, 45°, 90°, 135° and 180°) for enhancement of efficiency on solar cell application. FESEM, Energy-dispersive X-ray spectroscopy (EDX) and Raman spectroscopy were done to all samples. FESEM surfaces morphology obtained graphene flakes on top of SiNWs at magnification of 100k and EDX analysis shows a thick graphene layer occur on SiNWs at 70.87% of carbon element compared to a lower Si percentage at 28.13%. Raman spectroscopy shows less than 1 I_{2D}/I_G ratio that proves it is few layer graphene (FLG) and sample at 0° shows the highest I_{2D}/I_G ratio.

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