UNIVERSITI TEKNOLOGI MARA

SYNTHESIS OF GRAPHENE USING WASTE COOKING PALM OIL (WCPO) BY DOUBLE THERMAL CHEMICAL VAPOUR DEPOSITION (DTCVD) METHOD FOR HUMIDITY SENSOR APPLICATION

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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 result of my own work, unless otherwise indicated or acknowledged as referenced work. The topic has not been submitted to any other academic institution or non-academic institution for any other degree of qualification.

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

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ABSTRACT

The lack of waste cooking palm oil management especially from fried chicken is becoming problematic issues where it disposing to soil, kitchen sink, drainage system, river and others, which cause pollutions effect. Nowadays, graphene grows to be new types of materials for manufacturing humidity sensors with low cost and eco-friendly technology in industry. Conventionally, graphene was synthesized from fossil fuels with high toxicity such as methane, acetylene and ethanol benzene, xylene, toluene, etc. The costs of these carbon sources are expensive and non-renewable. Therefore, efforts by utilizing carbon source from natural source such as grass, plastics, vegetation waste, sugarcane, tea-tree extract, sesame oil, camphor oil, and palm oil have been studied. In this research, abundant of waste cooking palm oil (WCPO) was used as a natural carbon source for synthesis graphene. It is as alternative to conserve the environment and low-cost method. WCPO was used as a precursor and nickel foil was used as a substrate. Graphene was successfully deposited on nickel substrate by using double thermal chemical vapour deposition, (DTCVD) method. All samples were prepared at different cycle precursor (refined, first cycle, second cycles and third cycles), amount of precursor (5 µl, 10 µl, 50 µl, and 100 µl), temperature precursor (250°C-450°C), deposition temperature (850°C-1100°C), and synthesis time (5-30 minutes), respectively. The results indicate that graphene prepared at third cycles precursor with 10 µl at 350°C of temperature precursor, 1000°C of deposition temperature and 20 minutes deposition time have good arrangements graphene network structure with large active area and introduce less boundary defects. Additionally, the full width half maximum, (FWHM) of the (002) peak become larger (0.32) which indicate decreased size of the crystallite (25.24 nm), and decreases number of graphene layers (9 layers). Moreover, at the optimum parameter the formation of active carbon species (dehydrogenation) and diffusion of active carbon on the surface was energetic and increase the percentage of reflectance (66.37%). The growth of graphene film at an optimum parameter, resulting in the highest of I_{2D}/I_G (0.41) and lowest of I_D/I_G (0.02) since, the carbon atoms segregate and form multi layers graphene with high crystalline and low defective structure. Subsequently, the optimum sample of graphene on nickel substrate was transferred onto glass substrate by Poly (methyl methacrylate), (PMMA) polymer for humidity sensor application. The response-recovery time, sensitivity, and repeatability of humidity sensor were determined using humidity chamber. The adsorption (response time) and desorption (recovery time) process takes several hundred second, 597 and 503 second respectively. These attributed to the sheet resistant is height in multilayer graphene. However, it is found that the sensitivity of multilayer graphene-based humidity sensor using WCPO has potential to develop as sensing material in humidity sensors and comparable with other material that sensitive to water molecules. It shows the sensitivity at 40% to 90% RH, is 365%. In the meantime, humidity sensor using graphene quantum dots, rGO/Ls, graphene/polypyrrole, and SZO/SnO_2 sensor, the sensitivity are, 390, 298, 138, and 67.1%, respectively. Multilayer graphene-based humidity sensor using WCPO remains constant and similar at fifth cycles, indicating that sensor exhibits stable and excellent repeatability and have potential as a sensing material based with low cost and renewable energy.

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