HETEROJUNCTION CARBON BASED SOLAR CELLS

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The cost reduction of solar cell and establishment of environmentally friendly production process are very important for further spread of photovoltaic technology. Carbon (C) is a material of highly stable, cheap and non-toxic, which can be obtained from precursors that are sufficiently available in nature. It is a remarkable element existing in a variety of stable forms ranging from insulator/semi-conducting diamond to metallic/semi-metallic graphite to conducting/semi-conducting nano/micro tubes to fullerenes of highest order of symmetry, which show many interesting optoelectronic properties. Furthermore, carbon has been an attractive material for the fabrication of photovoltaic solar cells because of its outstanding properties such as chemical inertness, high hardness, high electrical resistivity, high thermal conductivity, high dielectric strength, infrared optical transparency and optical band gap varying over a wide range from about 5.5 eV for insulating diamond to 0.0 eV for metallic graphene.

In this work, we deposited carbon thin film directly on silicon and quartz substrates by microwave (MW) surface-wave plasma (SWP) chemical vapor deposition (CVD), using microwave frequency of 2.45 GHz. Before deposition, substrates were cleaned by ultrasonic cleaning by acetone and methanol for 10 and 5 min, respectively. Only silicon substrates were then etched with diluted hydrofluoric acid (10%) in order to remove the resistive native oxide layer over the surface. Finally, all substrates were rinsed with clean water and dried by nitrogen gas, before loading them on the stage of MW SWP CVD chamber. For film deposition, we used Argon (Ar: 100 sccm) as a carrier gas and Acetylene (C₂H₂: 20 sccm) as a carbon source gas. Films were deposited at 700 °C and deposition time for all samples was 10 min. The base pressure of the CVD chamber was 3 × 10⁻⁴ Pa and launched microwave power was 1000 W. Moreover, we demonstrated carbon/silicon heterojunction solar cells. Current-voltage (I-V) characteristics of the configurations; (p-C/n-Si) under dark and illumination are shown in Figure 1. It showed rectifying curve in dark indicating the formation of a heterojunction solar cell between p-C film and n-type silicon. When illuminated by the light, the configuration showed photovoltaic behaviour; with maximum open-circuit voltage (V_oc) of 0.47 V, short circuit current density (J_sc) of 8.91 mA/cm², fill factor (FF) of 0.44 and conversion efficiency (η) of 1.88 % are obtained.

The quantum efficiency (QE) of the solar cells configurations; p-C/n-Si are shown in Figure 2. The configuration (p-C/n-Si) has wide range of wavelength from 400 nm to almost 1000 nm. It is clearly represent carbon and silicon peaks at 500 nm and 900 nm respectively.

![Figure 1: Current-voltage characteristics of the p-C/n-Si heterojunction carbon based solar cells under dark and light illumination (AM 1.5, 100 mW/cm²).](image1)

![Figure 2: The spectral photo-response characteristics of p-C/n-Si heterojunction carbon based solar cells.](image2)