Graphene grow directly on silicon at low temperature for schottky junction solar cells

Sudip Adhikari[1]
Masayoshi Umeno[1, 2]

[1]*Chubu University, Matsumoto-cho 1200, Kasugai 487-5801, Aichi, Japan*
[2]*C`s Techno Inc, Nagoya Science Park, Moriyama-ku, Nagoya 463-0003, Aichi, Japan*

sudip@isc.chubu.ac.jp

Graphene grow directly on silicon substrate by microwave (MW) surface wave plasma (SWP) chemical vapor deposition (CVD) using hydrogenated carbon sources at low temperature (550°C). Analytical methods such as Raman spectroscopy, four-point resistance probe, UV/VIS/NIR spectroscopy, transmission electron microscopy (TEM) and solar simulator were employed to characterize properties of the graphene films. In our study, it is possible to grow graphene directly on silicon substrate (without using catalyst) due to high radical density of MW SWP CVD. Here, we introduced new method for making quality of graphene grown directly by cutting the ultraviolet rays during plasma. Moreover, we demonstrated graphene/silicon (G-Si) schottky junction solar cells with efficiency up to 4.3 %. Compared to conventional silicon solar cells, the fabrication process of G-Si schottky junction solar cell is greatly simplified; just graphene synthesized directly on n-type crystalline silicon wafer at low temperate.

Raman spectroscopy is performed at room temperature shown in Figure 1. Three peaks centred at 1341, 1578, 2695 cm^{-1} which is assigned to the D (disorder mode), G (graphite mode) and 2D (D mode overtone) modes of graphene respectively. The presence of 2D peak shows a good agreement of graphene structure formation into the film. Figure 2 shows Current-voltage (I-V) characteristics under dark and illumination of graphene/silicon (G-Si) schottky junction solar cells. It showed photovoltaic behaviour with maximum open-circuit voltage (V_{oc}) 0.409 V; short circuit current density (J_{sc}) 17.038 mA/cm^2, fill factor (*FF*) 0.623 and conversion efficiency (η) 4.348 % are obtained.

References

[1] S. Adhikari, A.M.M. Omer, S. Adhikary, M. Rusop, H. Uchida and M. Umeno, Diamond Relat. Mater. **15,** 2006, 913.
[2] Novoselov, K.S., Geim, A.K., Morozov, S.V., Jiang, D., Zhang, Y., Dubonos, S.V., Grigorieva, I.V. and Firsov A.A., *Science*, **306**, 2004, 666.
[3] A.C. Ferrari, J.C. Meyer, V. Scardaci, C. Casiraghi, M. Lazzeri, F. Mauri, S. Piscanec, D. Jiang, K.S. Novoselov, S. Roth and A.K. Geim, Phys. Rev. Lett. **97**, 2006,187401.

Figures

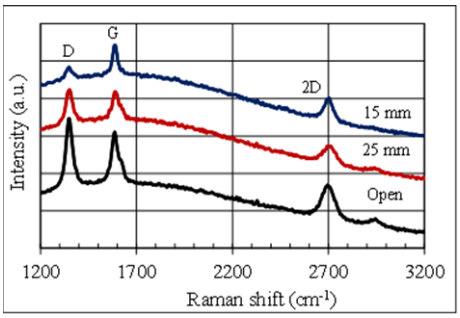

Figure 1: Raman spectra with different covers height.

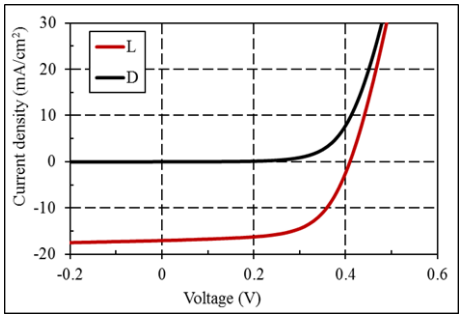

Figure 2: I-V characteristics of the graphene/silicon (G-Si) schottky junction solar cells under dark and light illumination (AM 1.5, 100 mW/cm^2).