Comparative characteristics of electrical and photoelectrical properties of Si/fullerite C_{60} and Si/nanocomposite fullerite C_{60}:Me (Me=Cu, Al, Sn and Te) heterostructures

Spoiala D.*, Evtodiev I., Prilepov V.

Moldova State University, MD-2009, Chisinau, Moldova
**e-mail: spodor@usm.md*

The electronic structure and optical properties of fullerite C_{60} thin films are suitable for using in efficient heterojunction solar cells and similar devices. Heterojunction behaviour with high rectifying ratio in the dark (k>10^4 at ± 2 V) and photovoltage generation were demonstrated, firstly, for a p-Si/C_{60} interface. Both isotype n-Si/C_{60}/M and anisotype p-Si/C_{60}/M heterojunctions (where M=Al, Au, Ti, Nb, etc. are top metallic electrodes) are studied by many scientific groups [1-3]. But very intrinsic conductivity of C_{60} thin film ($\sigma \sim 10^{-10}$-10^{-14} Ω·cm) is considered as one of the main limiting factors for Si/C_{60} solar cell efficiency. Therefore, "doping" of fullerite C_{60} is one the principal challenges for high efficiency fullerene-based solar cell production [1].

This work presents the results of research on electrical and photo-electrical properties of heterostructures Si/fullerite C_{60} and Si/nanocomposite fullerite C_{60}:Me (where Me=Cu, Al, Sn and Te) with various concentrations of Me. For the heterostructures Si/C_{60} and Si/C_{60}:Me obtaining, 4 types of silicon plates have been used: n-type crystalline Si wafers (111) (doped with P, 0.3 and 4.5 Ω·cm) and p-type crystalline Si wafers (111) (doped with B, 0.1 and 10 Ω·cm). Thin films of fullerite C_{60} (d~0.1–0.5 μm) were obtained by vacuum sublimation of C_{60} powder. Fullerite C_{60}:Me thin films (d~0.05–0.5 μm) have been prepared by simultaneous deposition of Me and fullerite C_{60} by double-source coevaporated system. Separately electrical and optical properties of fullerite C_{60}:Me films have been studied. The surface structures of fullerite C_{60} and fullerite C_{60}:Me thin films have been studies with atomic force microscope.

Current-voltage characteristics for all obtained heterostructures in darkness and under light illumination are obtained. The analysis of experimental dark current-voltage characteristics is performed being taken into account in the equivalent circuit of heterostructures of series and shunt resistances. At light illumination a photovoltaic effect for all types of obtained heterostructures is observed. The comparative analysis of electrical and photo-electrical properties of Si/fullerite C_{60} and Si/fullerite C_{60}:Me heterostructures has been performed.

[1] E.A.Katz, *Physics of the Solid State* **44**, 621 (2002).
[2] K.M. Chen, Y.Q.Jia, S.X.Jin, K.Wu, X.D.Zhang W.B.Zhao, C.Y.Li, Z.N.Gu, *J.Phys.: Cond. Matter.* **6**, L367 (1994).
[3] C.Wen, T.Aida, I.Honma, H.Komiyama, K.Yamada, *Denki Kagaku* **62**, 264 (1994).