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**Semitransparent perovskite solar cell with increased stability of top laminated carbon nanotube composite**Inga Ermanova<sup>1</sup>, Andrea Cerdán-Pasarán<sup>2</sup>, Arthur Ishteev<sup>1</sup>, Patricia Martínez<sup>3</sup>, Danila Saranin<sup>1</sup>, Ross Haroldson<sup>3</sup> and Anvar Zakhidov<sup>1,3</sup><sup>1</sup>National University of Science and Technology, Russia<sup>2</sup>Universidad de Guanajuato, México<sup>3</sup>University of Texas at Dallas, USA

Perovskite solar cell with semitransparent top electrode composed of layers of SWCNT+MWCNT (single-wall carbon nanotubes and multi-wall carbon nanotubes) soaked with transport layer (PCBM or Spiro-MeOTAD) is found to be more stable than the standard aluminum (Al) or gold (Au) electrodes. The improved performance was observed both for a cathode, made by the combination of both types of CNTs and through the PC<sub>61</sub>BM added, attributed to the enhanced contact between CNTs and the perovskite solar cell films. Similarly the anode, (made of MWCNT soaked by spiro-MeOTAD) shows good performance, as compared to traditional Au anode. An improvement in the stability under illumination was studied for both cathode and anode with the semitransparent CNT/transport layer composite electrode and improved stability is related with the chemically inactive nature of carbon material, which is non-reactive with iodine of the MAPbI<sub>3</sub> perovskite. Carbon nanotubes (CNT) both single-wall (SWCNT) and multi-wall (MWCNT) have been used in the past as transparent flexible electrodes in OPV and in organic light-emitting diodes (OLEDs) as substitute for brittle indium tin oxide (ITO). We have shown that dry drawn CNT sheets can be easily obtained in free standing films state and can be laminated either on glass as usual as anodes of OPV and OLED or if laminated on top, as cathodes collecting electrons. For cathodes in OPV, the CNT should be properly doped in order to lower the work function or raise the Fermi level. Recently, fast progress of hybrid perovskite solar cells in planar configuration is available. Although several approaches to solve task of top transparent electrode have been reported by using graphene or these carbon nanosheets, the top laminated perovskite solar cells with a CNT cathode has not been demonstrated. In present paper we show that using a combination of SWCNT and MWCNT both laminated on top of the ETL (electron transport layer) of the perovskite solar cells can solve a problem of top cathode and can be used instead of Al or Ag in perovskite.

**Biography**

Inga Ermanova is a Master's student who combined studies in National University of Science and Technology (NUST MISIS) in the Electronics and Nanoelectronics direction with working in Laboratory of Energy Efficiency. Her scientific employment is devoted to research optoelectrical characteristics and morphology of organometal halide perovskite solar cells.

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