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Graphene and carbon nanotube thermoelectric transducers

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Basic understanding of fundamental mechanisms the thermal and electric transport on nanoscale is required for new approaches and methodologies. Thermoelectric phenomena have a strong potential for the local cooling on the nano-scale, enabling to exploit the low-temperature phenomena at room temperatures with no needs in bulky and expensive refrigerating equipment. Thermoelectric cooling is observed in the carbon nanotube (CNT), whose opposite ends contain the charge carriers of opposite sign, either electrons or holes, created by doping with using of the local gate electrodes. Finite source-drain electric bias voltage DV causes change of the local effective electron temperature T_e at the middle of CNT, owing to the Peltier effect, whilst the magnitude is deduced from the change in the position and width of spectral singularities, which is manifested in the experimental curves of the source-drain electric conductance. Depending on the sign of DV , the thermoelectric effect causes either cooling or heating of the electron subsystem inside CNT, with the T_e change ~ 70 K. The value of deduced figure of merit is $ZT \sim 10$ and the cooling power density is ~ 80 kW/cm².

The thermal flux Q propagating along the graphene ribbon is determined by the frequency of the electron-restricted phonon scattering and depends on concentration of the electric charge carriers n_c . By using the electrode doping, n_c increases, causing a sharp rise of both the electric conductivity and Seebeck coefficient, while the thermal conductivity tumbles. Such the effect of thermal transistor improves the figure of merit of the thermoelectric transducing circuits.

Biography:

Serhii Shafraniuk has completed his Ph.D at the age of 26 years from Kiev State University and postdoctoral studies from Academy of Sciences of Ukraine. He is the Research Associate Professor at Physics and Astronomy Department, Northwestern University, a premier educational and research institution. He has published more than 100 papers in reputed journals and serving as an organizer of various International Conferences.