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Phonon Engineering at Nanoscale

Phonons manifest themselves in all major processes in semiconductors: they carry heat, limit electron mobility, affect optical response and transmit sound. Rapid miniaturization of electronic devices to nanoscale range requires new approaches for the efficient management of their heat and electrical conductions. One of these approaches, referred to as phonon engineering, is related to the optimization of thermal and electronic properties of nano-dimensional structures due to modification of their phonon properties.

In this talk a brief review of recent theoretical and experimental results on the phonon and thermal properties of quasi one- and two-dimensional semiconductor nanostructures and graphene will be presented. Different possibilities for phonon engineered optimization of their electrical and thermal conduction will be discussed. It will be theoretically demonstrated that strong reduction of lattice thermal conductivity can be achieved in semiconductor segmented nanowires or cross-section modulated nanowires due to the phonon filtering, i.e. trapping of the certain phonon modes in nanowire segments. It will be shown that the unique nature of quasi two-dimensional phonon transport in graphene, twisted graphene and graphene nanoribbons translates to unusually strong dependence of the lattice thermal conductivity on extrinsic parameters: flake size and shape, edge roughness, defects and strain distribution.

Speaker Biography

Denis L Nika is the chair of the Perlin department of theoretical physics and head of the E Pokatilov laboratory of physics and engineering of nanostructures at the Moldova State University. He received his PhD in theoretical and mathematical physics from the same University in 2006. As a visiting researcher he worked in the University of Antwerp, Belgium, Institute for Integrative Nano sciences, Germany and in the nano-device laboratory, University of California, USA. His research interests include various topics in physics of nanostructures such as phonons and thermal transport at nanoscale; multi-band theory of the electron, hole, exciton and impurity states. He was twice awarded the honorary title "The Best Young Scientist of the Republic of Moldova". He has over 80 technical journal publications, 7 reviews, 4 book chapters. His H-index is 30 and his papers were cited more than 4400 times (ISI Web of Science, 2018).

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