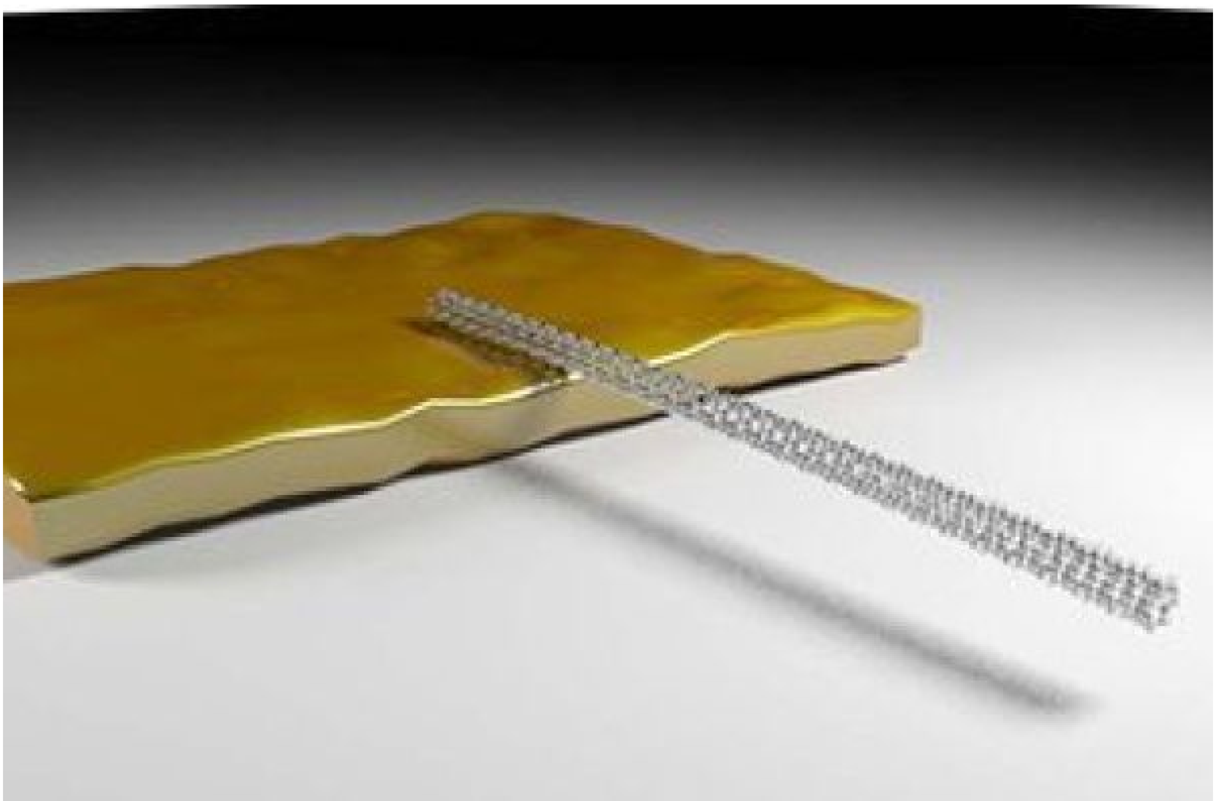

PhD Thesis Defense SLAVEN TEPSIC 'Optomechanical Resonators Based On Low Dimensional Materials'

SLAVEN TEPSIC

July 07, 2021

10:00

Blue Lecture Room and Online (Teams)

Wednesday, July 7, 10:00. Blue Lecture Room and Online (Teams)

SLAVEN TEPSIC

Quantum NanoElectronics And NanoMechanics

ICFO-The Institute of Photonic Sciences

Mechanical resonators based on low dimensional materials have attracted a lot of attention due to their remarkable properties. Their ultra-low mass and high Q factors make them exceptional sensors, offering new possibilities in the studies of the material strength and the thermodynamic properties of low dimensional materials. The goal of this thesis is to shed light on the thermal and elastic properties of low dimensional materials across a wide temperature range. The first part of the thesis is focused on the study of the temperature dependence of the stiffness of carbon nanotubes. By measuring the resonance frequency of singly clamped carbon nanotube resonators as a function of temperature, we can obtain information on the Young's modulus of the measured carbon nanotubes.

We observe a relative shift of the Young's modulus over a large temperature range with a slope of -(173 +/- 65) ppm/K, consistent with two different theoretical models based on the thermal dynamics of the lattice. The results show the dependence of the fundamental mechanical mode on the phonons in carbon nanotubes via the Young's modulus. The measured data also indicates the coupling between mechanical modes and the phonon thermal bath in nanotubes. The phonon thermal bath in our experiments likely operates in the Akhiezer limit.

In the second part of the thesis, we present the temperature dependence of the thermal conductivity and the specific heat capacity in the $MoSe_2$ monolayer in a larger temperature range. Both the thermal conductivity and the specific heat capacity measurements are consistent with predictions based on first-principles. The results show that the phonon transport in a $MoSe_2$ monolayer can be both diffusive and ballistic, depending on the temperature of the monolayer. The method used in this measurement can be used to investigate the thermal properties of many two-dimensional materials. Furthermore, it opens the possibility to investigate interesting thermal transport regimes in two-dimensional materials like hydro-dynamic regime or anomalous heat conduction.

Wednesday, July 7, 10:00. Blue Lecture Room and Online (Teams)

Thesis Advisor: Prof Dr Adrian Bachtold

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