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CiQUS Lecture

Thermal transport and mechanical properties of complex materials by non-contact laser-based techniques

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Monday, February 21, 2022
12:15 p.m. CiQUS Seminar Room & Zoom Session

FONDO EUROPEO DE DESENVOLVEMENTO REXIONAL
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Link to short bio: https://nanophononics.physik.unibas.ch/pages/people/people_BegonaAbad.htm

Abstract:

Nanofabrication techniques now make it possible to synthesize materials with atomic-scale characteristics. At these sizes, traditional models fail to predict the fundamental properties of materials, thus new experimental and theoretical tools are needed in order to discover new physics. Phonons—vibrations of the atomic lattice—are responsible for sound and heat propagation, and behave radically differently in nanostructured systems. Controlling phonons is key for engineering both mechanical and thermal properties, critical to lightweight and energy-efficient nano-electronics, thermoelectric devices, photovoltaics, and sensors. However, measuring thermal transport at the nanoscale is especially difficult due to small, localized temperature gradients as well as significant thermal contact resistances. Measuring nondestructively mechanical properties at the nanoscale is also challenging due to substrate influence and difficult control over the applied tensile stress, yet it is needed for designing compliant devices. To overcome these challenges, non-contact laser-based metrology techniques are used nondestructively to access these properties. In particular, the frequency-resolved photoacoustic effect enables the measurement of the thermal conductivity of a wide range of materials, while time-resolved techniques based on pump-probe schemes are ideal to access the fundamental mechanism of thermal transport in various materials. Here, I will present advances in both characterization of thermal properties of thermoelectric materials [1], as well as the understanding of non-diffusive heat flow away from nanoscale sources [2]. Additionally, I will show how we extended these measurements to probe the mechanical and structural properties of ultrathin films and complex metalattices [3,4]. Finally, I will present recent efforts in the development of a versatile technique based on transient reflectivity and time-resolved Raman spectroscopy to characterize carrier and lattice dynamics as well as different regimes of thermal transport.

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