

CONTRATOS PREDOCTORALES 2022 SEVERO OCHOA

PROJECT TITLE / JOB POSITION TITLE:

Bending Heat Through Molecular Orientation

JOB POSITION RESEARCH LINE:

RL1.- Sustainable Energy Conversion and Storage Systems

RESEARCH PROJECT / RESEARCH GROUP DESCRIPTION:

Controlling how light propagates and can be encoded has underpinned the information revolution witnessed in the past three decades, with ever faster communication speeds. A similar control of heat flow would have huge implications in electronics and in the energy sector, with highly efficient heat waste recovery, advance heat management materials, and electronic devices that last much longer. This PhD project aims at understanding if the fine control of the local thermal conductivity (the main magnitude governing heat propagation) of a material can lead to an effective control of heat flow. The project combines two frontier research lines: the fine control of thermal conductivity in organic and polymeric systems; and the highly advanced spectroscopic tools to investigate heat propagation.

The work will be performed within the Nanostructured Materials for Optoelectronics and Energy Harvesting (NANOPTO) research group, which focuses on producing and characterizing advanced semiconducting structures with the main objective of understanding their fundamental behavior in order to tailor and improve their functionalities and empower different applications in the areas of optoelectronics, energy-related, and sensing devices.

In particular, Mariano's team focusses on the experimental development of organic and hybrid-based materials for applications in energy (photovoltaics and thermoelectrics) as well as optoelectronics (e.g. photodetectors). The group has a strong background on advanced spectroscopic techniques as well as a broad processing toolkit. The PhD will be co-supervised by Mariano Campoy and Sebastian Reparaz (expert in thermal measurements).

JOB POSITION DESCRIPTION:

The project will extensively involve thin film fabrication and characterization addressing the thermal properties of different organic materials, for their use as heat management devices, as well as heat-to-electricity converters (i.e. thermoelectric devices).

The main family of polymers to be tested are semiconducting polymers, i.e. polymers that are conjugated (alternating single-double bonds), such as polythiophene. These materials will be processed by methods such as spin coating, blade coating or inkjet printing. The first step will consist of depositing the films and simultaneously controlling the molecular orientation at macroscopic level, developing further techniques based on directional crystallization [Advanced Functional Materials 23, 2368 (2013)], and then work on the orientation of the polymer chains only locally, using a recent technology developed by our group in the paper Nature Communications, 11, 3610, (2020).

During the project we will actually characterize the samples in two ways, on the one hand, its structural properties (e.g. degree of orientation) mainly using optical and spectroscopic techniques (such as POM and polarized Raman/photoluminescence measurements) [Advanced Optical Materials 5, 1700276 (2017)].

For macroscopically aligned samples, the candidate will dope the films [Advanced Energy Materials 12, 2104076 (2022)] in order to increase their electrical conductivity and characterize the anisotropic thermoelectric properties (Seebeck coefficient, electrical conductivity and the thermal conductivity).

For samples with local orientation, and thus controlled variations in thermal conductivity, we will image the heat flow through the system by using advanced spectroscopic imaging tools. We aim at fabricating molecular heat guides and rectifiers.

We are looking for a creative and motivated PhD candidate, who enjoys being part of a team and holds a Bachelor degree in Chemistry, Physics, Materials Science or Nanoscience.

GROUP LEADER:

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Research project / Research Group website: <https://nanopto.icmab.es/>

RELATED LINKS TO THE POSITION (optional)

URL: <https://nanopto.icmab.es/schematic-illustration-of-the-molecular-gate-concept-supplementary-movie-1/>

Title link: Video showing how to locally orient molecules using lasers