# TCSUH SPECIAL SEMINAR

## Dr. Nicolás Pérez

Institute for Metallic Materials, IFW-Dresden

**Friday, August 4, 2023**

In Person: Houston Science Center (HSC), Room 102; 12:00 pm – 1:00 pm

*Sandwiches will be provided on a first-come, first-served basis.*

## Electron localization in thermoelectric nanostructures

**ABSTRACT:** In this talk, I shall present experimental results indicating localization phenomena in macroscopic tetradymite thermoelectrics with nanostructured characteristics. The fact that these materials are strong topological insulators has made them main subjects for research in quantum solid-state physics in the last decade, mainly in the form of thin exfoliated single crystals, nanoflakes, or thin films. I will show how some of the characteristics typically observed in that case are translated onto macroscopic objects, provided a nanostructure component is present in the otherwise bulk material. Some implications for thermoelectric performance have been determined in preliminary results.

Anderson localization was realized in macroscopic ordered 3D-$Bi_2Te_3$ nanowire nano-network. Angle-dependent magnetoresistance measurements showed a unique weak antilocalization characteristic with a double feature that we could associate with transport along two perpendicular directions dictated by the spatial arrangement of the nanowires. The observed localization effects could be the reason for enhancing the Seebeck coefficient observed in the 3D-$Bi_2Te_3$ nanowire nano-network compared to individual nanowires.

Texturized bulk nanograined $Bi_2Se_3$ samples resulted in high conductivity due to drastically enhanced mobility, up to 1600 $cm^2V^{-1}s^{-1}$ at low temperature. The weak antilocalization effect was observed in the magnetoresistance of pressed samples with different textures, pointing towards surface-like transport channels. The addition of $Fe_3O_4$ nanoparticles drastically increased the conductivity of the samples, and the impact in the localization characteristics was evident at higher $Fe_3O_4$ volume fractions. In the studied $Bi_2Se_3$ samples, adding 5% volume fraction of $Fe_3O_4$ caused zT to increase significantly from 0.14 to 0.2 at room temperature and a moderate carrier concentration of $2x10^{19}$ $cm^{-3}$.

**BIO:** Nicolás Pérez Rodríguez is research group leader and the head of the PPMS Laboratory at the Institute for Metallic Materials, Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden. He was born in Spain in 1974. He received his Bachelor of Physics in 1999 from the University La Laguna in Spain, his MBA in 2002 from the MBA School, La Laguna, Spain, his MSc in Nanoscience in 2007 from the University of Barcelona, and his PhD in Nanoscience in 2012. He received the best doctorate prize in natural sciences. In parallel to his university studies, he started his professional career in 1997, continuing until 2006. He held management positions in banking and later in a communications company. He returned to academia in 2007, with his MSc topic focusing on the magnetism of nanoparticles. He continued with his Ph.D. on the application of magnetic nanoparticles and magnetic nanocomposites for biomedical applications. He was an assistant professor (lecturer) in Barcelona from 2010 to 2013 and then became a post-doc at IFW in 2014 to research magnetic thin films. In 2015 he began a second post-doc at IFW, changing his topic to thermoelectricity. He assumed a permanent position as head of the PPMS Laboratory facility in IFW in 2019.

Host: Prof. Zhifeng Ren, zren2@Central.UH.EDU

Persons who require special accommodations in attending this lecture should call 713-498-9703.