Contribution ID: **877** Type: **Oral**

Investigation of two-dimensional topological insulator candidate, Pt2HgSe3

Tuesday, 12 October 2021 16:00 (15 minutes)

In recent decades, it has become clear that the band structure of solids can be classified using the concept of topological invariants derived from geometry. This new classification of insulators divides them in conventional and topological insulators. Two dimensional topological insulators, or quantum spin-Hall insulators (QSH), are materials that do not conduct electrical current inside them, but have conductive edges protected by time reversal symmetry. Due to the properties of topological materials, edge states are created at the edges of the bulk material in such a manner, that they are able to conduct charge carriers without scattering or reflections, thus being very promising for electronic applications.
A major challenge in this area is the identification of wide band gap QSH materials that allow dissipationless electrical conduction by the edge states at room temperature. In the current research, I investigated a potential QSH material using various experimental tools, including ultra-high vacuum (5 * 10^{-11} Torr) and low temperature (9K) Scanning Tunneling Microscopy (STM), Atomic Force Microcopy (AFM) and confocal Raman spectroscopy. Using STM, I measured a band gap of the order of 100 meV, together with edge states characteristic for topological insulators. Because Jacutingaite (Pt_2HgSe_3) is a naturally occurring mineral, I was able to produce it in a stable normal atmosphere, as well as by exfoliation in thin layers of just a few atomic layers thickness.
The experimental work was performed in Budapest, in the framework of the Nanostructures Department, in the Institute of Technical Physics and Materials Science, part of the Centre for Energy Research Hungary. In this project, I achieved several new and scientifically groundbreaking results: I was the first to exfoliate Pt_2HgSe_3 to a thickness of 3 layers, I was the first to measure the Raman spectrum of the material, and I performed STM measurements for the first time, showing the band gap and the presence of electronic states along the edges. Continuing my work, my colleagues found during DFT calculations and further STM measurements that Pt_2HgSe_3 is a new and widely available platform for exploring the properties of topological two-dimensional electron systems. As a layered mineral, it can be exfoliated in a stable normal atmosphere in a thin layer with a thickness of a few atoms, and I have shown that it can be integrated into heterostructures with other two-dimensional materials. This expands the repository of 2D materials with a new topological insulator, and significantly improves the possibilities of manipulating 2D electronic systems by stacking layered materials. In addition, recent theoretical studies shed light on the possibility of superconductivity in doped Pt_2HgSe_3, which may provide an opportunity to investigate the coexistence of topological edge states with the superconducting phase in the same system. In summary, my work was the basis and contributed significantly to the publication of our scientific article in the journal Nano Letters.

Primary authors: Mr KANDRAI, Konrád (Topology in Nanomaterials Research Group; Institute of Technical Physics and Materials Science; Centre for Energy Research; Eötvös Lóránd Research Network Hungary); Dr NEMES-INCZE, Péter (Head of the Topology in Nanomaterials Research Group, www.nemeslab.com)

Presenter: Mr KANDRAI, Konrád (Topology in Nanomaterials Research Group; Institute of Technical Physics and Materials Science; Centre for Energy Research; Eötvös Lóránd Research Network Hungary)

Session Classification: Condensed Matter Physics

Track Classification: Condensed Matter Physics