Investigating topological insulator Bi_2Se_3 and Bi_2Te_3 nanoplatelets with scanning tunneling spectroscopy

Jara F. Vliem
Thomas C. Wigmans, Jesper R. Moes, Ingmar Swart, Daniel Vanmaekelbergh
Utrecht University, Debye Institute for Nanomaterials Science, Princetonplein 1 3584CC, Utrecht, The Netherlands
j.f.vliem@uu.nl

Topological insulators (TIs) have gained much interest in condensed matter physics due to their unique electronic properties. These materials are characterized by an insulating bulk with topological quantum states protected by time reversal symmetry at their surface (3D materials) or edge (2D materials). Their topological properties are related to the inversion of the conduction and valence band as a consequence of strong spin-orbit coupling. Of the many theoretically predicted and experimentally verified TIs, Bi_2Se_3 serves as a model system due to its large inverted bulk bandgap (0.3 eV) and its helical edge state, which manifests as a Dirac cone situated at the Γ point in the Brillouin zone[1-4].

While extended sheets and bulk crystals of Bi_2Se_3 and Bi_2Te_3 have been investigated thoroughly with scanning tunnelling microscopy (STM) and spectroscopy (STS), reports on the electronic properties of Bi_2Se_3 and Bi_2Te_3 nanoplatelets (NPLs) are scarce1. However, the small lateral size of NPLs (~200 nm) and their specific crystal shape provide a unique opportunity to study the effects of quantum confinement and shape on their opto-electronic properties and band inversion. Here, we present a colloidal synthesis method for the preparation of monocrystalline Bi_2Se_3 and Bi_2Te_3 NPLs with hexagonal symmetry. Furthermore, we give an overview of our research plans to use STM/STS to investigate the electronic properties of these highly interesting topological insulator NPLs.

REFERENCES

[1] Bhunia, Hrishikesh, et al. Physical Chemistry Chemical Physics 19.15 (2017) 9872-9878
[2] Liu, Chao-Xing, et al. Physical review B 81.4 (2010) 041307
[3] Zhang, Yi, et al. Nature Physics 6.8 (2010) 584-588
[4] Jung, Johannes, et al. Physical Review Letters 126.23 (2021) 236402

FIGURES

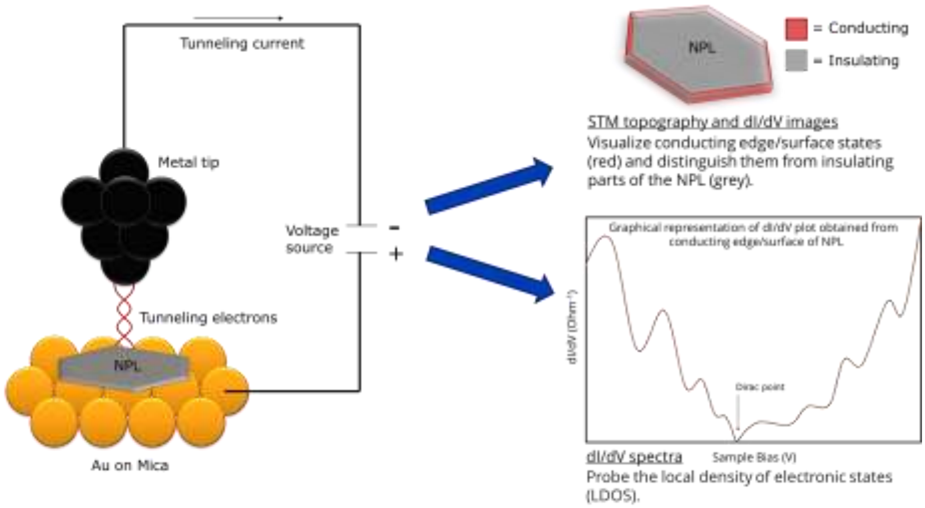

Figure 1: Graphical representation of experimental STM set-up and the types of results that can be obtained.