Interactions in a van der Waals heterostructure created from graphene and tungsten (IV) telluride

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Layered two-dimensional materials such as graphene and transition metal dichalcogenides (TMDC) characterise with a diverse range of physical properties. One of the characteristic properties of such materials is that they exhibit intermolecular van der Waals forces that bind the crystal layers in a plane perpendicular to the layers of the material. The presence of these interactions potentially enables the mixing of different layered materials into so-called van der Waals (vdW) heterostructures. Such-created materials may exhibit properties different than what could be expected from a simple mix of given components, due to the proximity effects that modify their electronic structure. Hybrids fabricated this way are not naturally found - they are unique and never before studied systems that require in-depth characterization.

In our research, a vdW heterostructure was produced by covering the WTe_2 surface with graphene. The properties of the hybrids obtained this way were then characterized using both global and local characterisation techniques. Due to the many interesting properties, a multi-layer WTe_2 bulk crystal was chosen as a material to fabricate the heterostructure. It belongs to the type-II Weyl semimetals group - a class of materials in which electrons exhibit the behaviour of massless Weyl fermions with a strictly defined chirality.

The mutual influence of the hybrid components interactions in the heterostructure has been characterized using a variety of research techniques, such as: scanning tunnelling microscopy (STM), current imaging tunnelling spectroscopy (CITS), low-energy electron diffraction technique (LEED), Raman spectroscopy, X-ray photoelectron spectroscopy (XPS) and angle-resolved photoelectron spectroscopy (ARPES). The data obtained using the above-mentioned methods suggest the existence of interactions caused by the proximity effect in the heterostructure and a modification of the electronic structure of its components.

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