Engineering a Spin-Orbit Bandgap in Graphene-Tellurium Heterostructures

Manuela Garnica[1,7], B. Muñiz Cano[1], D. Pacilè[2], M. G. Cuxart[1], A. Amiri[1], F. Calleja[1], M. Pisarra[1,2], A. Sindona[2,3], F. Martín[1,4], E. Salagre[5], P. Segovia[5,6,7], E. G. Michel[5,6,7], A. L. Vázquez de Parga[1,5,6,7], R. Miranda[1,5,6,7], J. Camarero[1,5,6,7], M. A. Valbuena[1]

[1]*Instituto Madrileño de Estudios Avanzados, IMDEA Nanociencia, 28049, Madrid, Spain*
[2]*Dipartimento di Fisica, Università della Calabria, I-87036 Rende (CS), Italy*
[3]*INFN, sezione LNF, Gruppo collegato di Cosenza, I-87036 Rende (CS), Italy*
[4]*Departamento de Química, Universidad Autónoma de Madrid, 28049 Madrid, Spain*
[5]*Departamento de Física de la Materia Condensada, Universidad Autónoma de Madrid 28049, Madrid, Spain*
[6]*Condensed Matter Physics Center (IFIMAC), Universidad Autónoma de Madrid (UAM), Campus de Cantoblanco, 28049, Madrid, Spain*
[7]*Instituto Universitario de Ciencia de Materiales "Nicolás Cabrera", Universidad Autónoma de Madrid, Madrid, Spain*
manuela.garnica@imdea.org

The spin-orbit interaction (SOI) plays a pivotal role in shaping the electronic properties of materials, especially in the context of graphene-based heterostructures. In these systems, the interplay between the intrinsic SOI and external factors, such as heavy elements or intercalated species, can be strategically manipulated to induce and control unique electronic phenomena.

In this work, we report on a combined scanning tunneling microscopy (STM), low energy electron diffraction (LEED) and Angle Resolved Photoemission Spectroscopy (ARPES) study on a new superstructure when Te is evaporated on graphene over Ir(111) [1]. Notably, a significant bandgap at the Dirac point is revealed at room temperature, rendering graphene nearly charge-neutral and allowing for the tuning of the Fermi level into the gap as a function of the Te coverage. The origin of the bandgap has been attributed to a substantial intrinsic SOI, presenting promising possibilities for electronic and spintronic device applications based on graphene/Te heterostructures.

Figures

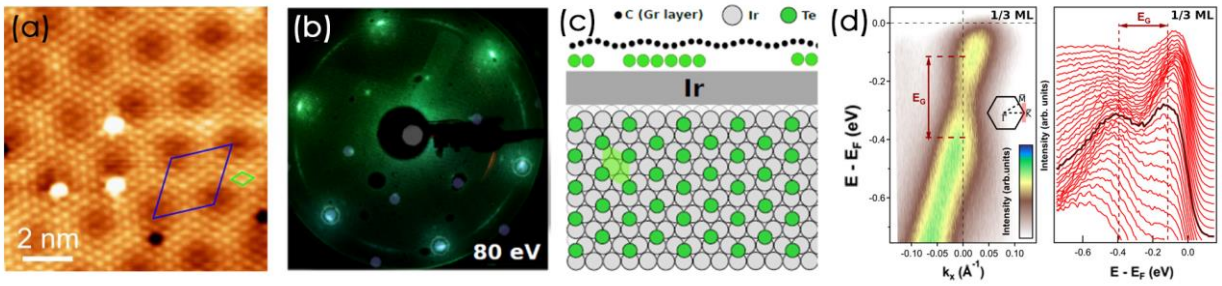

Figure 1: (a) High resolved STM image (V_b=2 V, I_t=0.35 nA). The moiré pattern unit cell of gr/Ir(111) and the one created by the intercalated Te are depicted in blue and green, respectively. (b) LEED pattern showing a pure (√3×√3)R30° reconstruction, described by the real space model in (c). (d) ARPES spectrum at K point of the Gr/Te/Ir(111) heterostructure and the corresponding Energy Distribution Curves evidence the gap opening at the Dirac point.

References

[1] B. Muñiz Cano, *et al.*, arXiv:2311.16792.