PROBING THE UNOCCUPIED BAND STRUCTURE WITH LOW-ENERGY ELECTRON MICROSCOPY

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The properties of any material are fundamentally determined by its electronic band structure. While the occupied bands can be routinely measured, it is remarkably difficult to characterize the empty part of the band structure experimentally. We now introduce a technique to measure these bands from nanoscopic samples [1]. It relies on the dependence of the reflectivity of low-energy electrons on their incidence angle on the sample and their kinetic energy. Since this angle-resolved reflected-electron spectroscopy (ARRES) is based on state-of-the-art low-energy electrons microscopy it has a spatial resolution 10nm, which is five orders of magnitude better than other techniques. We use ARRES to study the unoccupied band structure of so-called van der Waals crystals. Those custom made materials are built up by stacking layers of two-dimensional materials, such as graphene, boron nitride, or transitionmetal dichalcogenides, on top of each other. This allows it to construct crystals with specific properties that are not available in conventional materials. We also show how this novel technique can be used to shed light on the interaction between electronic states of individual layers. This knowledge is crucial for the understanding of how to tailor the properties of Van der Waals crystals in a LEGO-like fashion.

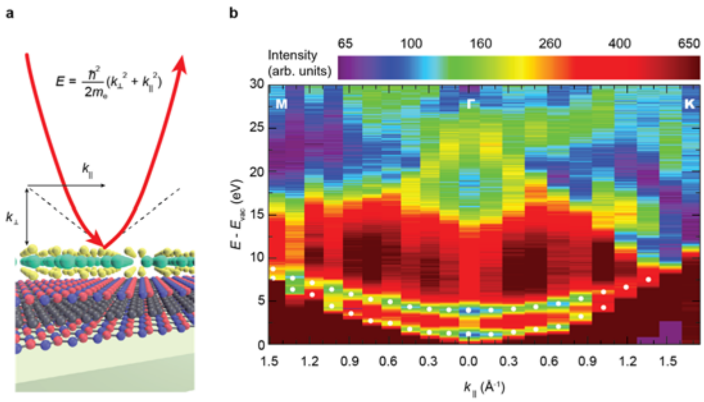

Fig. 1. **a**, Changing the angle of incidence of low-energy electrons onto a surface while recording their energy and reflected intensity yields insights into the materials unoccupied band structure. **b**, This ARRES measurement reveals, e.g., the bands of bilayer graphene and shows clear band quantization at low energies.

Keywords: Band structure; Low-energy electron microscopy; Van der Waals material

References

[1] J. Jobst et al. Nature Communications 6, 8926 (2015).