The characterization and electronic structure of nanostructured zirconium tellurides

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Zirconium tellurides, $ZrTe_X$ (X=2,3,5), are interesting because they can occur in a variety of crystal structures and display a range of exotic properties [1], ranging from semi-metallic character with massless Dirac fermions [1], anomalous resistivity [2], superconductivity and charge density wave phenomena [3]. This has made the electronic structure of pure and substituted zirconium tellurides the subject of numerous theoretical and experimental investigations. Here angle-resolved photoelectron spectroscopy (ARPES) has been extensively utilized to probe the electronic structure of zirconium telluride crystals or epitaxially-grown thin films [1-4]. As layered materials, nanostructures of the zirconium tellurides have been successfully isolated through mechanical exfoliation methods [5], however the sampling area of traditional lab-based ARPES systems has been a practical limitation in investigating the electronic structure of such exfoliated 2D materials [6].

In this work, we explore the creation and characterization of exfoliated zirconium telluride nanostructures through spectromicroscopy. This work is undertaken in view of identifying and exploring the electronic properties of isolated zirconium telluride structures with well characterized morphologies, which becomes possible through the combination of photoemission electron microscopy (PEEM) and micro ARPES (μARPES) available through the NanoESCA III momentum microscope at Flinders Microscopy and Microanalysis (FMMA). Here PEEM enables us to identify the zirconium telluride structures where we perform electronic structure investigations using μARPES. In this way, we can explore the influence that the structural morphology (flake dimensions and layer number) of the zirconium tellurides has on its electronic properties, as it is well-established that the dimensionality of materials, such as layer thickness, can influence the observed electronic structure [7]. Here we support our experimental investigations into the electronic structure of nanostructured zirconium tellurides through theoretical calculations.

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