Exfoliated 2H- and 1T'-$MoTe_2$ on gold substrates studied by photoemission spectroscopy

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Angle-Resolved Photoemission Spectroscopy (ARPES) serves as a powerful technique for investigating the electronic structure and interface properties of two-dimensional materials on various substrates. $MoTe_2$ is a transition-metal dichalcogenide (TMDC) that can exist in three stable crystal structures (2H, 1T', T_d) with distinct electronic properties. 2H-$MoTe_2$ is semiconducting, 1T'-$MoTe_2$ metallic, and T_d-$MoTe_2$ exhibits topological Weyl-semimetal behaviour [1-3]. Many recent works focus on the phase transition between the metallic 1T' phase and the topological T_d phase and its dependence on parameters like dimensionality (flake-thickness), pressure (strain), or charge doping [4]. Only recently, it was reported that 2H-$MoTe_2$ can also be locally transformed into T_d by laser irradiation [5].
So far, influences of the substrate on $MoTe_2$ properties have been widely neglected, although interface-induced strain or charge-transfer effects can be an interesting handle to influence the properties of $MoTe_2$ polymorphs. Here we present a micro-ARPES study of 2H- and 1T'-$MoTe_2$ directly exfoliated in air on a (111) Au substrate (Figure 1). The exfoliation of $MoTe_2$ on gold leads to high coverage of single-layer flakes for both polymorphs. After exfoliation, samples were immediately inserted back into UHV for ARPES and X-ray photoelectron spectroscopy (XPS) studies.
Comparing XPS core-level spectra and local ARPES data from bulk flakes and single-layer areas reveal chemical shifts in Mo and Te core levels induced by the interaction with the (111) Au substrate. Respective changes in the band structure, Fermi level, and work functions are discussed.

References

[1] X. Qian,J. Liu, L. Fu, and J. Li. Science 346, 1344 (2014).
[2] Y. Ma, L. Kou, X. Li, Y. Dai, S. C. Smith, and T. Heine. Phys. Rev. B 92, 085427 (2015).
[3] Y, Deng, X. Zhao, C. Zhu, P. Li, R. Duan, G. Liu, and Z. Liu ACS Nano 15, 12465 (2021).
[4] S.Paul, S. Talukdar, R. S. Singh, and S. Saha, Phys. Status Solidi RRL 17, 2200420 (2023).
[5] C. H. Lee et al., Nano Lett., 23, 2, 677–684 (2023).

Figures

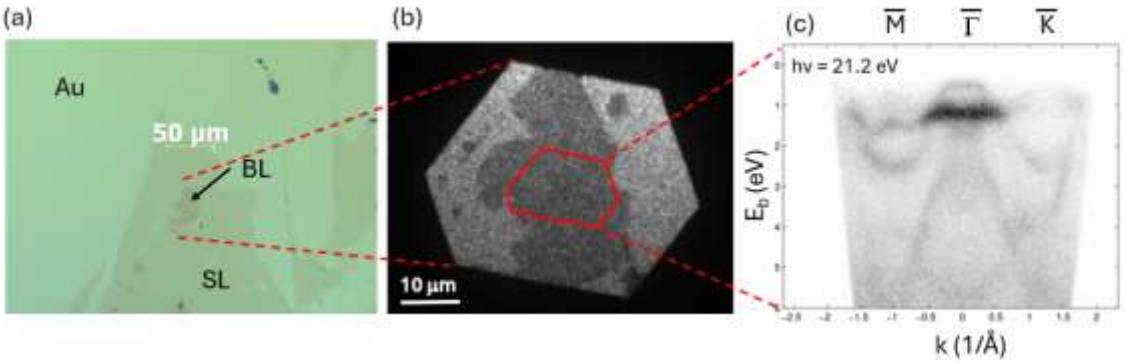

Figure 1: Optical picture of the exfoliated 2H-$MoTe_2$ sample indicating single-layer (SL) and bilayer (BL) regions (a). Photoemission electron microscopy of BL region is shown in (b). The red hexagon indicates the shape of closed iris used for acquiring ARPES from BL-2H-$MoTe_2$ (c).