

Interface Property of Metals and Semimetals Contact Transition Metal Dichalcogenides

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Abstract

In the last decade, transition metal dichalcogenides (TMDs) have been intensely studied and demonstrate to realize devices for their remarkable electronic properties, such as high carrier mobility and tunable band gap. However, the complex mechanism between metal and semiconductor TMD gives rise to the challenge to lowering barrier height, which obstacle the reduction of contact resistance at the interface, and therefore immensely lower the performance and degrades device reliability.

To address this longstanding issue and provide a more comprehensive understanding, we perform scanning tunnelling microscopy/spectroscopy (STM/S) to investigate the interfacial properties of various metal films grown on MoS₂ and WS₂. Our findings show that after metal contact, the density of state of MoS₂ and WS₂ all exhibit a band gap reduction behavior in every contact system, which origin from the interlayer hybridization between metal and TMDs, and could be effectively enhanced by selection different material. Moreover, we successfully demonstrate that this mechanism can drive semiconductor to semimetal transition after strongly hybridize for nickel (Ni) contact, which is the first experimental observation as far as the research we could spot to date. Last, distinct charge transfer occurs in bismuth (Bi) contact system, which dope the semiconductor TMD, and beneficially shift the Fermi level toward conduction band.

Our work reveals the interfacial property between metal films and the monolayer TMDs and provide a thorough picture for the contact mechanism. Which not only provide a new perspective in the field but also present a potential technique for electro fabrication.

Keywords - scanning tunnelling microscopy/spectroscopy, metal-semiconductor contact, 2D material.