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Fermi level de-pinning induced by metallic edge-contact to TMDC

Future semiconductor technology can be realized by employing atomically thin two-dimensional (2D) structures, eg. transition metal dichalcogenides (TMDCs). Fermi-level pinning occurs when a metal is in contact with a semiconductor. In most cases, semiconducting characteristics of TMDC are expected to be ambipolar, but that of MoS_2 showed strong n-type behavior. To achieve p-type behavior from MoS_2 semiconductor devices, de-pinning of the contact metal is required, since pinning is very strong in them. In this work, we demonstrate that, when the high work function of palladium (Pd) is used to form edge contact on multi-layer MoS_2, p-type behavior is realized. In contrast, multi-layer MoS_2 device fabricated with edge-contact of low work function chromium (Cr) did not show p-type behavior. Furthermore, to understand interfacial properties of another 2D material, we employed the same metals (Cr & Pd) on multi-layer $MoTe_2$ devices. The surface-contact samples of $MoTe_2$ using these metals showed only ambipolar behaviour, and no changes in electrical results were observed despite the use of different work function metals. However, when edge-contact made with low work function metal Cr showed n-type behavior, while edge-contact with high work function Pd showed p-type due to de-pinning of Fermi level at the $MoTe_2$ and metal interface. This opens up a new area of study to designs polarity control of 2D TMDC materials based electronic devices.

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