P-type molybdenum disulfide by Fermi level de-pinning effect of edge-contact

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Next revolution in semiconducting technology can be realized by unique properties of atomically thin two-dimensional (2D) structures, e.g. transition metal dichalcogenides(TMDCs), black phosphorous (BP), and graphene. Band gap of TMDCs (e.g. MoS_2,$MoTe_2$, and WSe_2) is found to be in the range of 1~2 eV which can be used for future switching and optoelectronic devices. It isgenerally known that Fermi-level pinning occurs when a metal is in contact with a semiconductor. The contact between metal and semiconductor, either surface oredge contact, can be related to n- or p-type behavior. In most cases, TMDCs are expected to be ambipolar, except for the MoS_2 that showed strong n-type behavior. To achieve p-type metal-contact with MoS_2, de-pinning of the contact metal in the 2D device structure is desired, since pinning effect is very strong in that configuration. In this work, the high work function of palladium (Pd) was used to form edge contact on multi-layer MoS_2 sheets, and thus formed device demonstrated p-type behavior. This shows the successful de-pinning is the result of employing high work function of Pd and the edge-contact structure. Edge-contact of chromium(Cr), however, did not show p-type behavior (due to its low work function). Meanwhile,surface-contacted samples showed only n-type behavior as was expected (due to the strong pinning effect).

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