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Fermi Level Pinning at Electrical Metal Contacts of Monolayer Molybdenum Dichalcogenides

Electrical metal contacts to two-dimensional (2D) semiconducting transition metal dichalcogenides (TMDCs) are considered as main obstacle to the device performance due to weak metal dependences, stubborn polarities and uncontrollable Schottky barrier heights (SBH), indicating strong Fermi level pinning. [1] Here, we investigate the first experimental Fermi level pinning of monolayer MoS_2 and monolayer $MoTe_2$. We estimated each SBH between monolayer TMDCs (MoS_2 and $MoTe_2$) and various metal contacts (Ti, Cr, Au, Pd) by measuring transfer curves in a wide temperature range from 173K to 473K. The pinning factors *S* were found to be 0.11 and -0.07 for monolayer MoS_2 and $MoTe_2$ respectively. Additionally, we quantitatively compared our results with theoretical calculations, in terms of the pinning factor and charge neutrality level of monolayer TMDCs. These suggest much stronger Fermi level pinning effect and lower SBH than theoretical prediction. [2] Our results further implies that metal work functions can be much weakly influential to contact properties on practical devices, overridden by the effect of defects.

References

[1] Adrien Allain et al, Nature materials. 14(12) (2015) p.1195-1205
[2] Changsik Kim et al, ACS Nano. 11 (2017) p.1588-1596

Figures

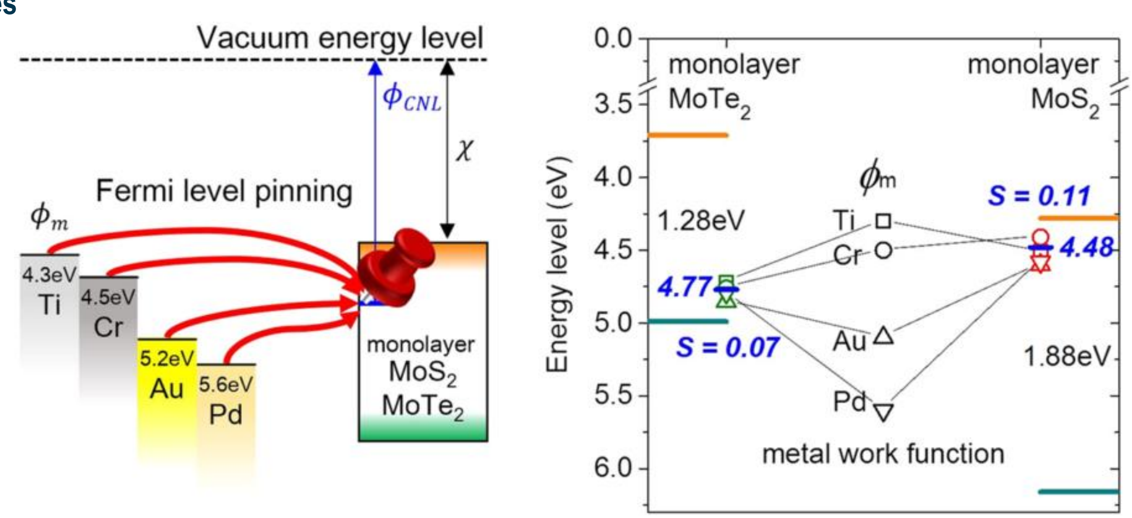

Figure 1: Schematic diagram and result of Fermi level pinning of monolayer MoS_2 and $MoTe_2$, (blue bar: charge neutrality level, blue S: pinning factor, orange line: conduction band edge, green line: valence band edge)

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