Contact Engineering in 2D-Material-Based Electrical Contacts*

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The engineering of efficient electrical contact to two-dimensional (2D) layered materials is crucial for the development of industrial-grade 2D-material-based electronics and optoelectronics. The undesirably large contact resistance, in particular, is a major obstacle and needs to be minimized.

We develop a new model to quantify electrical contact resistance and current distribution for 2D/2D and 2D/3D metal/semiconductor contact interfaces, based on a self-consistent transmission line model (TLM) [1] coupled with the thermionic charge injection model [2] of 2D materials (Figs. 1a and 1b). Results are validated with existing experimental works. We further model the effect of interfacial roughness at the 2D/3D electrical contact by including a Schottky barrier height (SBH) fluctuation term, i.e. $\Phi_B \rightarrow \Phi_B + \Delta\Phi_B$, where $\Delta\Phi_B$ is calculated by assuming that the SBH fluctuation follows a Gaussian distribution [3].

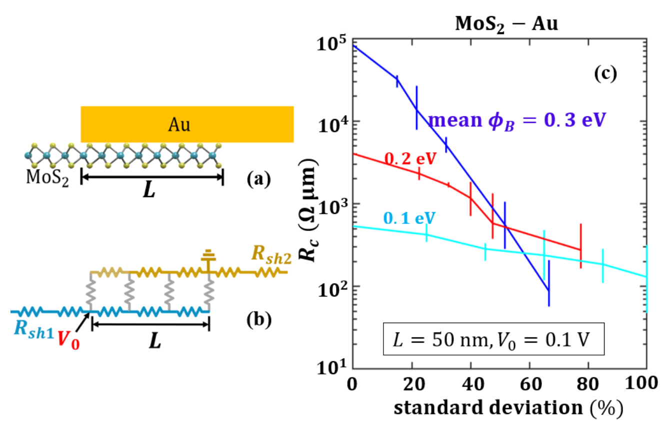

Figure 1 – (a) A parallel, partially overlapped electric contact between monolayer MoS_2 (2D semiconductor) and thin film gold (3D metal); (b) its transmission line model. (c) Contact resistance R_c as a function of interfacial surface roughness (standard deviation/ϕ_B) for different mean values of Schottky barrier height ϕ_B. Here, applied voltage $V_0 = 0.1$ V, and contact length $L =$ 50 nm. [3]

Figure 1c shows the SBH variation has a dramatic effect on the contact resistance. In general, R_c is reduced significantly in the presence of roughness. Such reduction is particularly effective for MoS_2/Au contact with large SBH (e.g. 0.3 eV).

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References

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