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# GENERALIZED SELF CONSISTENT MODEL FOR TUNNELING CURRENT IN DISSIMILAR METAL-INSULATOR-METAL JUNCTIONS

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When two conductors are separated by sufficiently thin insulating layer, electrical current can flow between them by quantum tunneling. Tunneling conductivity is important to nanoscale electrical contacts, plasmonic resonators, carbon nanotube, graphene, and other novel two-dimensional (2D) material based devices. Tunneling effects between electrodes separated by thin insulating films have been studied extensively by Simmons [1,2] in 1960s. Simmons formula is reliable only in low voltage regime for limited parameter space (insulator gap > 1nm, barrier height > 3eV) [3]. Zhang [3] improved Simmons's theory by including space charge and electron exchange correlation potential in the nanogap formed between similar electrodes. Here, we extend the theory for tunneling current density in nano- and subnano-meter metal-insulator-metal (MIM) junctions with dissimilar work functions. Unlike similar MIM junctions, the current is polarity dependent. The forward (lower work function metal is positively biased) and reverse (lower work function metal is negatively biased) characteristics cross over at higher voltages. The influence of material properties (i.e. work function of the electrodes, electron affinity and permittivity of the insulator) on the reverse and forward bias J-V curves are examined in detail for various regimes.

1. J. G. Simmons, "Generalized Formula for the Electric Tunnel Effect between Similar Electrodes Separated by a Thin Insulating Film", J. Appl. Phys. 34, 1793–1803 (1963).
2. J. G. Simmons, "Electric Tunnel Effect between Dissimilar Electrodes Separated by a Thin Insulating Film,"J. Appl. Phys., vol. 34, no. 9, pp. 2581–2590(1963).
3. P. Zhang, "Scaling for quantum tunneling current in nano- and subnano-scale plasmonic junctions", Sci. Rep., 5, 9826 (2015).

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