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ENGINEERED TUNNELING ELECTRICAL CONTACTS

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Contact resistance and current transport are important to nano scale electrical contacts, such as those based on metal-insulator-metal (MIM) thin junctions, carbon nanotube (CNT) networks, and novel two-dimensional (2D) materials. Current tunneling and contact resistance across such contacts greatly influence the device properties and performance. Current crowding effects in these contacts can lead to localized overheating and the formation of thermal hot spots. To improve reliability and lifetime of the device, it is crucial to engineer these contact structures to mitigate the local heating. In this study, we propose a method to design nanoscale electrical contacts with controlled current distribution and contact resistance via engineered spatially varying contact layer properties and geometry. A lumped circuit transmission line model (TLM) [1] is used to get self-consistent analysis of contact resistivity, current and voltage distribution across tunneling contacts formed between similar/dissimilar contacting members separated by a thin insulating gap with varying thickness. It is found the nonhomogeneous current and voltage distribution in parallel tunneling contacts can be reduced by varying the specific contact resistivity along the contact length. This specific contact resistivity is either predefined (for ohmic contacts), or calculated from the local tunneling current in case of insulating tunneling layer [2].

1. S. Banerjee, J. Luginsland, and P. Zhang, "Two dimensional tunneling resistance transmission line model for nanoscale parallel electrical contacts", under review, 2019.
2. P. Zhang, "Scaling for quantum tunneling current in nano- and subnano-scale plasmonic junctions", Sci. Rep., 5, 9826 (2015).

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Author: BANERJEE, Sneha (Michigan State University)

Co-authors: Dr LUGINSLAND, John; ZHANG, Peng (Michigan State University)

Presenter: BANERJEE, Sneha (Michigan State University)

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