RECENT ADVANCES ON ELECTRICAL CONTACT RESISTANCE: THEORY AND EXPERIMENT

Peng Zhang[1], Matthew R. Gomez[1], David M. French[1], Wilkin Tang[2], Y. Y. Lau[1], and R. M. Gilgenbach[1]
[1]*Department of Nuclear Engineering and Radiological Sciences, University of Michigan, Ann Arbor, MI 48109-2104, USA*
[2]*AFRL, Albuquerque, NM, USA*

Electrical contact is important to thin film devices and integrated circuits, carbon nanotubes based cathodes and interconnects, field emitters, wire-array *Z* pinches, metal insulator- vacuum junctions, and high power microwave sources, etc. Because of the surface roughness on a microscopic scale, true contact between two pieces of conductors occurs only at the asperities of the two contacting surfaces, leading to contact resistance.

For a long time, the basic model for contact resistance remains that of Holm's *a*-spot [1], where the current flows through a circular disk constriction of a small radius *a* and zero thickness at the bulk interface. In this paper, we vastly extend Holm's *a*-spot theory to higher dimensions, including dissimilar materials in the main current channels and in the connecting bridge joining them. Both Cartesian and cylindrical channels have been analyzed. A scaling law for the contact resistance has been constructed for arbitrary values of the dimensions of the channels and bridges, and for arbitrary electrical resistivity in each section. This scaling law was confirmed against spot checks with the MAXWELL 3D code. It also recovers the same results for all known cases, including connecting bridges of the same resistivity [2]. This latter special case was also confirmed in our recent experiments [3].

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[1] R. Holm, *Electric Contact*, 4th Edition, (Springer-Verlag, Berlin, 1967).
[2] Y. Y. Lau and Wilkin Tang, J. Appl. Phys. **105**, 124902 (2009).
[3] M. R. Gomez *et al*., Appl. Phys. Lett. **95**, 072103 (2009).