Bulk and Thin Film Electrical Contacts, RF Heating and Field Enhancement

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Surfaces are never perfectly flat. Because of the surface roughness on a microscopic scale, true contact between two pieces of conductors occurs only at the asperities (small protrusions) of the two contacting surfaces, leading to contact resistance, an important issue to high power microwave sources, pulsed power systems, field emitters, thin film devices and integrated circuits, and interconnects, etc. Contact problems account for 40 percent of all electrical/electronic failures. On a single surface, surface roughness may lead to (1) unacceptable ohmic loss on millimeter wave generators, (2) electrical breakdown due to enhanced electric field, and (3) increase in local magnetic field which triggers abrupt quenching in superconducting cavities.

This talk features recent advances made at the University of Michigan on the modeling of various effects of surface roughness, including electrical contact resistance for both bulk contacts and thin film contacts. Scaling laws are constructed for a large range of resistivity ratios and geometries in the contact members. The theory is extended to a contact spot of arbitrary geometry, and to the bulk contact resistance under AC condition. Also presented is roughness-induced enhanced RF heating, and the enhanced RF electric and magnetic fields.