Reduced Conductivity of Copper Between 400 and 850 GHz

MATTHEW KIRLEY, JOHN BOOSKE, University of Wisconsin-Madison — Effective design of sources and low-loss transmission line components for sub-millimeter wavelength radiation requires the ability to predict the amount of dissipation loss caused by conducting surfaces. However, the theoretical understanding of the conductivity of metals is incomplete beyond 100 gigahertz (GHz). Electromagnetic simulation tools, used in THz device design, would be enhanced by improved models for metal conductivity as a function of frequency and surface characteristics. Confirming such a theory is difficult because experimental measurements in this regime are unavailable, unrepeatable or even contradictory. We measured the conductivity of smooth (surface roughness \( \leq 5 \) nm) copper surfaces between 400 and 850 GHz using a high quality factor quasi-optical (QO) hemispherical resonator. These measurements are compared to the predictions of the Sommerfeld theory of electronic conduction and the classical relaxation effect model. Our results show that copper is significantly less conductive than expected in this frequency range. We are investigating the hypothesis that the microstructure of the copper metal is responsible for the discrepancy.

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