Far-Infrared Behavior of Discontinuous Gold Films Spanning the Percolation Transition

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Competing phases in electronic systems can lead to spatially mixed systems as well as emergent phenomena, spurring interest in the study of intentionally inhomogeneous materials. This includes metal-insulator mixtures spanning the percolation transition. This presentation will describe the far-infrared behavior of a set of ten discontinuous gold island films on sapphire substrates, designed to be in close proximity to the percolation transition. A combination of transmission & reflection measurements revealed a wide range of frequency-dependent conductivities. The film nearest the percolation transition showed an approximate power-law behavior $\sigma(\omega) \sim \omega^x$ where $x \approx ½$, a result consistent with both scaling theory as well as Bruggeman's effective medium approximation (EMA). This is in contrast with some previous studies[1], possibly due to differences in film topology (as revealed by SEM and AFM imaging) that stem from the choice of substrate and growth conditions. Results of DC transport as well as EMA fits to the spectra (see figures below) will be discussed.

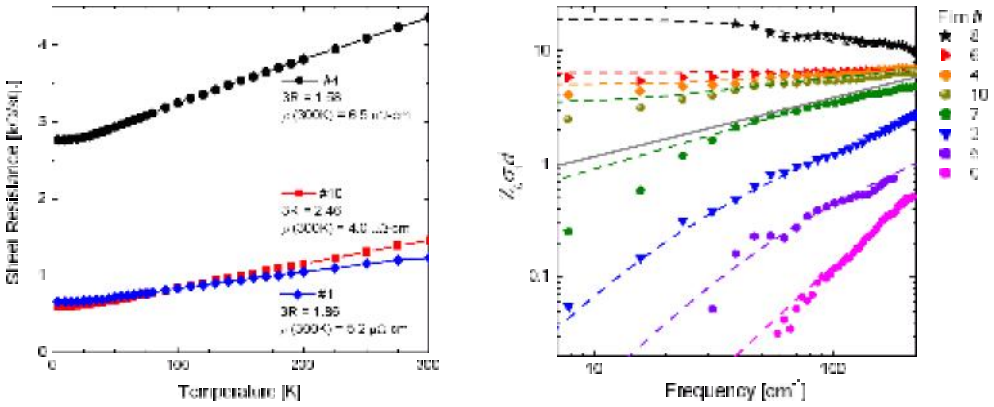

Figure. *Left panel*: Temperature dependent sheet resistance for three films just above percolation, showing metallic behavior. *Right panel*: Extracted dimensionless sheet admittance $Z_0 \pm_1 d$ for eight film samples (symbols) plus EMA fits (dashed lines). Film #10 is the 1st film above percolation. Here, Z_0 is the impedance of free space (377Ω) and d is the film thickness. The solid gray line corresponds to a conductivity $\pm(\mu) \sim \mu^{1/2}$.

References

[1] M. Walther et al, *Physical Review* B **76**, 125408 (2007).