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Far-infrared Studies of Superconductivity in Amorphous MoGe Films

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Sputtered films of molybdenum germanium (MoGe) serve as a model system for studying the interplay between superconductivity and electron localization.[1] For this study, 4 amorphous MoGe films of different thickness were deposited onto sapphire substrates. The far-infrared transmission was measured for both the normal and superconducting states (where appropriate). The normal-state transmission was found to be independent of both temperature and frequency, as expected for thin metallic films with a very high impurity scattering rate. Fits to the transmission yielded values for each film's sheet resistance, shown in Figure 1 in a log-log plot versus thickness. The deviation from 1/thickness (dashed line) is an indication of localization effects, which appear when the sheet resistance approaches the quantum of conductance $2e^2/h \sim 13\ k\Omega/sq$. Localization interferes with the pairing process in superconductors, which is observed as a suppressed T_c, smaller energy gap, etc. Our low-temperature transmission measurements (see Figure 2, solid circles) reveal the presence of an energy gap that is consistent with BCS theory[2] (solid curves). The ratio of $2\Delta/kT_c \sim 3{,}5m$ is near the BCS weak coupling result.

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1. J. M. Graybeal and M. R. Beasley, Phys. Rev. B **29**, 4167 (1984); . M. Graybeal and M. R. Beasley, Phys. Rev. Lett. **56**, 173 (1986).
2. D.C. Mattis and J. Bardeen, Phys. Rev. **111**, 412 (1958).

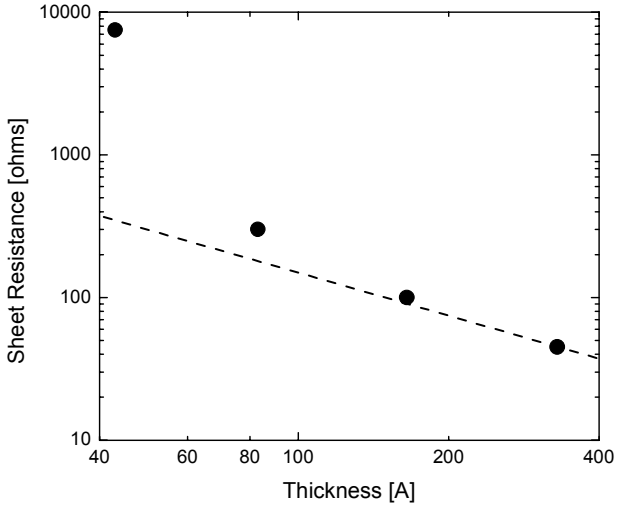

Figure 1. The sheet resistance for 4 different MoGe films, determined from the far-infrared transmission, versus film thickness. The dashed line is the expected dependence assuming a 1/thickness dependence, or a constant resistivity.

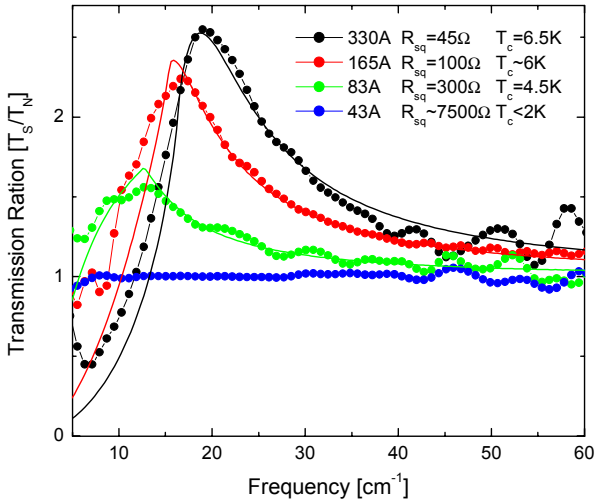

Figure 2. The far-infrared transmission through 4 different MoGe films, normalized its transmission at T=10K. The peak position is an indication of the superconductiing energy gap.