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Transient Photo-reflectance Spectroscopy of Superconducting MgB_2

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We have used a transient photoreflectance technique to probe the energy gap for MgB_2. The sample was a thin film deposited onto a sapphire substrate. Measurements of the far-infrared reflectance change when the sample was cooled below T_c (about 30K for this particular sample) show clear evidence for a BCS-like energy gap (see Fig. 1). Fits to the reflectance using BCS theory are in reasonable agreement with experiment. The fit is slightly improved if one assumes the existence of two energy gaps. In the photoreflectance measurement, laser light is used to break Cooper pairs and produce excess quasiparticles. This weakens the superconducting state, detectable as a shift in the energy gap. The photoreflectance data is shown in Fig. 2, along with two calculations. The calculation assuming the single energy gap obtained from Fig. 1 does not agree with the data. But a calculation assuming two gaps (also parameters from Fig 1) is in good agreement if one assumes only the smaller gap is shifted. Such behavior is likely to occur in a system with more than one energy gap. The excess quasiparticles settle to the lowest gap, leaving the other gap unperturbed.

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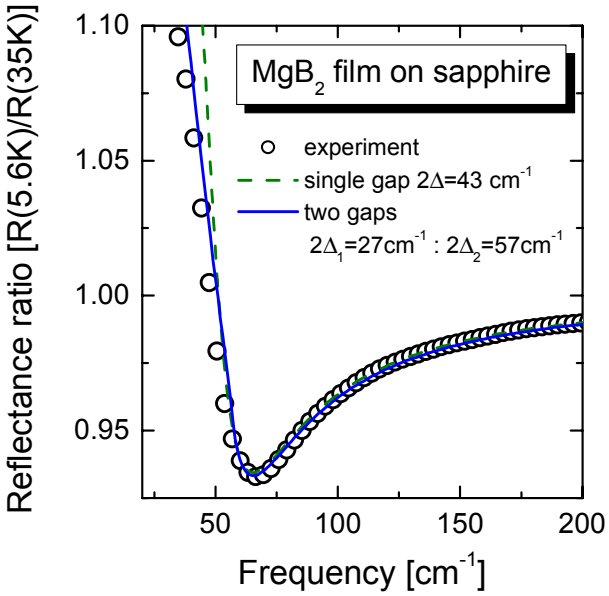

Figure 1. MgB_2 film reflectance at T-6K (superconducting) relative to the same film at T=35K (normal state). Also shown are two fits based on BCS theory.

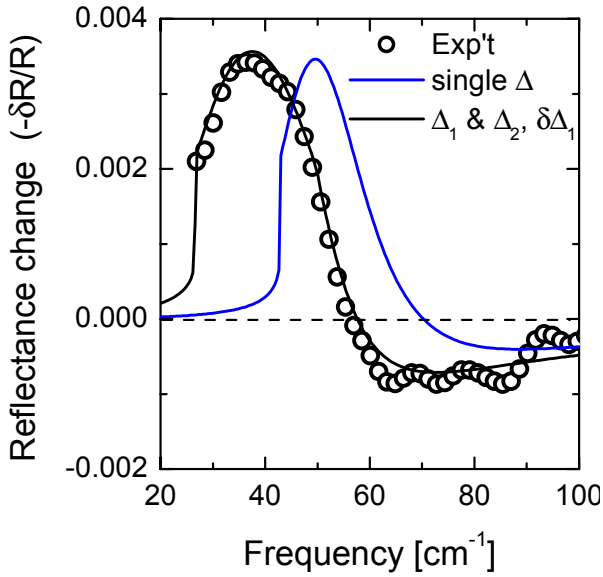

Figure 2. Normalized reflectance change due to exposing the film to laser light, along with two BCS fits. Only the two-gap fit allows for good agreement with experiment.