

Electron Spin Resonance and Microwave Conductivity Studies of MgB₂

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(October 4, 2002)

We report the observation of conduction electron spin resonance (CESR) in MgB₂ powder samples using multifrequency (3-225 GHz, 0.1-8 T) ESR technique. The normal state spin-susceptibility, \tilde{A}_s , measured from the CESR signal intensity agrees with band structure calculations confirming that MgB₂ is a weakly correlated metal. The CESR linewidth, that measures the spin-lattice relaxation, follows the normal state resistivity, which also shows a conventional metallic behavior. Below T_c , we observe a peculiar magnetic field dependence of the CESR signal: above 75 GHz (2.7 T Zeeman field) we find that part of the sample is in the normal state in addition to the superconducting material. The normal state fraction grows with magnetic field at the cost of the superconducting one. We conclude that a significant H_{c2} anisotropy ($H_{c2}^a/H_{c2}^b=H_{c2}^c=8$) can explain the observations. Field and temperature dependent magnetization data confirms this explanation [1]. Since our original report on powders, this has been confirmed by measurements on good quality single crystals. We also observe an anomalously large magnetic field induced \tilde{A}_s below T_c at low magnetic fields, where only the superconducting phase is present. At the lowest magnetic field (0.14 T, 0.38 GHz), the opening of the gap is observed and the temperature dependence of \tilde{A}_s is compatible with the two-gap superconductivity model suggested for MgB₂. For fields above 0.2 T there is an anomalously large field induced \tilde{A}_s and microwave conductivity that can not be explained by the current theories.

[1] F. Simon et al., Phys. Rev. Lett. 87, 047002 (2001).