INVESTIGATION OF PHOTOINDUCED EFFECTS IN Ca-DOPED AND FAST NEUTRON IRRADIATED $YBa_2Cu_3O_{6+\delta}$ THIN FILMS

Abstract

by

Ann Klunzinger Heilman

It has been known for some time that photoinduced superconductivity (PISC), the initiation of superconductivity or an increase in the transition temperature due to laser light illumination, and persistent photoconductivity (PPC), a decrease in the normal state resistance due to laser light illumination, exists in deoxygenated $YBa_2Cu_3O_{6+\delta}$ (Y123) thin films. These photoeffects are persistent in time, if the materials are kept below room temperature, but relax to their original state if kept above room temperature for several days. Many theories have been formulated to explain PISC and PPC, including photoinduced oxygen ordering, photoinduced vacancy capture, and features of the Blackstead-Dow (B-D) general model of high temperature superconductivity. In an effort to provide evidence supporting one type of theory over the others, both Ca-doped and fast neutron irradiated Y123 thin films were probed for photoinduced effects. One of the two methods of measurement employed in this study, the microwave spectrometer, measures the power dissipation reflected from a resonant cavity containing the film, which is proportional to the surface re-

sistance, before, during, and after illumination with an argon ion or Ti:sapphire laser. A conventional four-point dc probe, which measures the resistances of the films, is also employed in these experiments. Both of the Y123 films irradiated with different neutron fluences show photoeffects when illuminated with laser light, with the higher neutron fluence film exhibiting a larger effect. This result is incompatible with oxygen ordering theories since the disorder was created with the neutron bombardment of much higher energies (> 1 MeV) than the energy of the photons (2.4 eV). The Ca-doped films all showed photoinduced effects, with the T_c and the conductivity decreasing after illumination. These results, as well as some previously published reports concerning $Tl_2Ba_2CuO_{6+\delta}$ films, show that the magnitude and sign of the photoeffects are affected by the doping of the material. Arguments against the validity of several photoinduced superconductivity models are presented.