Ultrafast Optical Response and Terahertz Radiation from Superconducting YBCO Films

Masanori Hangyo

Research Center for Superconducting Materials and Electronics, Osaka University, Osaka 565-0871, Japan

Masayoshi Tonouchi

Research Center for Superconducting Materials and Electronics, Osaka University, Osaka 565-0871, Japan

Abstract

Three years ago, we found that ultrashort electromagnetic pulses (called THz radiation because of their Fourier spectrum extending up to THz region) are radiated into free space from current biased supeconducting YBCO-film devices by exciting with femtosecond optical pulses [Hangyo*et al.*, Appl. Phys. Lett. **69**, 2122 (1996)]. Later, we also found that the THz radiation is emitted from YBCO thin films under external magnetic fields or magnetic-flux trapped states even without a bias current [Tonouchi*et al.*, Jpn. J. Appl. Phys. **36**, L93 (1997)]. These phenomena are explained in terms of the ultrafast modulation of a transport, shielding or persistent current associated with the breaking of the Cooper pairs by optical pulses and subsequent recombination of the quasiparticles [Hangyo *et al.*, IEICE Trans. Electron. **E80-C**, 1282 (1997)].

Recently, we demonstrated that the direction and the amount of magnetic flux trapped in films can be controlled by the combination of the laser pulse spot position and the bias current [Tonouchi*et al.*, Appl. Phys. Lett. **71**, 2364

(1997)]. A new type of superconducting memory can be made by using this phenomena. Since the amplitude of the THz radiation is proportional to the supercurrent density at the exciting laser spot position, the two-dimensional distribution of the supercurrent can be measured by scanning the laser spot with detecting the THz radiation. The persistent current circulating around the trapped magnetic flux is visualized by this method. Mechanisms of the magnetic flux trapping and the THz radiation are discussed.