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Effects of Proton Irradiation on the Microwave Properties of $YBa_2Cu_3O_{7-\delta}$ Films and MgB_2 Films

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Proton irradiations on superconducting bulk materials and thin films have enabled to enhance the critical current density and the upper critical field in the mixed state due to increased vortex pinning. We investigated the microwave surface resistance (R_s) of proton-irradiated $YBa_2Cu_3O_{7-\delta}$ (YBCO) films grown on $LaAlO_3$ (LAO) and MgB_2 films grown on r-cut sapphire in the Meissner state. The intrinsic R_s was measured at ~8.5 GHz at temperatures below the critical temperature with the effects of the finite film thickness taken into account. Significant reduction in the R_s of YBCO films were observed at temperatures of 40 K to 70 K when the films were irradiated with 20 MeV proton for 10 minutes to the fluence of 0.47 x 10^{15} ions/cm^2 with the value of 100 μΩ of the proton-irradiated one at 60 K appearing significantly lower than the corresponding one of 140 μΩ before irradiation. For MgB_2 films, reduced T_C was observed along with reduced intrinsic R_S at temperatures below 24 - 26 K after proton irradiation to the fluence of 4.8 x 10^{15} protons/cm^2. An increase of 9 – 14% in the π-band gap energy was observed for proton-irradiated MgB_2 films, which are attributable to enhanced interband scattering between the σ-band and the π-band caused by increased disorder. Meanwhile, the reduction in the R_S of proton-irradiated YBCO films at 40 - 70 K was attributed to enhanced impurity scattering rate of ~ 2 x 10^{12} /s compared to a value of ~ 7.6 x 10^{11}/s for unirradiated YBCO.

Keywords : Proton irradiation, $YBa_2Cu_3O_{7-\delta}$ film, MgB_2 film, surface resistance, quasiparticle scattering