Effects of Splayed Columnar Defects on the Current Density of $Tl_2Ba_2CaCu_2O_x$ Superconductor and its Equilibrium Magnetization

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Randomly oriented columnar defects (CD) were created in polycrystalline $Tl_2Ba_2CaCu_2O_x$ (Tl–2212) superconductor via irradiation with 0.8 GeV protons. The fission-generated CD's had area densities corresponding to nominal matching fields $B_\phi = 0$ to ≈ 1.5 tesla. The transition temperature T_c decreased linearly from 97 K to 87 K with increasing proton fluence, while the *Meissner* fraction $-4\pi\chi$ decreased somewhat, from 0.58 to 0.49. The persistent current density J, which was measured magnetically, increased by a factor of $\sim 10^2$ at the optimal defect density $B_\phi \approx 1$ T; this increase was accompanied by a ~10 K elevation of the irreversibility line $H_{irr}(T)$. The stability of J was determined by measurement of its time dependence, for a range of temperatures and magnetic fields. We found further that the equilibrium magnetization $M_{eq}(H,T)$ decreases substantially with B_ϕ, due to vortex-defect interactions. While $M_{eq}(H,T)$ in the virgin material follows a London behavior with $M_{eq}(H) \propto \ln(H)$, it becomes distinctly non-London-like in the irradiated samples. This unusual field dependence resembles the $M_{eq}(H)$ curves in Bi-2212 crystals containing parallel CD's created by heavy ion irradiation.

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