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Improvement of critical current densities for Hf, Ce and La doped Gd123 thin film fabricated by fluorine-free MOD method

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Copper oxide superconductors have been expected for the next generation superconducting wire materials because of their high T_c and J_c in magnetic fields. In this study we have fabricated Hf, Ce and La doped Gd123 films by the fluorine-free MOD method to improve J_c. T_c indicated around 92 K and it didn't change for Hf and La doped films. J_c increased by about 63 % at 77.3 K and 1 T for 2 mol% Hf doped film than that for non-doped film. Furthermore we found the improvement of the crystal structure by La doping. Additionally, J_c indicated 3.10 MA cm^{-2} at 77.3 K and 0 T, and 0.32 MA cm^{-2} at 77.3 K and 1 T for 2 mol% Hf and 1 mol% La doped film. J_c increased by about 50 % at 77.3 K and 0 T for 2 mol% Hf and 1 mol% La doped film than that for 2 mol% Hf doped film. Jc increased by about 68 % at 77.3 K and 1 T for 2 mol% Hf and 1 mol% La doped film than that for non-doped film. We analyzed the density of effective pinning center (n_{eff}) according to the single vortex theory. n_{eff} indicated 7.74 m^{-2} and increased by about 95 % at 4.2 K for 2 mol% Hf doped film than that for non-doped film. In conclusion, the effective APCs in magnetic fields were introduced by Hf doping and the improvement of the crystallization was observed by La doping. We also have studied the optimization of the heat treatment condition and investigated the properties of Ce doped film to improve J_c further.

Keywords: fluorine-free metal organic deposition, GdBa2Cu3Oy, Hf, Ce and La doping