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Formation of Nanosize Secondary Phase in MOCVD-Processed YBCO Films with Ce Doping

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Many researchers have studied the effect of nanosized secondary particles produced by rare-earth doping on flux motion under applied magnetic field in $YBa_2Cu_3O_{7-\delta}$ (YBCO) coated conductors. In this study, we investigated the influence of Ce doping on nanosized secondary phase formation in YBCO films. Ce-doped YBCO films on single $SrTiO_3$ crystals were prepared by metalorganic chemical vapor deposition (MOCVD). MOCVD YBCO films of various Ce doping concentrations from 0 to 3 wt.% were analyzed in terms of the film microstructures. Through Ce doping, a Y_2BaCuO_5 secondary phase was observed in the Ce-doped YBCO films, while the pure YBCO film contained only a Y_2O_3 secondary phase. Transmission electron microscopy observations of the microstructures of the Ce doped YBCO films revealed that the $BaCeO_3$ secondary phase formed when Ce doping concentration reached 3 wt.%. We speculate that it originated from the low solubility limit of Ce for Y in the MOCVD YBCO film. Critical current density (J_c) of the 1 wt.% Ce doped YBCO film under applied magnetic fields was estimated to be the highest amongst the investigated films. As Ce doping concentration increased above 3 wt.%, at which micrometer-sized $BaCeO_3$ particles began to be observed, J_c of the Ce doped YBCO films degraded drastically.

Since oxygen partial pressure is one of the key factors affecting the J_c of YBCO films, the effect of oxygen partial pressure on the morphology and J_c of the 1 wt.% Ce-doped YBCO film was also investigated at oxygen partial pressures ranging from 1.9 to 10.0 Torr. The 1 wt.% Ce-doped YBCO film had a stoichiometric, dense surface, resulting from enhanced migration of surface adatoms under reduced oxygen partial pressure. The zero-field J_c (at 77K) of the 1 wt.% Ce-doped YBCO film deposited at reduced oxygen partial pressure was increased to 1.66 MA/cm^2. Regardless of the amount of Ce, the Ce doped YBCO film showed an improved zero-field J_c (at 77 K) under reduced oxygen partial pressure.

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Keywords : YBCO, MOCVD, Ce doping, Y211, $BaCeO_3$