# Fabrication of magnetically bi-axial aligned Dy123 green compact by colloidal solution with various viscosities and evaporation times

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Densification and bi-axial grain alignment are essential for $REBa_2Cu_3O_y$ (RE123) superconductors (SCs) with practical critical current ($I_c$). Conventionally, thin-film epitaxial technology has provided high critical current density ($J_c$). However, it has a practical problem on $I_c$ due to the restriction on thickness. Our group focuses on the magnetic alignment for fabricating densified thick RE123 films (> $100\mu m^t$) with bi-axial aligned microstructures. The bi-axial alignment of RE123 grains with twinned microstructure in epoxy resin has been achieved under the modulated rotating magnetic field (MRF) of a solenoidal SC magnet (SC-MRF) [1] and linear drive type MRF (LDT-MRF) [2, 3]. As the next step, our group aims at development of the biaxial aligned RE123 ceramics by the colloidal process and LDT-MRF. A colloidal solution having the appropriate viscosity with considering magnetic alignment time into account, which is depending on magnetic anisotropy, is essential in this context [4]. Our group found that a binder (Hydroxypropyl cellulose, HPC-H) in ethanol can control of the viscosity of the $DyBa_2Cu_3O_y$ (Dy123) colloidal solutions. In this study, the magnetically aligned Dy123 green compacts are fabricated from the Dy123 colloidal solution with various viscosities and evaporation time.

Dy123 (y ~ 7) polycrystals were synthesized by the standard solid-state reaction and oxygen annealing, then pulverized by the ball-milling. Incidentally, its average particle size is ~ 0.5 µm. Dispersant (polyethyleneimine, 1 wt%, PEI) is mixed with ethanol or butanol. Then, the binder and fined Dy123 powder (5 – 15 vol%) were added to the PEI mixtures. Prepared Dy123 colloidal solutions were dried in a rectangular mold under LDT-MRF at RT. The static field and rotating field in the LDT-MRF equipment generated by the permanent magnet array were approximately 0.9 T and 0.8 T, respectively. The orientation degrees of the magnetically aligned Dy123 samples were evaluated by the (103) pole figure measurements.

Figure 1(a) shows the (103) pole figure of green compact of magnetically aligned Dy123 with ethanol . Its initial viscosity of Dy123 colloidal solution is roughly 500 mPa・s, and it was evaporated in 2 h. Note that the measurement plane for the (103) pole figure is normal to the direction of the static field component and is equivalent to the top surface of the Dy123 green compact. Four-fold symmetric spots with broad streaks along $\psi$ and $\phi$ directions were obtained, meaning that Dy123 grains were partially bi-axially aligned in ethanol. Figure 1(b) shows the (103) pole figure of the green compact of magnetically aligned Dy123 with butanol. Its initial viscosity is roughly 500 mPa・s, however it was evaporated in 5 h. In contrast, more obvious four-fold symmetric spots were observed, indicating that Dy123 grains were bi-axially aligned in butanol. Figs. 1(a) and 1(b) suggested that the bi-axial orientation degrees were improved by using the solvent with longer evaporation time. In this presentation, we will show the change in bi-axial orientation degrees on the magnetically aligned Dy123 green compacts as functions of viscosities and evaporation times of Dy123 colloidal solutions.

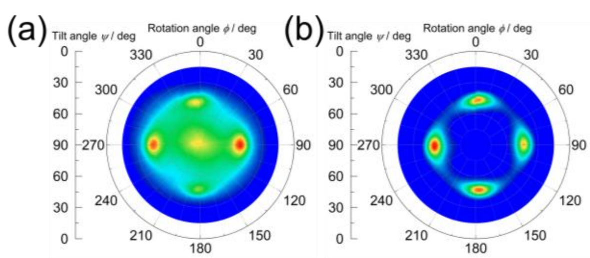


Figure 1. (103) pole figures of the magnetically aligned Dy123 ceramics prepared with (a) ethanol and (b) butanol as solvent.

**References:** [1] Horii et al., SuST **29** (2016) 125007. [2] Ali et al., J. Appl. Phys. **134** (2023) 163901. [3] Horii et al., J. Ceram. Soc. Jpn. **126** (2018) 885. [4] Kimura et al., CrystEngCom **20** (2018) 861.