Recent Progress in Melt Processed (RE)BCO HTS

David A. Cardwell, Yun-Hua Shi, Nadendla Hari Babu, Anthony R.Dennis,
John H. Durrell, and Mark D. Ainslie

Department of Engineering, University of Cambridge, Trumpington Street, Cambridge, CB2 1PZ, UK

E-mail: dc135@cam.ac.uk

Abstract - (RE)-Ba-Cu-O [(RE)BCO, where RE = rare earth element such as Y, Nd, Sm, Eu, Gd, etc.] high temperature superconductors (HTS) have significant potential for high field engineering applications at 77 K when fabricated in the form of large single grains by the so-called top seeded melt growth process (TSMG). A novel $Y_2Ba_4CuMO_y$ (Y-2411, where M = U, Zr, Hf, Nb, Ta, W and Mo) phase that is effective at pinning magnetic flux quanta in bulk (RE)BCO HTS on the nm scale has been developed recently at Cambridge with a number of desirable properties, including crystallographic compatibility with the superconducting $(RE)Ba_2Cu_3O_7$ (RE-123) phase, chemical stability at the melt processing temperature and an ability to resist coarsening during the melt process. This novel phase, which is more effective at pinning flux than the RE_2BaCuO_5 (RE-211) phase produced as a by-product of the melt growth process, has been used to the development a practical processing method for the fabrication in air of large, single grain RE-Ba-Cu-O superconductors. The process also includes a new type of generic seed crystal (Mg-doped NdBCO) that can promote effectively the epitaxial nucleation of any (RE)-Ba-Cu-O system and secondly by suppressing the formation of (RE)/Ba solid solution in a controlled manner within large (RE)BCO grains processed in air. This process has enabled fabrication of single grain samples of GdBCO that exhibit a record trapped field of 17.6 T at 26 K [1]. The recent development of multi-seeding techniques for the fabrication of larger sample of conformal geometry has improved further the prospects of these technologically important materials for practical applications, which will also be presented.

[1] Durrell, J. H., Dennis, A. R., Jaroszynski, J., Ainslie, M. D., Palmer, K. G. B., Shi, Y.-H., Campbell, A. M., Hull, J., Strasik, M., Hellstrom, E. E. and Cardwell, D. A., Trapped Field of 17.6 T in Melt-Processed, Bulk Gd-Ba-Cu-O Reinforced with Shrink-Fit Steel, Supercond. Sci. Technol., 27, 082001, 2014.

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