WB6-1-INV

Towards Robust High Field Performance in Bulk HTS Magnets

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In 2014 we reported a record trapped field of 17.6T in an HTS bulk at 26K. While this was a pleasing achievement it did not pave the way immediately to practical operation at such high fields. Significant challenges remain including the fact that individual samples tend to only achieve high fields once, being damaged in the process and that most samples fail at fields much below the headline world record field.

In this talk I will report on progress that has been made in the Cambridge group in addressing these concerns. I will report on a new “Hybrid Stack” approach that has allowed us to achieve repeated magnetisation to 17.6T as well as progress in incorporating Silicon Carbide fibres into bulks to provide intrinsic reinforcement. Underlying this I will discuss our increased understanding of the behaviour of bulks under large magnetising forces.

Keywords: Critical Current, High Field, Bulk Superconductor

WB6-2-INV

Development of ultra small cryogen-free Superconducting Magnet for High-Resolution NMR

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In 2007, we reported observations of NMR signals of superconducting bulk magnets [1]. The first NMR signal was very broad and could not be used for analytical purposes. However, we achieved a magnetic field strength of 3T that could not be reached with a permanent magnet, found that the stability of the magnetic field was very high, and convinced that the bulk magnet could be used for NMR analysis if the inhomogeneity was solved. Using FEM, we determined the bulk magnet size to keep the magnet homogeneity from the commercial widebore (i.e. 89 mm inner diameter) NMR superconducting magnet to the superconducting bulk magnet. The concept of copying a homogeneous magnetic field from a superconducting magnet for NMR to a bulk magnet is based on a stack of several annular bulk superconductors and is placed on the NMR superconducting magnet using a magnetic field cooling method. By using this method and dealing with magnetic field inhomogeneities that occur during the magnetization process, the magnetic field homogeneity of bulk magnets has improved dramatically. In 2011, we reported the results of MRI [2], and in 2015 we reported a magnet that can observe chemical shifts by NMR [3]. We also found a way to compensate for the inhomogeneous that occurs when magnetizing by inserting HTS tape on the cylinder into bulk magnet[4]. Using these achievements, we integrated an RF probe, room temperature shim, and magnetic field lock system necessary for high-resolution NMR observation, and created a cryogen-free ultra-small superconducting NMR bulk magnet.

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Keywords: Bulk Superconductor, Superconducting Bulk Magnet, Bench-top NMR, Cryogen-free

WB6-3

Magnetic Flux Trapping and Flux Jumps in Pulsed Field Magnetizing Processes in REBCO and Mg-B Bulk Magnets

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Pulsed field magnetization PFM technique is expected to be a cheaper and easier way to utilize the HTS bulk materials as high field trapped magnets. As the heat generation due to the flux motion in the bulk magnets causes degradation of field trapping performances, the flux motions during PFM should be clarified in various modes of field applications. As a way among various field-feeding modes, the authors applied the various shapes and intensities of pulsed magnetic fields to the cryo-cooled RE123/Mg-B bulk magnets to watch the field invasion behaviors. In the PFM evolutional profiles, the authors classify the flux motion in three categories as “no flux flow (NFF)”, “fast flux flow (FFF)”, and “flux jump (FJ)”. To clarify the conditions which allow the flux jumps to happen, we may have a couple of approaches in our experimental procedures. One is the variation of evolutional profiles of pulsed field application, and the other should be a compositional or structural approach like a metallic inclusion arrangement to enhance the specific heat or heat draining structure. In the experiments, we observed the highest field trapping appeared at the upper end of NFF region, and FFF caused to FJ. This means the heat generation and its propagation paths should be attributed to flux trapping behaviors.

Keywords: bulk superconductor, pulsed-field magnetization, flux trapping, flux jump

WB6-4

Sm123 bulk superconductors composited by small-sized Sm211 particles formed by homogeneous nucleation catastrophe

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The refinement of RE_2BaCuO_5 (RE211) particles is of significant importance in preparing high performance $REBa_2Cu_3O_{7-\delta}$ (RE123) bulks by top-seeded melt-growth (TSMG). However, the pre-existing RE211 phase in the conventional precursor powder (CPP) inevitably results in its size-enlargement caused by coarsening and epitaxial growth. In our previous work, a novel modified precursor powder (MPP, Y_2O_3 and $Ba_2Cu_3O_5$) has been used to enhance the performance of $YBa_2Cu_3O_{7-\delta}$ bulks with Y211 nanoparticles. Here, we extended that new conception in the preparation of $SmBa_2Cu_3O_{7-\delta}$ bulks to reduce Sm211 size. Additionally, in order to suppress the Sm/Ba substitution, we replaced $Ba_2Cu_3O_5$ with $Ba_3Cu_4O_7$ to apply Ba-rich MPP (B-MPP). As a consequence, improved levitation force was achieved from the novel processed $SmBa_2Cu_3O_{7-\delta}$ bulk. Most importantly, this time and cost saving method is feasible to prepare other light rare-earth superconductor bulks (LRE123, LRE=Gd, Nd) with high performance.

Keywords: precursor, nanoparticles, SmBCO