WB7-1-INV

History of QMG™ and recent progress on QMG™ bulk magnets

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The microstructure of QMG consists of the single crystal $REBa_2Cu_3O_x$ phase and fine RE_2BaCuO_5 particles. QMG was first produced in 1988 by the Quench and Melt Growth method[1-4]. A bulk magnet made by QMG was proposed in 1989[5]. QMG bulk magnets were realized by enlargement technology using RE substitute seed crystals[6-8]. Based on these technological innovations, recently, the development of NMR and MDDS, which are applied products of bulk magnets, has been reported. We will review the history of the initial development of these QMG materials and QMG bulk magnets.

In addition, as a progress of recent QMG bulk magnet development, we will report on a new reinforcement method for large ring bulk magnets that can trap 10 T class strong magnetic field magnetization[9].

For high field magnetization, the reinforcement of bulk magnets is essential to prevent cracking due to large hoop force. Compared to the traditional reinforcement method using only the outer metal ring, we reinforce by using thin QMG rings and metal ring sheets as the composite material with the inner and outer metal ring. Figure 1 (a) shows the strain behavior at each position at 10T and 60K when a new reinforcement method is used. Figure 1 (b) shows the distortion behavior when using the conventional method for magnetizing at 9T and 60K. According to the conventional method, cracking occurred at 10 T magnetization, whereas the MSR method successfully trapped approximately 10 T. From these comparisons, we found that the distortion of the QMG bulk magnet magnetized by the new reinforcement method can be significantly reduced.

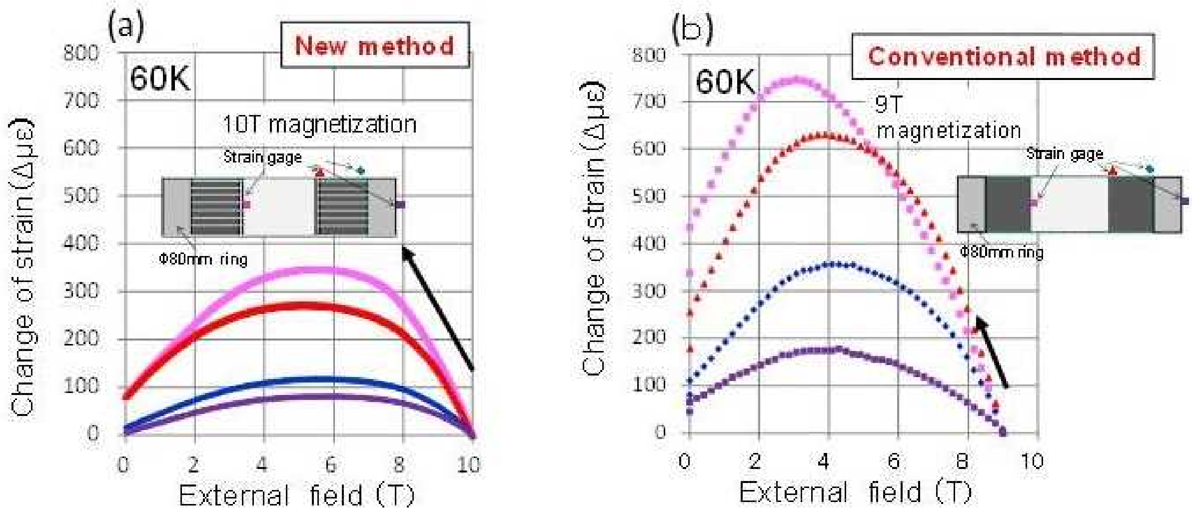

Fig. 1 (a) Change of strain at 10 T magnetization of QMG magnet reinforced by new method
(b) Change of strain at 9 T magnetization of QMG magnet reinforced by conventional method

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Keywords: QMG, bulk magnet, reinfoecement

WB7-2-INV

Collecting Ni-Sulfate Compound from Electroless Plating Waste by Magnetic Separation Technique with Use of HTS Bulk Magnets

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The authors have developed a useful technique for extracting the Ni-sulfate compound from the waste fluid of the electroless Ni-plating processes. The plating waste still contains the Ni ions with high concentration even after the several plating cycles. After forming the fine $NiHPO_3$ precipitate from the waste, the coarse $NiSO_4$ crystals were synthesized through the reaction with the concentrated sulfuric acid. In the experiment, the open-gradient magnetic separation was employed to collect the $NiSO_4$ crystals from the muddy mixture composed of these compounds due to the difference between their magnetic properties. The experiments were practically conducted with use of the Gd123-based HTS bulk magnets generating up to 4 T with the steep gradient of magnetic field, which were activated by the field cooling magnetization process operated at 35 K. The ratio of $NiSO_4$ content in the slurry attracted to the magnetic pole has reached up to 85.7%. This preferential collection suggests a feasible recycling system of Ni resource as a raw material in the plating processes.

Keywords: high Tc superconductor, bulk magnet, magnetic separation, nickel plating

WB7-3

SmBCO single grain bulk superconductors via Top seeded infiltration and growth process

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(RE)-Ba-Cu-O bulk superconductors in single grain form can trap magnetic fields which are an order of magnitude higher compared to the conventional permanent magnets and hence are attractive for a variety of engineering and technological applications. In the present work, the fabrication procedure of SmBCO single grain superconductors via Top seeded infiltration and growth (TSIG) technique is presented. The TSIG approach results in near-net shaped dense SmBCO products. The superconducting and microstructural properties of single grain SmBCO bulk superconductors obtained by the TSIG technique will be presented.

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WB7-4

How to Control the Gd211 Particles and Enhance the Levitation Force of Single Domain GdBCO Bulks Prepared by Gd+011 TSIG Method

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The empirical evidences have indicated that the new RE+011 TSIG method is a very effective method for fabrication of high quality REBCO bulk superconductors, because of strong flux pinning force by the uniformly distributed unknown nanometer particles. But there are still many larger size RE211 particles in the REBCO bulks. To overcome this problem, a sires single domain GdBCO bulk superconductors have been prepared with different solid phase pellets sintered at different temperature (T) by the Gd+011 TSIG method, the results indicate that: (1) The average size of Gd211 particles in precursor solid phase pellets is monotonously increasing from nanometer to 4.23 μm with increasing of the sintering temperature up to 1200 ℃. (2) The density of the precursor solid phase pellets increases with the increasing T when T is great than 950 ℃, but the density is lower than that of the as pressed pellets when T is less than 1000 ℃. (3) The average size of Gd211 particles in the single domain GdBCO bulks first decreases from 10.9 μm to 2.81 μm and then increases from 2.81 μm to 3.96 μm with increasing T, and the smallest Gd211 particles 2.81 μm is obtained in the sample sintered at 1050 ℃; this is much different from the result of the samples prepared by the traditional TSIG process. (4) The maximum levitation force 38 N (77 K, 0.5 T) is obtained in the sample with a relatively larger size of Gd211 particles and higher density, but not achieved in the sample with the smallest Gd211 particles.
In order to further improve the quality of single domain GdBCO bulk samples, another sires of single domain GdBCO bulk superconductors have also prepared with solid phase pellets sintered at 1000 ℃ with different times by Gd+011 TSIG method, the results indicate that: the levitation force of the samples firstly increases from 37 N to 51 N when the t increases from 10 h to 15 h and then decrease to 16 N when the t further increases to 30 h. The largest levitation force 51 Nis about 38% higher than that of the best samples mentioned above. This result provides a very effective way to fabricate high quality REBCO bulk superconductors by control the density, RE211 particle size and their distributions in the solid phase pellets.

Keywords: single domain GdBCO bulk superconductors, Gd+011 TSIG method, Gd211 particles, density of solid phase pellet

WB7-5

Single Grain Bulk $YBa_2Cu_3O_y$ Superconductors Grown by IG process Utilising the Mixture of Yb-123+Liquid phase as a Liquid Source

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The top-seeded infiltration-growth (IG) process of $YBa_2Cu_3O_y$ (Y-123) has several advantages compared to the same material produced by the melt-processed technique such as no shrinkage, negligible pores, and uniform Y_2BaCuO_5 (Y-211) secondary phase particle dispersion in the Y-123 matrix. These characteristics of IG process are very attractive for several industrial applications to be utilized as their role as superconducting super-magnets. In this presentation, we produced a large single grain Y-123 by IG process by top seeded melt-growth process. First, we produced the $YbBa_2Cu_3O_y$(Yb-123) and Y-211 by using the solid state sintering technique and checked the purity of the phase by XRD analysis. Then utilizing the homemade Yb-123 and Y-211, we produced the bulk $YBa_2Cu_3O_y$ samples by means of Yb-123+liquid (1:1) as a liquid source. The top surface of grown samples clearly indicates that four facet lines are grown from seed and extended up to sample edges (see in Fig.1). Trapped field results confirmed that single grain Y-123 samples were produced utilizing with Yb-123+liquid as a liquid source. The large bulk samples has been thoroughly characterized by SEM, Magnetization measurements by SQUID magnetometer, mapping analysis etc., and will be discussed.

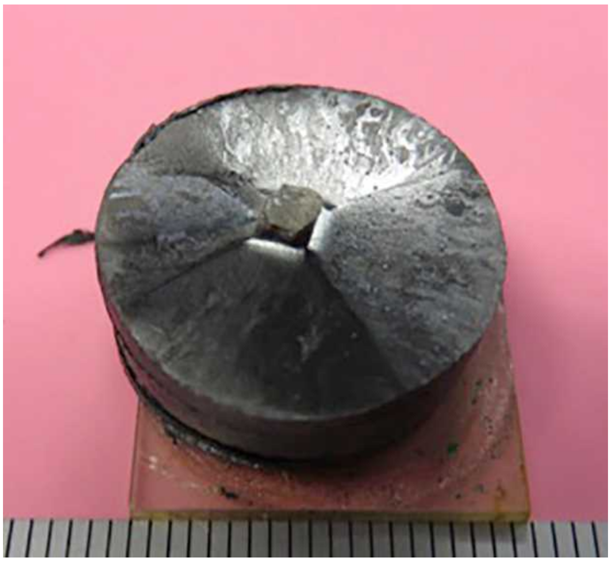

Figure 1. As grown bulk Y-123 superconductor produced by Top Seeded Infiltration Growth Process utilising the mixture of Yb-123+liquid phase as a liquid source.

Keywords: Infiltration Growth Process, Microstructure Analysis, Trapped Field Measurements, Critical Current Density