Improvement of magnetic levitation force of YBCO superconductor

Sang Heon Lee[1]

1. Department of Electronic Engineering, Sunmoon University

SUNMOON UNIVERSITY

Background

This study presents interior seeding, a seeding technique that allows the growth of the YBaCuO grain in the interior of superconducting compacts. The seeding growth process provides a suitable open space for seeds in the interior of YBaCuO compacts to supply air to the seeds and to minimize the contact area between the seeds and the liquid. The advantages of interior seeding include the simultaneous growth from the seed to the top and bottom of YBaCuO compacts.

Objectives

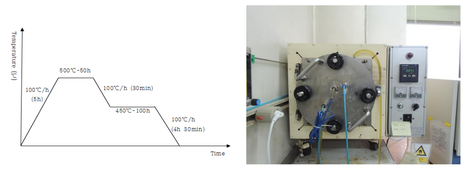
- **To improve the electromagnetic properties of the surface area of YBCO superconductors that can be applies to DC fault current limiters.**
- **To obtain (Y_1Sm)BCO superconductors by putting top-seeded melt growth(TSMG) made YBCO single crystal bulk in Sm_2O_3 powder and applying heat treatment.**

Conclusion

- **As a result of putting in the Sm_2O_3 powder and heat treating the YBCO single crystal bulks, a green form(Sm_2BaCuO_5) appeared on the surface of the superconductor.**
- **As a result of observing the refined structure, on the surface where the reaction occurred a liquid form and a form of Sm211 was created. The reaction layer was about 70 μm.**
- **Due to the reaction layer that came about through the Sm_2O_3 heat treatment and the growth of the YBCO particle inside the Y211 the trapped magnetic force characteristics and self levitation force decreased**

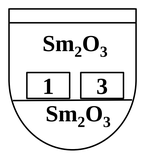
Methods

Oxygen Heat Treatment

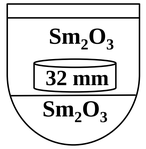


▶ **Test the 32 mm specimen and the number 1 20 mm specimen using the following oxygen heat treatment conditions.**

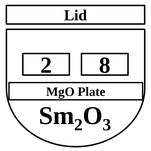
Heat Treatment Mimetic Diagram



This is the figure of the 20 mm 1 and 3 specimen placed on top of and then covered with Sm_2O_3. The specimen must be covered on all sides with Sm_2O_3.



This is the figure of the 32 mm specimen placed on the top of and then covered with Sm_2O_3. The specimen must be covered on all sides with Sm_2O_3.

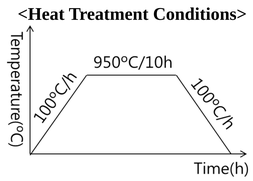


This is the figure of the number 2 and 8 20 mm specimens placed on top of the MgO plate which in turn is placed on the Sm_2O_3. After which is all covered with a lid and subjected to heat treatment. The specimens must not touch the Sm_2O_3.

Samples

Heat Treatment

<Heat Treatment Conditions>



20 mm

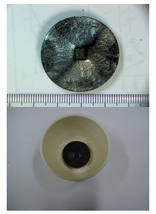
①Number from 1 to 9

③ Close the lid and treat with heat.

② Place specimen 2 and 8 on top of the MgO plate

③ Close the lid and treat with heat.

32 mm

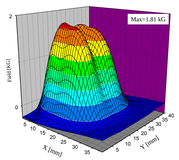


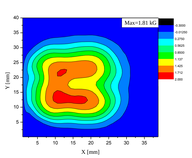
① Place the specimen on top of the Sm_2O_3

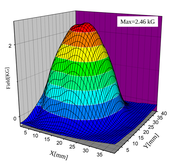
② Place the Sm_2O_3 on top of the specimen and treat with heat.

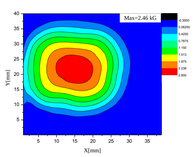
Results

Φ 32 mm Specimen's Trapped Magnetic Force









▶ **Maximum Trapped Magnetic Force**

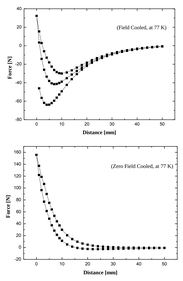
Before Oxygen Heat Treatment : More than 1.81 kG , 48.2 % was saturated.
After Oxygen Heat Treatment: More than 2.46 kG , 64.6 % was saturated.

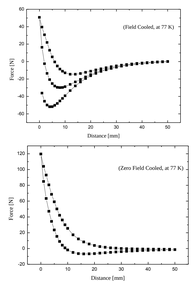
▶ **After the oxygen heat treatment two peak values appeared, this is due to the inner part of the single crystals superconductive characteristics not being uniform.**

▶ **After the oxygen heat treatment the saturation capacity decreased.**

▶ **A Φ 50 mm – 3.75 kG permanent magnet was used.**

Φ 32 mm Specimen's Self Levitating Force





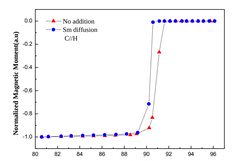
Field Cooling	Before Oxygen Heat Treatment	After Oxygen Heat Treatment	
Maximum Magnetic Force	50.764 N	63.896 N	20.552 % Decrease (Difference Between The Two Values 13.132)
Maximum Repelling Force	51.842 N	32.242 N	60.79 % Increase (Difference Between The Two Values 19.6)

Zero Field Cooling	Before Oxygen Heat Treatment	After Oxygen Heat Treatment	
Maximum Repelling Force	155 N	119.658 N	22.8 % Decrease (Difference Between The Two Values 35.342)

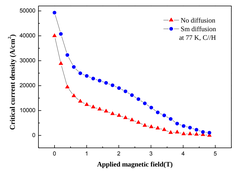
▶**With field cooling the maximum magnetic force decrease by 20.552% and the maximum repelling force increases by 60.79%. However, in comparison to this, zero field cooling has a maximum repelling force decrease of 22.8%.**

▶ **A Nd-B-Fe permanent magnetΦ 30 mm - 5.27 kG was used.**

MPMS



	$T_{C,\ onset}$ (K)	$T_{C,\ mid}$ (K)
No diffusion	91.62	90.89
Sm diffusion	91.17	90.32



▶ **The seed's edge was measured.**

▶ **The two specimens starting temperature were extremely high at 91.62 K and 91.17 K**

▶ **It was also observed that the specimen that diffused Sm had both high critical current density and critical temperature.**