

세라믹 선재의 전기 구조적 특성

이상현^{1*}, 이영희^{2*}

선문대학교 전자공학부

Sang-Heon Lee^{1*}, Young-Hie Lee²

Department of Electronic Engineering, Sun Moon University^{1*}, Dept. of Electronic Materials Engineering
Kwangwoon University

Abstract

Fabrication of *c*-axis oriented $(\text{Hg}_{0.75}\text{Re}_{0.25})\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ thick fabricated has been attempted using Ni substrates with the buffer layer of Cr or NiO. Coexistence of $(\text{Hg}_{0.75}\text{Re}_{0.25})\text{Ba}_2\text{Ca}_3\text{Cu}_4\text{O}_y$ pellets wad found to stabilize $(\text{Hg}_{0.75}\text{Re}_{0.25})\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ phase of the tape. The *c*-axis oriented tapes were reproducibly obtained on the NiO/Ni substerate and they recorded high B_{IR} at 77K. $(\text{Hg}_{0.75}\text{Re}_{0.25})\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ 1223.

Keywords : $(\text{Hg}_{0.75}\text{Re}_{0.25})\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_y$, NiO/Ni, buffer layer

1. Introduction

We have reported that $(\text{Hg}_{0.75}\text{Re}_{0.25})\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ superconductor was chemically stable with high T_c above 130K[1]. In ddition, its intragrain J_c under magnetic fields was dramatically enhanced with increasing Re doping level up to $x=0.25$, suggesting that $(\text{Hg}_{0.75}\text{Re}_{0.25})\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ can be considered as a candidate material for practical high field applications at high temperatures. We have attempted to increase Re doping level in *c*-axis oriented $(\text{Hg}_{0.75}\text{Re}_{0.25})\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ tapes for further improvement of critical current properties.

2. Experimental

The calcined powder of nominal composition $\text{Re}_{0.25}\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ percursor, which was prepared from mixed powders of ReO_3 , BaCO_3 , CaCO_3 , and CuO , was mixed with HgO , then sintered at 90

0°C for 20h in a sealed quartz ampoule. The obtained $(\text{Hg}_{0.75}\text{Re}_{0.25})\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_y$ 1223 pellets were ground and used as starting powder of the thick film. The Hg-containing pellets as Hg vapor source were prepared with nominal compositions of $(\text{Hg}_{0.75}\text{Re}_{0.25})\text{Ba}_2\text{Ca}_2\text{Cu}_4\text{O}_y$ in the similar way. In the case of the Cr/Ni substerate 1223 thick film was formed on the substrate by painting method using a slurry containing calcined powder of 1223. On the other hand, the thick film on the NiO/Ni substrate was formed by the doctor-blade technique [2], using the mixture of the precursor and 1223. Here the NiO layer was prepared by oxidizing the surface of the Ni foil at 900°C in air. The tapes were put into Al_2O_3 tube, then sintered at various temperatures in a sealed quartz ampoule together with Hg-containing pellets. The microstructure of the tape surface was observed by a scanning electron microscope. The electrical transport

properties of the tapes were measured under magnetic fields up to 9T by the conventional four probe method T_c and B_{irr} were determined by the resistivity of $1\mu\Omega cm$.

3. Results and Discussions

$(Hg_{0.75}Re_{0.25})Ba_2Ca_2Cu_3O_y$ 1223 tapes were obtained with the Cr/Ni and NiO/Ni substrates, when pellets of $Hg_{0.75}Re_{0.25}Ba_2Ca_3Cu_4O_y$ and $Hg_{0.6}Re_{0.4}Ba_2CaCu_2O_y$ were used as Hg vapor source. In addition, platelet crystals of $(Hg_{0.75}Re_{0.25})Ba_2Ca_2Cu_3O_y$ 1223 were grown on the substrate by sintering at 830-890°C. In the case of the Cr/Ni substrate, strongly c-axis oriented $(Hg_{0.75}Re_{0.25})$ 1223 tape was fabricated by sintering at 890°C with an intermediate uniaxial pressing. The oriented tape exhibited $T_c=127K$ under zero magnetic field and $B_{irr}=5T$ at 77K. This B_{irr} at 77K is much higher than that of pure Hg1223 single crystals[3], suggesting that Re doping is effective for enhancement of B_{irr} under $B//c$.

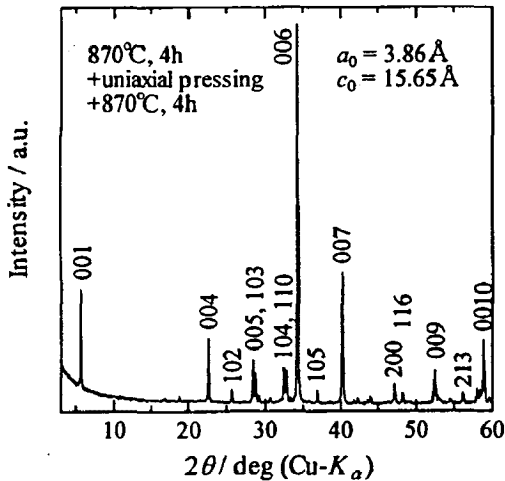


Fig. 1. The X-ray diffraction pattern for $(Hg_{0.75}Re_{0.25})$ 1223/NiO/Ni tape.

However, it has been difficult to reproduce $(Hg_{0.75}Re_{0.25})$ 1223/Cr/Ni/Ni tapes possibly due to the incompleteness of Cr coating on the Ni substrate. On the other hand, $(Hg_{0.75}Re_{0.25})$ 1223/NiO/Ni tapes could be synthesized reproducibly and the surface morphology was found to be improved. Figure 1 shows a typical X-ray diffraction pattern of the tape. The best tape exhibited $T_c=119K$ and $T_{irr}=82K$ under the magnetic field of 5T applied perpendicular to the tapes surface as shown in Fig.2. Though T_c of the tape was lower than that of the oriented Cr/Ni tape because of partial substitution of Ni for Cu, the T_c still remained high. These results indicate that the NiO/Ni substrate is more preferable for $(Hg_{0.75}Re_{0.25})$ 1223/NiO/Ni tapes than the Cr/Ni substrate.

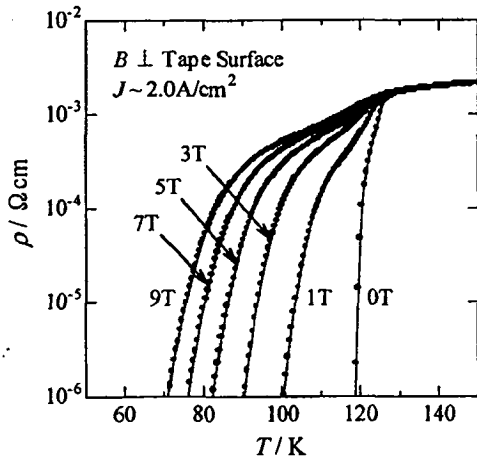


Fig. 2. Temperature dependence of the resistivity of $(Hg_{0.75}Re_{0.25})$ 1223/NiO/Ni tape.

4. Conclusions

$(Hg_{0.75}Re_{0.25})$ 1223/NiO/Ni tapes were fabricated on the Cr/Ni and NiO/Ni substrates. The c-axis oriented $(Hg_{0.75}Re_{0.25})$ 1223/NiO/Ni tapes were reproducibly fabricated. The observed B_{irr} was quite high, $> 5T$ at 77K.

References

- [1] P. N. Peter, R. C. Sick, E. W. Urbon, C. Y. Huang, M. K. Wu, "Observation of enhanced properties in samples of silver oxide doped $YBa_2Cu_3O_x$ ", Appl. Phys. Lett., 52, 24, 2066, 1988.
- [2] P. J. Oueph, "Effect of an External Force on Levitation of a Magnet Over a Superconductor", Appl. Phys. A, Vol. 50, pp. 361-364, 1990.
- [3] 이상현 "YBaCuO계 초전도체의 자기적 성질", 전기전자재료학회 논문지, 12권, 6호, pp. 542-549, 1999.