

# Anisotropic properties of high - te superconducting YBCO films grown on SrTiO3 (110) substrates

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## ABSTRACT

We studied the anisotropic properties of High-T<sub>c</sub> superconducting YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7-x</sub> (YBCO) films grown on SrTiO<sub>3</sub> (110) substrates. The YBCO films were characterized by X-Ray diffraction, the atomic force microscope (AFM), and resistivity measurement. We researched the upper critical field (H<sub>c2</sub>) and the pinning potential energy (U) in the different direction. The critical temperature (T<sub>c</sub>) was decreasing with the field was increasing. As the anisotropic angle increased, the plot of H<sub>c2</sub> vs T<sub>c</sub> curves of films showed downward straight lines. The pinning potential energy was decreasing the field was increasing.

Keywords : High-T<sub>c</sub> superconductor、critical temperature、upper critical field、pinning potential energy

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## REFERENCES

- [1] J. G. Bednorz, K. A. Müller, Z. Phys. B64(1986)189.
- [2] M. K. Wu, J. R. Ashburn, C. J. Trong, P. H. Hor, R. L. Gao, Z. J. Huang, Y. Q. Wang, and C. W. Chu, Phys. Rev. B35(1987)5337.
- [3] H. Maeda, Y. Tanaka, M. Fukutomi, and T. Asano, Japan, J. Appl. Phys.27(1988)L209.
- [4] A. Schalling, M. Cantori, J. D. Guo, and H. R. Ott, Nature, 363(1993)56.
- [5] A. Inam, C. T. Rogers, R. Ramesh, K. Remschnig, L. Farrow, D. Hart, T. Venkatesan, and B. Wilkens, Appl. Phys. Lett. 57, 2484(1990).
- [6] J. P. Zeng, S. Y. Dong, D. Bhattacharya, and H. S. Kwock, J. Appl. Phys. 70, 7167(1991).
- [7] S. Poelders, R. Auer, G. Linker, R. Smithey, R. Schneider, Physica C 247, 309(1995).
- [8] J-P. Krumme, V. Doormann, F. Welz, R. Eckart, and O. Dörschel, J. Mater. Res., Vol. 9, No. 12 (1994).
- [9] L. M. Wang, Chih-Chian Guo, and Shih-Min Lai, Chinese Journal of Physics, VOL. 43, NO. 3-II(2005).
- [10] A. Lisauskas, S. I. Khartsev, and A. Grishin, Appl. Phys. Lett. 77, 3302(2000).
- [11] P. W. Anderson, Phys. Rev. Lett. 9, 309(1962).

- [12] P. W. Anderson, and Y. B. Kim, rev. of Mod. Phys.(1964)39.
- [13] O. Brunner, L. Antognazza, J-M. Triscone, L. Mieville, and O. Fisher, Phys.RRev. Lett. 67(1991)1354.
- [14] X.W.Cao, X.J.Xu, Z.H.Wang, J. Fang, R.L.Wang, H.C.Li, Physica C 282-287(1997) 1993-1994.
- [15] P.K. Petrov, Z.G. Ivanov, and S.S. Gevorgyan, Materials Science andEngineering A288 (2000) 231 – 234.
- [16] Sansheng WANG, Lin WANG and Bingfu GU, J. Mater. Sci. Technol., Vol.24No.6, 2008.
- [17] Toshiyuki Usagawa, Yoshihiro Ishimaru, Jianguo Wen, Satoshi Koyama, and Youichi Enomoto, Physica C 282-287 (1997) 597-598.
- [18] 大葉大學, 郭致謙, 95年碩士論文 [19] 大葉大學, 白順昌, 98年碩士論文 [20] 台灣大學, 陳政宏, 84年碩士論文