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$\text{Tl}_2\text{Ba}_2\text{CuO}_{6+\delta}$ AS A MODEL SYSTEM FOR FUNDAMENTAL STUDIES
OF HIGH TEMPERATURE SUPERCONDUCTIVITY

Final Report

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Z. F. Ren and J. H. Wang

The Research Foundation of State University of New York at Buffalo
Buffalo, NY 14260

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Principal Investigator:

Z. F. Ren

Project Participants:

Senior Personnel:

PI: Z. F. Ren

Co-PI: *J. H. Wang*

Postdoctoral Fellow:

D. Z. Wang

S. X. Yang

Ph. D Graduate Students:

J. Y. Lao (graduated from SUNY-Buffalo with Ph. D degree in Dec. 1999)

W. Li (switched to another group at SUNY-Buffalo with the leaving of Z. F. Ren to Boston College)

Primary Collaborators:

R. P. Vasquez, California Institute of Technology

D. K. Christen, Oak Ridge National Laboratory

Project Activities and Findings:

During the past year, the PI (Z. F. Ren) moved from SUNY-Buffalo to Boston College as an Associate Professor in the Department of Physics to further enhance the future success of this program. Due to the moving and set up of the new laboratory at Boston College, the project was slowed down in some extent. Nevertheless, the PI and his associates have been able to accomplish the following:

1. The upper critical field study has been carried out on the early samples (made when the PI was still with SUNY-Buffalo). Those samples have either high T_c ($>20K$) with single transition or low T_c but with double transitions. Therefore, there has no definitive conclusion been drawn yet.
2. X-ray photoemission has been used to study the Tl-2201 thin films.
3. In addition, J. Y. Lao has synthesized the epitaxial thallium-containing 1212 films with critical current density up to $10^6/cm^2$ at 77K and zero magnetic field as part of his Ph.D thesis. The success of this research has enabled us to consider using this material as an alternative for $Yb_a_2Cu_3O_7$ (YBCO) or $TlBa_2Ca_2Cu_3O_9$ (Tl-1223) for long length wire development for applications such as transmission cables, motors, generators, etc.

Journal Publications:

1. J. Y. Lao, J. H. Wang, D. Z. Wang, Y. Tu, S. X. Yang, H. L. Wu, Z. F. Ren, D. T. Verebelyi, M. Paranthaman, T. Aytug, D. K. Christen, R. N. Bhattacharya, and R. D. Blaugher, "Synthesis and Characterization of Chromium-Containing Thallium-Based 1212 Films", *Physica C* **333**, 221-228 (2000).

2. J. Y. Lao, J. H. Wang, D. Z. Wang, S. X. Yang, Y. Tu, J. G. Wen, H. L. Wu, Z. F. Ren, D. T. Verebelyi, M. Paranthaman, T. Aytug, D. K. Christen, R. N. Bhattacharya, and R. D. Blaugher, "Synthesis and Characterization of Thallium-Based 1212 Films with High Critical Current Density on LaAlO_3 Substrates", *Superconductor Science and Technology* **13**, 173-177 (2000).
3. R. P. Vasquez, M. P. Siegal, D. L. Overmyer, Z. F. Ren, J. Y. Lao, and J. H. Wang, "Tl Cuprate Superconductors Studied by XPS", *Surface Science Spectra* **6**, 237-253 (1999).
4. R. P. Vasquez, M. P. Siegal, Z. F. Ren, J. Y. Lao, and J. H. Wang, "Chemical Bonding in Tl Cuprates Studied by X-ray Photoemission", *Phys. Rev. B* **60**, 4309 (1999).
5. Z. F. Ren, J. Y. Lao, W. Li, D. Z. Wang, J. H. Wang, C. C. Tsuei, J. R. Kirtley, D. K. Christen, and D. van der Marel, "Physics and Applications of Thallium-based Superconductors", Invited review article in "*RECENT RESEARCH DEVELOPMENT IN APPLIED PHYSICS*" **2**, 291-325 (1999).

Books or Other One-time Publications:

6. J. Y. Lao, J. H. Wang, D. Z. Wang, S. X. Yang, and Z. F. Ren, "Ex Situ Processing of Tl-Containing Films", Book Chapter in "Next Generation High Temperature Superconductors", Published by Plenum Publisher (submitted).
7. Z. F. Ren and J. H. Wang, "Preparation of Superconductive Ceramics", Pages 258 – 315, Chapter 17.3.10, Volume 18, "Inorganic Reactions and Methods", edited by J. J. Zuckerman and Jim D. Atwood, published by Wiley-VCH, (1999).
8. A. Hoffman, I. K. Schuller, Z. F. Ren, J. Y. Lao, J. H. Wang, D. Girata, W. Lopera, and P. Prieto, "Persistent Photoconductivity in High- T_c Superconductors", Book Chapter in "Application of Spectroscopy to Superconducting Materials", ACS Symp. Series **730**, page 216 – 229 (1999).