Project No. : 15002 Core Institution in Japan: University of Tsukuba

JSPS Core-to-Core Program -Strategic Research Networks-
FY2006 Research Report

Project No.	**15002**
Research Theme	**Nanoscience and Engineering in Superconductivity**
Duration of Project	**April 1, 2006～March 31, 2009**
Core Institution in Japan	**University of Tsukuba**

Implementing Organizations

Country	Japan
Core Institution	University of Tsukuba
Co-Chair (name and title)	Professor Kazuo Kadowaki
Number of Cooperating Institutions	9
Cooperating Institutions	Keio University, Tohoku University, University of Tokyo, Tokyo Institute of Technology, National Institute for Materials Science, Japan Atomic Energy Agency, RIKEN, Hitachi Advanced Research Laboratory, NEC

Country	EU
Core Institution	Katholieke Universiteit Leuven
Co-Chair (name and title)	Professor Victor Moshchalkov
Number of Cooperating Institutions	16
Cooperating Institutions	University of Antwerp, CNRS-CRTBT, University of Bordeaux. Research Center Julich, University of Tubingen, University of Erlangen-Nurunberg, Walther Meissner Institute, University of Naple, Leiden University, University of twente, University of Madrid, Chalmers University of Technokogy, University de Geneve, ETH, University of Bath, University of Cambridge,
Matching Fund	Yes, about 100K EURO

Country	USA
Core Institution	Argonne National Laboratory
Co-Chair (name and title)	Dr. Wai Kwong Kwok
Number of Cooperating Institutions	8
Cooperating Institutions	University of Notre Dame, Northern Illinois University, Texas A & M University, The University of Chicago, University of Illinois at Chicago, University of South Carolina, University of California at Davis, University of Chicago at Urbana-Champaign
Matching Fund	about 200 kUS$

Result of Program Implementation

Superconducting phenomena exhibiting absolute zero resistance are extraordinary physical realization in metals, in which a macroscopic scale of quantum mechanical coherence develops as a result of strong electron-electron correlations. Understanding the superconducting phenomena more deeply utilizing the advanced nano-technology more sharply, a quest for new superconducting states and superconductors with transition temperatures as high as room temperature, research of quantum computation, etc. will be pursued based on the fundamental materials science. With emphasis on the characteristics of the core institutions and in collaboration with core researchers internationally it is of our final goal to explore a new scientific and technological paradigm for the future society in a quarter of century in advance.

We heve set up international collaborative research organization between three partners over the world (Japan, EU and USA) on superconductivity fully utilizing nano-enginnering techniques for preparing materials as well as for experimental techniques during past two years, and could successfully obtain a number of remarkable results.

Achievements in FY2006 (Self Review)

We have tried continuous effort to obtain interesting achievements being important for the applications. In the following we list only 4 items achieved in FY2006.

1. Direct detection of THz radiation: We have succeeded in detecting THz radiation from intrinsic Josephson junction system $Bi_2Sr_2CaCu_2O_{8+\delta}$ by meas of bolometric technique.
2. Study of macroscopic quantum tunneling (MQT) phenomena using the intrinsic Josephson junction system $Bi_2Sr_2CaCu_2O_{8+\delta}$ artificially engineered into a mesoscopic size. We have found a profoud extraordinary high crossover temperature T^* of the order of 1 K, which exceeds an order of magnitude and is in favor for the quantum computing.
3. We were successfully able to understand the mechanism of the BEC(Bose-Einstein condensation) phenomena using the Feshbach mechanism.
4. We were able to synthesize a new superconductor $Ca_{1-x}Mg_xC_6$ intercalation compound, whose Tc value of 11.6 K is rapidly suppreseed as a function of x.

In addition to these scientific achievements, we organized 3 International Conefences: 5th International Symposium on the Intrinsic Josephson Effect in High Tc Superconductors, International Workshopon Mesoscopic Superconductivity and Magnetism, 4th International Symposium on Future-Oriented Interdisciplinary Materials Science.

Future Plan (Measures toward Achieving Research Objectives)

Within the strategic research network organizaion, we plan to extend our researches to more focussed subjects of the currently important problems: THz generation using high Tc superconductor intrinsic Josephson junctions and the macroscopic quantum phenomena utilizing deeply nanotechnology. The former one was originated from our study on the Josephson plasma so that we intend to concentrate on this problem. The latter one is important in the sense of future information technology and quantum computations. Multi-stacks of high Tc intrinsic Josephson junctions are considered as a most ideal candidate for these purposes. Furthermore, development of new materials with higher Tc is crucial for the future prosperity of our society. Room temperature superconductors are desired to be a target materials as an ultimate goal of our research. Both wide overviews of materials from point of view of Physics and Chemistry and detailed calculations based on the various models are needed for. By the time at the end of this program we hope to have a dramatic increase of the critical temperature towards room temperature or even beyond it.