University of Wollongong

Centre for Superconducting & Electronic Materials

Annual Report

1994/5

1994/5 ANNUAL REPORT

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I. PROGRESS REPORT

1. Objectives of CSEM

The UoW decided to establish the Centre for Superconducting & Electronic Materials (CSEM) in early 1994. The Institute of Materials Technology and Manufacturing was launched at the end of 1995, which consists of CSEM, Centre of Advanced Materials Processing and a Group of Energy Storage Materials. The mission of the CSEM is to establish a world class interdisciplinary research team in HTSC science and technology, and to stimulate the technological and commercial development of the Australian HTSC industry. The CSEM will carry out this mission by:

[1] Utilising nationwide expertise to enhance progress in HTSC science and technology;
[2] Establishing interdisciplinary research team for conducting high quality basic/generic research;
[3] Maintaining an awareness of emerging HTSC science and technology from around the world;
[4] Promoting the commercialisation of HTSC materials technology to sponsoring companies;
[5] Enhancing the existing strong, national and international links in the field;
[6] Contributing to the education of high quality postgraduates and postdoctoral fellows in HTSC science and technology.

2 Research Programs and Progress

The CSEM consists of more than 30 researchers and postgraduate students in the fields of materials science, ceramic engineering, chemistry, physics, electrical engineering and electronics. The research carried out by this large group covers a wide range of projects from materials aspects to theoretical modeling in HTSC. The quality of the research is clear by the number of refereed publications, invited seminars at national and international conferences, competitive grants, postgraduate students and by the strong national and international collaboration developed by this group. The research program includes projects in the areas of:

[1] Theory and mechanism of HTSC phenomenon
[2] Fabrication of bulk HTSC materials, wires, tapes and coils
[3] Critical current density, transport mechanism and flux pinning
[4] Studies on structure, microstructure and stability
[5] Applications in electrical and electronic systems

The group has built its expertise on a sound scientific base. A number of techniques in powder processing, deformation and heat treatment have been developed to improve the J_c in HTSC materials. A continuous tube forming and filling process as an alternative to the powder-in-tube process has been jointly developed with Dr. Collings in Ohio State University. A sandwich rolling technique and a controlled atmosphere process were developed for fabrication of silver-clad Bi-based superconducting wires. A record high J_c, 30,000A/cm^2 at 77K and 300,000A/cm^2 at 4K in self-field has been achieved for Ag-clad Bi-2212 tapes. The J_c of Ag-clad Bi-2223 tapes are 40,000 A/cm^2 and 9,000 A/cm^2 at 77 K and 0 and 1 tesla magnetic field respectively. Tapes and multifilaments up to 50 meter long with a J_c over 10,000 A/cm^2 at 77 K on

the entire length have been fabricated. Prototype fault current limiter, current leads and high voltage generator have been designed and tested using HTSC tapes.

Significant progress has been made in the fundamental research in materials processing and electromagnetic properties of HTSC. Improvement in transport J_c has been demonstrated in the Bi-2223 tapes by neutron irradiation, chemical doping, thermo-mechanical deformation, control of defects, grain alignment and phase assemblage in Bi-based superconductors. The relationship between microstructure of the HTSC tapes and their critical current anoisotropy, first established by this group, has been widely referenced by others. High quality publications on separation of intergrain current and intragrain current; magnetoresistance; dissipation mechanisms; weak links and strong links; TEM on grain boundaries and defects; pinning potential measurements and current limiting factors were published, in collaboration with a number of leading research teams around the world, which have lead to a better understanding on these important issues. The ultimate goal of these studies is to establish a clear correlation between the electromagnetic properties and microstructure, thus providing a means to optimise processing parameters and hence raise the critical current density.

In the area of energy storage materials, a Research Group, coordinated by HK Liu, was established I 1994. A novel technique for low temperature coating developed by the Energy Storage Group is capable of producing a highly active surface coating at room temperature. Ti_2Ni alloys microencapsulated with this technique at room temperature have shown a superior performance in cycle life, specific capacity and capacity decay to that of Ti_2Ni coated at high temperatures. The specific capacity of the Co-doped Ti_2Ni has reached the highest value (222 mAh/g) known in A_2B series. They have also identified a hydride phase $Ti_2NiH_{0.5}$, which can not be reversibly charged and discharged. The formation and accumulation of this compound is consequently proposed as a predominant mechanism responsible for the early capacity loss of the electrodes fabricated from Ti_2Ni alloys. The modified Mg-Nickel hydride was found for the first time to have a good kinetics of hydriding and dehydriding at room temperatures with capacity of 170mAh/g. The studies of impedance and in situ neutron diffraction have generated important information on rate controlling steps of charge-discharge process and effect of hydrogen absorption on lattice.

3 Personnel Developmet

The CSEM has experienced a rapid growth in the last two years. At the present, CSEM has 10 full time research staff, 6 long term visiting fellows, 11 associated research staff from Departments of Physics, Chemistry, Materials Eng, Electrical Eng, Mechanical Eng and ITC, 2 supporting staff and 15 postgraduate students. In the last two years, 7 fellows, a technical assistant and a half time administrative officer have been employed. 9 long term visiting fellows have been appointed. S.X. Dou was elected as a fellow of Australian Academy of Technological Science and Engineering in 1994, appointed as the Director of Insitutte of Materials Technology and Manufacturing and reappointed as an Advisoray Board member of Superconductor Science and Technology. Dr. E.W. Collings was appointed as Honoray Visiting Professor and Professor S. Kambe from Yamagata University, Japan, has been awarded a Visiting Professorship at CSEM for 6 months by Australian Academy of Science. We have accepted a number of short term visiting scientists. Y.C. Guo and J.X. Jin have been awarded a PhD and MEg respectively. A PhD thesis of Q.Y. Hu has been aproved by the examiners and J.M. Xu and M. Inonescu have completed their PhD theses. 7 postgraduate students have joined the CSEM. The CSEM was reported by The Sydney Morning Herald, Campus Review, Engineers Australia, Campus News, Illawarra Mercury, The Independence Daily, Australian Chinese Daily and Sing Tao Jihpao for more than 10 times in last two years. SX Dou was also interviewed by ABC and SBS for three times.

4 Research Funding

In respect to our research funding, CSEM has a continuous success following 1993, with new funds of over $2.5m obtained up to now. Grants from ERDC, DIST, Dept of Energy of NSW have been obtained which, together with funds from ESAA and MM Ltd, formed the program of Australian Technology of HTSC Wires undertaken by the UoW-CSIRO-MM consortium. The total investment for this project is $6m, the largest project in this field in Australia. In addition, 2 ARC RIEF by SX. Dou and HK. Liu with 12 institutes around Australia, two collaborative ARC by SX Dou with other 3 institutions and H.K. Liu and T. Chandra respectively, a small ARC by H.K. Liu, have been successful. Other grants include Australian Academy Science Exchange Program with Japan and ANISE grant. Existing grants include two ARC fellowships, two APA(I), four UPA and six OPRS .

5 Infrastructure, Equipment and Facilities

The Centre for Superconducting and Electronic Materials is equipped with modern materials processing facilities. Facilities for drawing, swaging, pressing and rolling are available in the Centre. Equipment for powder processing and characterisation have been installed at the Centre, including Attrition Mill, Plenetary Mill, Spray Drier, Freeze Drier, Laser Beam Particle Size Analyzer. More than 20 programable furnaces with varying capabilities are currently used for heat treatment of HTSC. SEM, XRD, TEM, STM, AFS and Optical spectroscopy are available for compositional and microstructural analysis. A simultaneous DTA and TGA and a DSA for studying thermal properties and Instron machines for testing mechanical properties are also available.

Equipment for testing electrical and magnetic properties is available at the Centre, including 8 Tesla magnet, Physical Property Measurement System by QUANTUM DESIGN operated from 4K to 300K, 0T to 9T, Computerised four probe DC resistivity measurement system, AC susceptibility equipment, large current DC/AC power supply upto 200A and closed cycle cryogenic system are available in our laboratory. A number of multimeters including high precision nanovoltmeter for I-V measurements, high precision power supplies, lock-in amplifiers, flux meter, oscilloscopes, and software and interfaces have been installed for physical characterisation.

6 End-User Support and Co-operation

Industrial Partners include Metal Manufactures Ltd (MM), MM Cables, Pacific Power, and Electric Supply Association of Australia (ESAA). MM Ltd with its long standing involvement in the project is in an excellent position to commercialise the technology in the due course of the project. Recently, The research results' user, Metal Manufactures Ltd, has initiated a large program to commercialise the UoW group's laboratory achievements by building a pilot plant at the Australian Technology Park with a total investment $6 million from various sectors. This has further strengthened Australian competitiveness in this field and placed Australian HTSC R&D at forefront of the field in the world. This scaling-up approach will provide valuable information for further industrial development of HTSC materials, and hence is a critical step bringing the laboratory success to the commercialisation of HTSC.

7 Strong International Links

Recognition of many of this team's achievements in HTSC by leading groups in the field has come in the form of requests for collaborative work. UoW team has established an international multidisciplinary collaborative network. This strong international links are evidenced by the following facts:

More than 40 joint publications with 15 overseas institutions around the world, including Cambridge University, Oxford University and Imperial College in the UK, the Argonne National Laboratory, Battelle Memorial Institute, National Institute of Standards and Technology, Ohio State University and the

University of Houston in the USA, Atomic Institute of the Austrian Universities, University of Zagreb, University of Geneve, Siemens AG and Lulea University in Europe, Northeastern University and General Institute of Non-ferrous Metals in China.

Eight joint Bilateral research grants have been successful with the Oxford University, Ohio State University, the Ames Laboratory at Iowa State University, National Research Institute of Metals, Yamagata Uni (Japan), Institute of Physics and Northeastern University in China from DIST, Australian Academy of Science, Australian-China Council, MITI of Japan and NSF of USA. SX Dou has presented more than 10 invited talks, seminars and lectures to international conferences and other institutions. and 17 distinguished scientists visited and gave 20 lectures to CSEM in last two years. 9 postgraduate students have been jointly supervised by S.X. Dou, H.K. Liu with 6 overseas academic staff. 2 Targeted Institutional Links programs have been conducted with Institute of Physics and Northeastern University, Nankai University and Harbin University in China, Osaka National Research Institute in Japan.

II. ACADEMIC AND RESEARCH STAFF

Full time staff:

Professor S.X. Dou, Director, ARC Professorial Research Fellow
A/Professor H.K. Liu, ARC A/Professorial Research Fellow
Dr. M. Ionescu, Research Fellow, Assistant Director
Dr. P.N. Mikneenko, Senior Research fellow
Dr. V.P.S. Awana, Research Fellow
Dr. Y.C. Guo, Research Fellow
Dr. J. Horvat, Research Fellow
Dr. Q.Y. Hu, Research Fellow
Dr. J.N. Li, Research Fellow
Mr. C. Rossi, Technical Officer
Ms M. Harrison, Administrative Assistant
Mr. M. Pride, Administrative Officer (half time)

Visiting Staff:

A/Prof. S. Kambe, Yamagata Uni, Japan (9/95 - 4/96)
Dr. V. Murashov, Institutte of Electronics & Radio-physics, Russia (3/96-3/98)
Dr. E.A. Goodilin, Moscow State Uni (3/96-4/97)
Mr. L. Sun, Institute of Metals Research (3/96-4/97)
Mrs. J.Z. Wang, Harbin Normal Uni (11/95-11/97)
Mr. X.Z. Liao, University of Hong Kong (4/96-7/97)

Associate Staff:

Dr. E.W. Collings, Honoray Visiting Professor(Ohio State Uni)
Prof. H. Worner (ITC)
Prof. C. Cook (Electrical Eng)
Prof. P. Fisher (Physics)
A/Prof. T. Chandra (Mater Eng)
Dr. D. Bradhurst (ITC)
Dr. D.K. Yu (Mater Eng)
Dr. C. Zhang (Physics)
Dr. M. Jagdish(Physics)

Dr. D. Platt(Electrical Eng)

Visiting Fellows Left

Dr. R.K. Wang, Institute of Non-ferrous Metals, PRC (9/93 - 10/94)
Mr. B. Zeimetz, Achen University, Germany (6/94 - 2/95)
Mr. A. Pan, Institute of Metals, Ukraine (5/94 - 5/95)
Dr. H. Wang, Shanghai Ceramic Institute, PRC (4/95 - 4/96)
Dr. J. Ostenson, Ames Lab, USA (5/94 - 8/94, 7/95-8/95)
Dr. M. Xu, Ames Lab, USA (5/95)
Dr. Y.T. Huang, Industrial Technology Research Institute, Taiwan (11/94)
Mr. R.J. Lin, Industrial Technology Research Institute, Taiwan (11/94)

III. POSTGRADUATE STUDENTS

1. Q.Y. Hu, PhD, 1991-5
2. M. Ionescu, PhD, 1991-5
3. M. Yavuz, PhD, 1994-
4. J.M. Xu, PhD, 1992-
5. J.X. Jin, PhD, 1994-
6. R. Bhasale, PhD, 1993-
7. B.L. Luan, PhD, 1993-
8. Y.X. Chen, PhD, 1994-
9. N. Cui, PhD, 1993-
10. N. Vo, PhD, 1994
11. W.G. Wang, PhD, 1994-
12. P. Bain, PhD, 1994-
13. S. Zahiri, MEg, 1995-
14. Y.S. Wu, MEg, 1995-
15. B. Zeimetz, PhD, 1995-
16. S. Zhong, PhD, 1995-
17. J. Chen, PhD, 1996-
18. X.L. Wang, PhD, 1996-

IV. RESEARCH GRANTS

[1] SX Dou, ARC Professorial Fellowship on HTSC Processing, 1993-97 ($520,000)

[2] HK Liu, ARC Senior Research Fellowship on Long Wires of HTSC, 1994-98 ($410,000)

[3] S.X. Dou, L. Vance, B. Bonwick and N. Savvides, "Microstructures and Critical Current of HTSC", ARC Collaborative, 1994-6 ($383,000)

[4] SX Dou, HK Liu IDR MacKinnon, PJK Paterson, N Savvides, K Muller, ER Vance, MP Das, WJ Bonwick, T Finlaynson, GB Smith, JM Bell, DN Jamieson, S Myhra, IM Low and DY Li from 11 Insitutions, "HTSC Laboratory", ARC RIEF, 1995 ($300,000 from ARC, $120,000 from UoW)

[5] SX Dou, HK Liu, IDR MacKinnon, ER Vance, MP Das, S Myhra, IM Low, PD Killen and C Zhang from 7 institutions, " PPMS", ARC RIEF, 1996 ($250,000 from ARC, $72,000 from UoW)

[6] J. Spinks, D. Dunne, S.X. Dou et al., "Atomic Force Microscope", ARC, Equipment and Infracstruture, 1995 ($177,000 from ARC and $100,000 from UoW).

[7] H.K. Liu and T. Chandra, "Thermomechanical processing of HTSC", ARC Collaborative, 1995-1997 ($273,000).

[8] S.X. Dou and H.K. Liu, "Fabrication and application of HTS Wires and Tapes", Energy Office of NSW, 1996-98 ($382,728).

[9] S.X. Dou, N. Savvides, M. Apperley, "A Plan for Australian Technology in HTS Wire", ERDC, 1995-8 ($1,600,000)

[10] S.X. Dou and H.K. Liu, "Fabrication and Application of HTS Wires and Tapes", ESAA Grant, 1994-96 ($160,000)

[11] SX Dou, HK Liu and CC Sorrell, "Targeted Institutional Link program with Northeastern Uni and Institute of Physics of PRC on HTSC", DEET, 1992-94 ($162,000)

[12] SX Dou, HK Liu, N. Savvides and K. Muller, " A Plan for Australian Technology of HTSC Wires", DIST, 1996-98 ($500,000)

[13] S.X. Dou and H.K. Liu, "Technology and Applications of HTSC Wires", MM Ltd. 1993-96 ($275,000)

[14] H.K. Liu, " Nickel-Metal Hydride Alloy", ARC, 1995 ($6,000).

[15] SX Dou and D Finnemore(Ames), " Bilateral Program on HTSC Wires", DIST ($5,500) and D. Finnemore, NSF(USA, $23,000) 1994

[16] S.X. Dou, Y.C. Guo, and H. Maeda (NRIM), "Bilateral Program of Composite HTSC", DIST (AUS.), $8,000, STA (JAPAN), $5,000, 1995-96.

[17] HK Liu, M Ionescu and EW Collings (Ohio), "Bilateral Program of 2212 HTSC Wires", DIST ($4,600) 1996

[18] SX Dou, J. Horvat and D. Dew-Hughes(Oxford), "Bilateral Program of Critical Current and Flux Pinning of HTSC", DIST($4,100)

[19] S. Kambe(Yamagata Uni) and SX Dou, " Japanese-Australian Exchange Program on HTSC", Australian Academy of Science ($14,000), 1995-6

[20] SX Dou and HK Liu, Two APA(I) on HTSC, DEET($140,000), 1993-96

[21] HK Liu and S Kennedy(ANSTO), "Neutron Diffraction of Metal Hydride", AINSE ($9,000), 1995/6

[22] SX Dou and HK Liu, " HTSC lab", UoW ($200,000), 1994-6

[23] S.X. Dou, Centre for Supercoducting Materials, UoW, $44,730, 1995.

[24] H.K. Liu, Group of Energy Storage Materials, UoW, $11,140, 1995.

[25] SX Dou, Institute of Materials Technology and Manufacturing, UoW($210,000), 1996-98

[26] 7 OPRS, DEET ($315,000), 1994-8

[27] 5 UPA and APA, DEET ($225,000), 1994-98

[28] AINSE suplement scholarship of HTSC powder processing with Dr. ER Vance in ANSTO, 1994-96 ($45,000)

V. ASSOCIATED COMPANIES

* Metal Manufactures Ltd (MM Cables)
* Pacific Power
* Electric Supply Association of Australia
* Australian Batteries Technology Ltd.
* Au-Ling Batteries Co. Ltd
* Hua-Ao batteries Co Ltd

VI. COLLABORATIVE RESEARCH TEAMS

1. CSIRO Division of Applied Physics, N. Savvides, K. Muller and G. Slogget
2. ANSTO, ER Vance and S Kennedy
3. Electron Microscope Unit, University of Sydney, D.J.H. Cockayne
5. UNSW Schools of Physics and Elec., J. Cadogan, & C. Grantham
6. Monash University, Dept of Elec. & Computer Eng.(W. Bonwick)
7. University of Melbourne, Dept of Physics (D. Jamieson)
8. Curtin Uni of Technol, Dept of Phys. (J. Low)
9. Blackett Lab. Imperial College (A.D. Caplin), London, UK
10. Oxford University, Eng Dept (D. Dew-Hughes)
11. National Research Institute of Metals (H. Maeda)
12. Ames Lab. Iowa State University(D. Finnemore), Iowa, USA.
13. Ohio State University (E.D. Collings), Columbus, OH, USA.
14. University of Zagreb (E. Babic), Zagreb, Croatia.
15. Argonne national Lab(DL Shi, now in Cincinati Uni), Argonne, IL, USA.
16. Atomic Institute of Austrian Universities (H. Weber), Viena, Austria.
17. Institute of Physics, Academy Science, Beijing, PRC (Z.X. Zhao)
18. Northeastern University, Shenyang, PRC, (Prof. Y.F. Zhang).
19. National Institute of Standard Technology (J. Ekin), Boulder, USA
20. Institute of Non-ferrous Metals, Beijing, PRC, (Prof. RK Wang).

VII. INVITED TALKS

1. 31 March 1994, "Manufacture of HTSC", Institute of Engineers, Australia, Sydney

2. 11 July 1994, "Fabrication of HTSC wire and tapes", University of Geneve, Switzerland

3. 18 August 1994, "Introduction and Application of HTSC", IMMA, Wollongong

4. 19-22 Oct. 1994, "Novel processing and microstructures of HTSC", Pacific Coast Regional Meeting of American Ceramic Society, Los Angeles, CA, USA

5. 12-16 Feb, 1995, "Sandwich rolling, J_c and pinning energy in Ag-sheathed BPSCCO superconducting tapes", Symposium of Synthesis, processing, and large scale applications of HTSC, 1995 TMS Annual Meeting in las Vegas, Nevada, USA

6. 20-22 Feb 1995, "Critical current and pinning energy in Ag/BPSCCO tapes", International Conference on Advances in High Magnetic Field (AHMF'95), Tsukuba, Japan

7.18-21 June 1995, "Crystal growth and critical curerent of HTSC", International Workshop on Superconductivity co-sponsored by MRS/ISTEC, Maui, Hawaii, USA

8. 27/Nov-1/Dec. 1995, "Effect of defects on prperties of HTSC", Symposium F of HTSC for MRS Fall Meeting, Boston, MA, USA

9. 13-15 Dec. 1995, JIM/TMS/ASM joint Fall Meeting, Honolulu, Hawaii, USA

10. 4-8 Feb 1996, Symposium of Synthesis, Processing and Large scale applications of HTSC, TMS Annual Meeting, Anaheim, CA, USA

11. 27-29 May 1996, 8th IWCC in superconductors, Kitakyushu, Japan

VIII. DISTINGUISHED VISITORS TO GIVE SEMINARS

Prof. H. Weber, Atomic Institute, University of Viena, Austra, Feb. 1994, 96
Dr. E.W. Collings, Ohio State Uni., Columbus, OH, USA, Feb. 1994, 95, 96
Prof. D. Finnemore, Ames Lab. Iowa State University, Iowa, USA, Feb. 1994
Dr. N. Koshizuka, ISTEC, Japan, Feb. 1994
Prof. H. King, University of Western Ontario, Canada, May, 1994
Dr. K. Muller, CSIRO, May 1994
Prof. Z.X. Zhao, Institute of Physics, Beijing, China, June 1994
Dr. M.P. Das, ANU, Canberra, June 1994, May 1995
Dr. Y.T, Huang, Industrial Tech. Res. Ins, Tawain, Nov. 1994
Dr. J.C. Macfarlane, Uni of Strathclyde, UK, Feb 1995
Dr. G. Samadi, Atomic Institute of the Austrian Universities, Feb 1995
Prof. A. Bourdillon, National Uni of Singapore, March 1995
Prof. E. Babic, Uni of Zagreb, Croatia, April 1995
Prof. S.E. Hsu, UNSW, June 1995
Dr. D. Dew-Hughes, Oxford Uni, UK, Jan 1996
Dr. H. Maeda, National Research Institute of Metals, Japan, Jan 1996

IX. THESIS FINISHED

Y.C. Guo, PhD, "Processing and Characterisation of Ag/Bi-based Tapes", March 1994.

J.X. Jin, MSc, "HTSC Ceramics and Their Application in The Design and Construction of Electrical Fault Current Limiters", March 1995

Q.Y. Hu, PhD, "Fabrication and Enhancement of Critical Currents of Silver-Sheathed Bi-2223 Tapes", Dec 1995

X. PROJECTS FOR RESEARCHERS AND POSTGRADUATE STUDENTS:

1. S.X. Dou, "Microstructures, flux pinning and J_c of Ag-clad Bi-Pb-Sr-Ca-Cu-O Wires"
2. H.K. Liu, "Fabrication and properties of Ag-Bi-2223 tapes",
3. Y.C. Guo, "Critical current, microstructure and fabrication of long Bi-2223 tapes", 1994-
4. M. Ionescu, "Fabrication and application of Bi-2212 tapes", 1994-
5. J. Horvat, "Current limiting mechanisms in HTSC wires", 1994-
6. J.N. Li, "Improvement of flux pinning and weak links in Bi-2223 tapes", 1994-
7. B. Zeimetz, "Investigation of HTSC current leads", 1994-
8. A. Pan, "Ag/Cu-based Bi-2212 HTSC tapes", 1994-
9. R.K. Wang, "TEM study of HTSC tapes", 1993-
10. Q.Y. Hu (S.X. Dou with H. Weber in Viena), OPRS, UPRA, "Critical current density of superconducting Bi- 2223 tapes and multifilaments", 1991-.
11. M. Ionescu (Dou with E.W. Collings, Battelle, USA), APRA, 1991-
"Growth of Bi-2212 single Crystals and fabrication of Bi-2212 tapes"
12. M. Yavuz (Dou with E. Vance, ANSTO), UPRA, ANISE,
"Superconductor powders", 1993-
13. R. Bhasale (S.X. Dou and H.K. Liu), APRA(I),
"Mechanical deformation of Ag-Bi2223 long HTSC Wires", 1993-
14. J.M. Xu (Dou with J. Cadogan, UNSW), OPRS and CSEM
"Permanet magnetic materials", 1992-
15. J.X. Jin (Dou, H.K. Liu with C. Grantham, UNSW), UPRA and CSEM($15,000)
"Superconducting current limiting device using HTSC", 1994-
16. B.L. Luan (Dou, H.K. Liu and T. Rozgonyi), AIDB and JCSS
"Nickel-metal hydride alloy for batteries", 1993-
17. S. Zhong(Dou and Liu), "Electrode materials for lead-acid batteries", OPRS, UPRA, 1994-
18. N. Cui (Dou, H.K. Liu and D. Bradhurst), OPRS and UPRA
"Magnesium based nickel metal hydride alloy for batteries', 1993-

19. N. Vo (Dou), "Bi-2223 HTSC coils and magnets", APRA(I), 1994-

20. W.G. Wang (S.X. Dou and H.K. Liu), "Fabrication and microstructure of HTSC wires", OPRS and CSEM, 1994-

21. P. Bain (Dou and H.K. Liu), "Hot deformation of HTSC wires", CSEM, 1994-

22. S. Zahiri (Liu & Dou), "Carbonised electrode materials", CSEM, 1995

23. YS Wu (HK Liu & SX Dou), "Mechanical Alloying of metal- hydrides", 1995-

24. J Chen (HK Liu & SX Dou), "Substituted AB_5 hydrides for batteries", 1996-

25. XL Wang(SX Dou and HK Liu), "Single crystals and textured HTSC for energy storage", 1996

26. H Wang, "Bulk HTSC for microwave application" 1995

XI. PUBLICATIONS IN 1994-95

1. Refereed Papers:

1. E. Babic, I. Kusevic, S.X. Dou, H.K. Liu and Q.Y. Hu, "Magnetoresistance and I-V Curves of Ag-Sheathed $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10-y}$ tape", Phys. Rev. B 49, 15312-6 (1994).

2. E. Babic, I. Kusevic, H.K. Liu and S.X. Dou,"Flux Creep in BPSCCO Superconductors: An Interplay of Pinning Centres and Anisotropy", Physica C 235-240 3035 (1994).

3. E.D. Collings, M.D. Sumption, S.X. Dou, and H.K. Liu, "Effect of Final Cold Rolling on Flux Pinning in Multiply-Processed Bi-2223 Powder-in-Tube tapes", CEC/ICMC Conference, Albuquerque, NM, July 12-16, 1993, Advances in Cryogenic Materials 40, 161-68 (1993).

4. M.N. Cuthbert, M. Dhalle, G.K. Perkins, L.E. Cohen, Y.C. Guo, H.K. Liu, S.X. Dou, G. Grasso, R. Flükiger, S. Penn, T. Beales, A.D. Caplin,"Magnetic and Transport Studies of Bi2223/Ag Tapes", Physica C 235-240 3027 (1994).

5. M. Dhalle, M.N. Cuthbert, G.K. Perkins, L.F. Cohen, A.D. Caplin, Y.C. Guo, H.K. Liu and S.X. Dou, "Grains or Boundaries - the Controlling Factors in the Critical Current of BiSrCaCuO Conductors", Proceedings of the 7th International Workshop on Critical Currents in Superconductors, pp553-6, ed. by H.W. Weber, Alpbach, Austria, 24-27 Jan 1994

6. S.X. Dou, H.K. Liu, Q.Y. Hu, C. Czurda, H.W. Weber, S.M. Cassidy, L.F. Cohen and A.D. Caplin, "Weak Links and Flux Pinning in Ag/BiPbSrCaCuO Tapes", Physica B, 194-6, 1829 (1994).

7. S.X. Dou, J. Yau, Y.C. Guo, J.X. Jin and H.K. Liu, "Mechanical Properties of Ag-clad Bi-based Superconducting Composite tapes", Physica B 194-6, 1577 (1994).

8. S.X. Dou, H.K. Liu, Y.C. Guo, R. Bhasale, M. Ionescu, E. Babic and I. Kusevic, "Effect of Silver on the Processing and Properties of Bi-2223/Ag tapes", Appl. Supercond. 2, 191-9 (1994)

9. Y.C. Guo, H.K. Liu and S.X. Dou, "Fabrication and Properties of Silver-Sheathed $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10}$ high-temperature superconducting tapes", Physica B 194-6, 2075 (1994).

10. Y.C. Guo, H.K. Liu and S.X. Dou, "Microstructure and Electromagnetic Properties in Silver-Doped $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10}$/Ag Superconducting Composites", Physica B 194-6, 2283 (1994).

11. Y.C. Guo, H.K. Liu and S.X. Dou, "Effect of Silver Additions on Properties of $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10}$/Ag High-temperature Superconducting Tapes", Mater. Lett. 18, 334-40 (1994).

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