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MIDWEST SUPERCONDUCTIVITY CONSORTIUM

1995 Progress Report

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Midwest Superconductivity Consortium

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Table of Contents

	Page
1. Summary.....	1
2. Program Overview.....	5
3. Peer Review.....	8
4. Research Program Thrusts.....	9
5. Research Program.....	11
6. Selected Research Highlights.....	11
7. Talks and Presentations.....	38
8. Publications.....	48
In Print.....	48
Accepted for Publication.....	54
Submitted.....	56
9. Theses.....	59
10. Appendix I. - Research Program Listing.....	61
11. Appendix II. - 1995 Cooperative Interactions.....	65
12. Appendix III. - Partnership Augmentation Grants.....	84
13. Appendix IV. - Organization.....	85

SUMMARY

The mission of the Midwest Superconductivity Consortium, MISCON, is to advance the science and understanding of high T_c superconductivity.

During the past year, twenty-six (26) projects produced over one hundred thirty-three (133) talks and one hundred twenty-seven (127) publications. Three (3) Master's Degrees and nine (9) Doctor's of Philosophy Degrees were granted to students working on MISCON projects.

Group activities and interactions involved two (2) MISCON group meetings (held in January and July); the third MISCON Summer School held in July; twelve (12) external speakers; eighty-one (81) collaborations (with universities, industry, Federal laboratories, and foreign research centers); and fifty-four (54) exchanges of samples and/or measurements.

Research achievements this past year focused on understanding the effects of processing phenomena on structure-property interrelationships and the fundamental nature of transport properties in high-temperature superconductors.

In the synthesis and processing area: new low-temperature routes for processing bulk and thin film materials were developed; understandings of crystallization, grain growth and texture development in solidified melts and deposited thin films were broadened; important effects of substitutions; second phases, texture alignments, modulated microstructures and composite and microlaminate structures on superconducting properties were characterized; and, processing routes for improving the density and texture of tubular shielding structures were explored.

In the area of transport phenomena: theories for universal conductivity at superconductor-insulator transitions, flux-lattice melting transitions, the electrodynamics and thermodynamics of vortex motion, electromagnetic wave dissipation, and Josephson current densities through insulating barriers were advanced; important experimental techniques for measuring magneto-transmission and reflections of mm microwaves, vortex correlation fluctuations, magnetic penetration depths, the softening of in-plane phonon modes, flux pinning by complex defects and interfaces, weak-link behaviors, and reproducible sub-energy-gap structures were studied.

The following are examples of notable achievements by MISCON investigators during the year:

- The first direct measurement of temperature-driven dynamics in the vortex chain state of a YBCO untwinned single crystal was performed using an atomic-beam imaging technique. The predictions of the London model were confirmed, and a hysteresis between the freezing and melting of the vortex chains was observed (G. Lafyatis, The Ohio State University).
- A quantitative, 3-dimensional model of a high-temperature superconductor as a non-Fermi liquid has been formulated which calculates explicitly the transition temperature and the spatial modulation of the order parameter. Agreement between theory and experiment is excellent. The derived formula allows for a prediction of the T_c value within a given family for the number of CuO_2 layers not yet studied experimentally to include a limiting value of T_c for a large number of CuO_2 planes within the group (J. M. Honig and J. Spałek, Purdue University).
- For the first time (Hg,Tl)-1223 films have been fabricated and have exhibited the highest T_c (133K at onset) reported for a superconducting film (S-H Liou, University of Nebraska-Lincoln).
- The reagents Et_3PO and Me_3NO have been found to bind to $\text{BaCu}_2(\text{O}^t\text{Bu})_4$ (normally insoluble) and solubilize it. This finding makes possible the processing of this precursor into oxides by thermolysis and hydrolysis methods (D. V. Baxter, K. G. Caulton and M. H. Chisholm, Indiana University).
- A technique for determining the absolute time scales for relaxation dynamics near the vortex glass transition has been developed. Knowledge of the absolute time scale allows an experimentalist to predict the scale of frequency needed to see deviations from a DC response (A.H. MacDonald and S. Girvin, Indiana University).

- The first calculation of the fluctuation magnetization in a high- T_c superconductor (in this case YBCO) has been carried out in excellent agreement with experiment. This result is important because it shows that we now have an excellent description of the thermodynamics of flux motion in high- T_c superconductors, especially at high fields (D.G. Stroud, The Ohio State University).
- The possibility of growing high-quality, biaxially-aligned, thin films of YBCO with distinctly different in-plane directions on vicinal SrTiO_3 substrates was demonstrated for the first time. This result is particularly significant for some applications and for the study of transport properties of thin films (E. P. Kvam, Purdue University).
- Transverse relaxation (T_2) contribution in YBCO, resulting from the ^{89}Y - $^{63,65}\text{Cu}$ magnetic dipole interaction, has been calculated using no adjustable parameters. This relaxation mechanism fully explains normal state data (C. Pennington, The Ohio State University).
- A method has been developed for producing BSCCO single-crystal samples that are ideally suited for studying the vortex glass phase in a layered system where the number of Josephson-coupled Cu-O bilayers can be varied (J.C. Garland, The Ohio State University).
- The first observation of two superconducting transitions in $\lambda(T)$ in a multilayer superconductor have been made in films composed of several alternating layers of Bi2201 and Bi2278. We observed that the proximity effect between the two layers increases the transition temperature of the Bi2201 layer from 20K to 40K (T.R. Lemberger, The Ohio State University).
- Modifications in the relaxation of magnetic flux in strong pinning superconductors due to demagnetization effects have been determined both experimentally and theoretically. The distribution of currents is quite different from that expected from the standard Bean Critical State model and as a result the relaxation behavior is different from the expected behavior (M.W. McElfresh and E.P. Kvam, Purdue University).

- A new method has been developed for fabricating $\text{YBa}_2\text{Cu}_3\text{O}_y$ /noble metal microlaminates which takes advantage of the malleability of mixtures of Y and Ba powders. Y-Ba powder packed between an inner ingot of Ag-Cu and an outer tube of Ag can be rolled to form a geometrically uniform Y-Ba inner layer, which when oxidized forms $\text{YBa}_2\text{Cu}_3\text{O}_y$ by concurrent diffusion of Cu from the Ag-Cu core (Ken H. Sandhage, The Ohio State University and Paul J. McGinn, University of Notre Dame).
- Pure $\text{PrBa}_2\text{Cu}_3\text{O}_{7-\delta}$ has been synthesized in order to understand the effect of Pr substitution on superconductivity of "124" cuprate phase, its use as a buffer layer in thin film device applications, and why it is not a superconductor (J. Betanabhatla, University of Nebraska-Omaha, J. R. Hardy, University of Nebraska-Lincoln, and R. R. Berliner, University of Missouri-Columbia).
- It has been shown that the T-linear behavior in clean YBCO crystals and films comes from nodes in the order parameter and not from thermal fluctuations suggested by current theory (T.R. Lemberger, The Ohio State University).
- A solid-state process involving elevated oxygen pressures has been developed to align grains in silver-sheathed $\text{Bi}_2\text{Sr}_2\text{Ca}_1\text{Cu}_2\text{O}_{8\pm\delta}$. This process avoids the coarsening of non-superconducting grains that occurs in commonly used melt texturing (Ken H. Sandhage, The Ohio State University).
- The melt texturing of Y-123 samples in air with excess rare earth additions (Nd_2O_3 , La_2O_3 , and Sm_2O_3) showed improvements in both magnetization and T_c . The enhanced magnetization is thought to be due to pinning effects caused by rare earth ions being present on Y^{3+} and/or Ba^{2+} sites in the 123 lattice (P. McGinn, University of Notre Dame).
- Calculations of the effects of impurity scattering for different types of superconducting order parameters have shown that for certain types of order parameters, the addition of impurity scattering can actually increase the superfluid density in certain directions (P. Muzikar, Purdue University).

- The production of phase-pure 2212 and 2223 in the system Bi-Sr-Ca-Cu-O has been achieved permitting the study of the influence of oxygen pressure and temperature on the partitioning of Ca and Sr between equilibrated 2212-2223 couples (David R. Gaskell, Purdue University).
- An extended theory to all orders of inelastic scattering in a Josephson junction predicts that in suitable situations the inelastic scattering can enhance the pair tunneling and lead to a corresponding maximum in the critical current (G.F. Giuliani, Purdue University)
- For the first time, dissipation from Josephson vortices has been demonstrated in (Y,Pr)Ba₂Cu₃O₇. These vortices strongly effect the electromagnetic properties of this layered superconductor (H.A. Blackstead, University of Notre Dame).

PROGRAM OVERVIEW

The Midwest Superconductivity Consortium, MISCON, in the sixth year of operations further strengthened its mission to advance the science and understanding of high T_c superconductivity. These goals of the organization and the individual projects continue to reflect the current needs for new knowledge in the field and the unique capabilities of the institutions involved. Group efforts and cooperative laboratory interactions to achieve the greatest possible synergy under the Consortium continue to be emphasized. Industrial affiliations coupled with technology transfer initiatives were expanded. Activities of the participants during the past year achieved an interactive and high level of performance. The number of notable achievements in the field contributed by Consortium investigators continues to be high.

The programmatic research continues to focus upon key materials-related problems in two areas. The first area has a focus upon "Synthesis and Processing" while the second is centered around "Limiting Features in Transport Properties of High T_c Materials". The two areas involve twenty-six (26) research projects and thirty-six (36) principal investigators. The research projects involve sixteen (16) undergraduate students, fifty-three (53) graduate students and thirteen (13) postdoctoral associates. In the past year, these participants have published seventy-five (75) papers; twenty-three (23) more

papers are in press and an additional twenty-nine (29) have been submitted. Further, the participants have given over one hundred thirty-three (133) talks or conference presentations. During this past year, three (3) Master's Degrees and nine (9) Doctor's of Philosophy degrees were granted to students working on MISCON projects.

Group activities and interactions with others were again a major activity under the Consortium. MISCON group meetings were held in January and July. A two day schedule for each meeting provided ample opportunity for the desired interactions to take place. Based upon these meetings the Program Committee reexamined the goals and programmatic research and made desirable program changes.

In addition to the group meetings, a summer school entitled "The Josephson Effect and its Applicability to High Temperature Superconductors", was held on July 13-14, 1995. Outstanding speakers from both within and outside MISCON participated.

Coupled with the group meetings and summer school, the participants were very active in cooperative interactions with MISCON Affiliates and other organizations. Among these activities were twelve (12) external speakers, eighty-one (81) collaborations, fifty-four (54) exchanges of samples and/or measurements, and two (2) gifts of equipment from industry. The number of actively participating industrial affiliates is seventeen (17) with additions of American Superconductor Corporation, DuPont Superconductivity, Jet Propulsion Laboratory, and Plastronics, Inc. Additional affiliations are pending.

Group activities are fostered by four programs: first, a seminar exchange promotes interaction within and between the groups; second, a programmatic exchange facilitates the use of special capabilities by all participants; third, a program augmentation grant (PAG) of \$10K is provided under active projects where specific joint technology transfer developments involving participating affiliates on a cost sharing basis are formally agreed to by both parties. During the past year, six (6) Partnership Augmentation Grants were awarded. These grants are proving to be a successful means to improve the effectiveness of collaborations between a MISCON research participant and their industrial partner. Finally, a special capital equipment competition addresses group needs as the primary criterion. Cost sharing realized over \$434,015 worth of

equipment that was selected to provide new capabilities to the Consortium with less \$120K of MISCON funds invested.

Industrial affiliations and technology transfer activities were expanded during the year. Fifteen (15) written agreements and two (2) equipment access agreements were formalized this year with seventeen (17) different industry and national laboratory groups. Additional agreements are pending. Such interactions make all participants more aware of industry's needs for new knowledge and the current state of the technology.

PEER REVIEW

In accordance with MISCON procedures all fourth-year proposals and new proposals are reviewed by an independent external peer review panel. The 1995 peer review was conducted by ten outstanding experts in the field of high- T_c superconductivity. Project renewal decisions were then based on the results of this peer review. Prior to the review, one existing project was withdrawn. Consequently, seven fourth-year projects and eight new proposals were submitted to this outside panel for review. As a result of the panel's review, the seven ongoing projects were renewed and one of the new proposals scored sufficiently high to justify funding for 1995/96.

The peer review scoring is based on NSF method which scores according to "excellent", "very good", "good", and "reject". The average score of all projects is near the midpoint between "very good" and "excellent" and has steadily improved each year.

The abstract for the new research project is indicated in Appendix I.

The process of peer review will continue to be the principal means within MISCON for continuous improvement of project quality, productivity and synergy and for dynamic renewal of project compositions within the two main program thrusts.

RESEARCH PROGRAM THRUSTS

MISSION: The basic mission of the Consortium is to advance the understanding of high- T_c superconductivity and to promote the development of new materials and improved processing technology for the commercialization of superconductivity.

GOALS: The goals of the Consortium are:

- a) To develop, utilizing effective group efforts, the scientific and technological foundation for the industrial applications and commercialization of high-temperature superconductivity;
- b) To facilitate the transfer of technology from the Consortium research laboratories into the industries of the Midwest; and
- c) To ensure that there is a continuing supply of engineers and scientists trained in this important field.

PROGRAMMATIC RESEARCH: To achieve the research goals within the mission of the Consortium, two general programmatic areas of research have been defined. These two areas were selected from many possible ones to focus upon key materials-related problems where unique capabilities exist within the Consortium. In addition to cooperative research programs in these areas, the Consortium encourages proposals for studies of new materials which can be expected to exhibit useful high-temperature superconductivity.

Area 1: New and Improved High T_c Superconducting Materials:

Phase Relations, Reactions, Synthesis and Processing

The development of high-temperature superconductors is contingent upon a thorough understanding of their material properties and of the processing variables that control these properties. Such properties include both thermodynamic and kinetic information about superconducting and normal-state phases. Processing variables encompass those necessary for optimizing synthesis and processing procedures for materials properties control. The Consortium supports investigation of these topics, as well as

studies pertaining to the fabrication and characterization of high-temperature superconducting composites, multilayers, modulated structures, thin films, and other novel structures of potential usefulness.

**Area 2: High T_c Superconductor Transport Properties:
Controlling/Limiting Factors**

Most proposed applications of high-temperature superconductors involve their ability to carry bulk supercurrents (e.g., wires, ribbons), to screen magnetic fields (e.g., enclosures, cavities), or to be components of electronic devices (e.g. sensors, magnetometers). All of these applications are contingent upon an understanding and control of transport properties. The Consortium supports research in this general area, including studies of weak links (both artificially produced, and naturally occurring, as by defects, grain boundaries and textures); dynamics (flux lattice pinning, melting, and related phenomena); and interfacial transport (such as that between grains, films, contacts, substrates, and coatings).

RESEARCH PROGRAM

Titles of the projects within the two principal research program areas are given in Appendix I, along with industrial affiliations of the principle investigators for each project. A major emphasis during the past year was to increase the number of affiliations with other organizations. Seven (7) out of twenty-six (26) projects now involve formalized working agreements. Those affiliations covered by formalized agreements are also indicated in Appendix I.

SELECTED RESEARCH HIGHLIGHTS

The following are selected research accomplishments by MISCON participants in the past year. These achievements provide an insight into some of the new and exciting areas of research in progress by MISCON participants. Formal affiliations are noted by an asterisk.

Area 1: New and Improved High T_c Superconducting Materials:

Phase Relations, Reactions, Synthesis and Processing

Low Temperature Routes to Processing of High-Temperature Superconductors

***David V. Baxter, Kenneth G. Caulton, and Malcolm H. Chisholm
Indiana University***

The objectives of this research are to:

- 1. elucidate the mechanisms through which molecular precursors are transformed into superconducting materials during the CVD process; and*
- 2. understand the extent to which molecular design may control the stoichiometry (including oxidation states) and morphology of high- T_c superconductors made through CVD or bulk processing.*

Over the last 6 months a series of Cu(II)hfac compounds derived from ethanolamines were prepared and their use as single source precursors for the CVD of Cu(m) or Cu-oxide films was investigated. The reaction between Cu(hfac)₂•H₂O and both 2-(dimethylamino)ethanol and triethanolamine lead to coordination of nitrogen to copper and proton transfer from the hydroxyl group

of the alcohol to hfac leading to amino alkoxide hfac $\text{Cu}(2+)$ complexes with loss of hfacH. The sterically less demanding 2-(dimethylamino) ethoxide yields a dimeric product while the more sterically demanding complex derived from triethanolamine is monomeric. With the exception of the triethanolamine derivative, all of the new compounds are volatile and sublime at 1 atm in the temperature range 136°-300°C and are liquid at 60°-80°C, which may allow their use as precursors in preference to the higher melting and less volatile $\text{Cu}(\text{hfac})_2\text{H}_2\text{O}$.

In our attempts to develop a single source precursor for the formation of bulk YBCO we have been studying our new molecule, $\text{BaCu}_2(\text{O}^t\text{Bu})_4$, which combines barium and copper. We have found that Et_3PO or Me_3NO bind to $\text{BaCu}_2(\text{O}^t\text{Bu})_4$ (normally insoluble) and solubilize it. This finding makes possible the processing of this precursor into oxides by thermolysis and hydrolysis methods.

Finally, we have begun an investigation of the effect of a plasma on the deposition of Cu-based films from $\text{Cu}(\text{hfac})_2$ using *in-situ* mass spectrometry. We find that even a remote plasma has a dramatic impact on the precursor causing it to fragment and yield poor (carbon containing) films. By inserting a grounded grid between the plasma and the precursor inlet we have been able to reduce the effect of the plasma and yet also reduce the substrate temperature needed to initiate reactions in the precursor.

Optical Studies of New 123- and 124- Materials

Meera Chandrasekhar

University of Missouri-Columbia

The objective of this project is to study three related families of materials using optical techniques:

- 1. the 124 materials $(\text{YPr})\text{Ba}_2\text{Cu}_4\text{O}_8$ and doped Y-124's;*
- 2. two new superconducting materials: $\text{YSr}_2\text{Cu}_{2.7}\text{Fe}_{0.3}\text{O}_{7-\delta}$ and $\text{YBa}_2\text{Cu}_{2.7}\text{Fe}_{0.3}\text{O}_{7-\delta}$ and*
- 3. quantum nanostructures of YBCO.*

A study of low temperature Raman scattering of Pr-doped Y-124's reveals a mixed mode behavior of these materials. In addition, the O- associated chain mode around 600 cm^{-1} is strongly enhanced in the Raman spectrum. While

most of the modes exhibit one-mode behavior, the O-chain mode exhibits two mode behavior not previously observed. Of particular interest in these materials is the apical oxygen mode ($\sim 500 \text{ cm}^{-1}$), which was shown to play a crucial role in the charge transfer between Y- and Pr-123 layers in Y/Pr superlattice structures and in the large frequency Raman scattering.

We have also studied samples of $\text{YBa}_2\text{Cu}_{4-y}\text{M}_y\text{O}_8$ where M is either Ni or Zn. In the Zn-doped materials (dopant concentration 0 to 25%), there is little change in the vibrational frequencies for either the in-plane, bridging oxygen or chain modes. The substitution of Zn into the planes appears to have little effect on the Cu-O plane modes at 340 and 438 cm^{-1} . In contrast, the Ni-doped samples showed a large shift of about 10 cm^{-1} over a doping range of 0 to 10% for one mode alone: the Cu chain mode at 260 cm^{-1} . The other modes remained unaffected by the substitution of Ni for Cu. We therefore conclude that the Ni substitutes preferentially in the chain sites.

Pressure dependent studies of Tl-2201 have shown anomalous dT_c/dP 's out to 44 kbar. T_c in this material changes rapidly under pressure when the pressure is changed at room temperature, while it changes about ten times slower if the pressure is changed at $\sim 50\text{K}$. The model that has been advanced is that the interstitial oxygens reorder when warm, but not when cold.

We have studied both Raman scattering and photoluminescence from CdS quantum dots grown by S. Bandyopadhyay, et. al. in order to observe quantum confinement, and will study quantum-confined YBCO when it becomes available.

***Investigations of Structure and Superconducting Properties
Relationships in Copper-free Bismuth Oxides***

J. Betanabhatla

University of Nebraska-Omaha

J.R. Hardy

University of Nebraska-Lincoln

R.R. Berliner

University of Missouri-Columbia

The objectives of this research are to :

1. *study the effects of annealing temperature and pressure on the crystal structure and superconducting properties of copper-free, bismuth oxide phases,*
2. *continue to explore new systems and compositions which show promise as high-temperature superconductors,*
3. *thoroughly characterize the structure and superconducting properties of these new materials to identify the superconducting phases.*

We have been able for the first time to demonstrate that superconductivity in the vicinity of 26K can be observed in tetragonal $\text{Ba}_{1+x-y}\text{K}_y\text{Ba}_{1-x}\text{O}_{3-\delta}$. We are now studying the effect of high pressure on elevating the superconducting transition further.

We have been investigating cation substitutions in stronthates and bismuthates in order to identify promising systems for the introduction of superconductivity and their effect on metal-insulator transitions. $\text{Ba}_2(\text{Bi}_{1.6}\text{Ba}_{0.4})\text{O}_z$ materials synthesized in air at 1100K crystallize in a double perovskite structure with two distinct Bi sites, whereas the one synthesized in argon at the same temperature crystallizes in a conventional perovskite structure with one Bi site. We believe that the difference in substitution of Ba for Bi in oxidizing and reducing conditions reflects on the stability of the charge density wave. We found that $\text{Ba}_2(\text{Bi}_{1.6}\text{A}_{0.4})\text{O}_z$ with A cations such as Ni, Cu, and Ag also crystallize in a conventional perovskite structure. Ni and Cu containing materials show a resistivity higher than that of normal material, whereas Ag substituted materials show almost metallic conductivity. The possibility that Ag^{+1} is twice as effective as Ni^{+2} in hole doping and/or the possibility that the doped holes are rendered itinerant due to complete breakdown of the charge density wave seem to be relevant to the understanding of the metal-insulator transition.

We have been able to synthesize pure $\text{PrBa}_2\text{Cu}_3\text{O}_{7-\delta}$ in order to understand the true effect of Pr substitution for barium on the superconductivity of "124" phase. Such an understanding can be significant to the use of this material as a buffer material in thin film device applications.

Hg- and Tl- Based Superconducting Films

S-H. Liou

University of Nebraska-Lincoln

The objectives of this project are:

- 1. to fabricate and characterize Tl- and Hg- based superconducting films, and*
- 2. to correlate the transport and microstructure properties of Tl- and Hg- based superconducting films.*

We have successfully fabricated (Hg,Tl)-Ba-Ca-Cu-O superconducting films with more than 80% $(\text{Hg,Tl})_1\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_{8+\delta}$ as determined by x-ray diffraction. The films grew epitaxially with the c-axis oriented perpendicular to the surface of the film. The films are very well connected as indicated by a low resistivity of the normal state. Films annealed in oxygen for 1 hour show a $T_c(\text{onset}) = 133\text{K}$ and $T_c(\text{zero}) = 127\text{K}$, determined from resistivity measurements. To the best of our knowledge, this is the first time that (Hg,Tl)-1223 films have been fabricated and is the highest T_c reported for a superconducting film.

(Hg,Tl)-1223 bulk superconductors have been fabricated with purity of up to 94% from a single step syntheses using BaO, CaO, CuO, HgO and Tl_2O_3 . Less than 6% of HgCaO_2 and Ca_xCuO_2 were found. The T_c 's of the as-sintered samples were about 120 K and increased to 133 K after annealing at 300°C for 1 hour in O_2 . The small differences of Hg and Tl contents in samples that were sintered at $830\text{-}880^\circ\text{C}$ did not effect the T_c much. Variations in oxygen contents, however, changed the T_c significantly.

***Microstructural Dependence of Critical Current Density in Melt Textured
YBa₂Cu₃O_{6+x} Superconductors***

Paul J. McGinn

University of Notre Dame

Plastronics, Inc.*

Superconductive Components, Inc.*

The goal for this project is to investigate the microstructural dependence of J_c in zone-melt-textured YBCO so as to optimize its microstructure and improve its properties and processibility.

Work on development of the SLMG ("solid-liquid melt growth") process has continued. Current work has shown that the properties of Y-123 suffer if the BaCuO₂ precursor is aged. We are examining low pO₂ thermal schedules to "rejuvenate" the BaCuO₂ and increase its reactivity.

In collaboration with Dr. Bhargava at the University of Queensland the effect of Y₂O₃ precursor particle size on 211 size and distribution is being examined. Nano-phase yttria produced by the sol-gel process is being compared with the more expensive, commercial, high-energy-milled powder.

The melt texturing of Y-123 samples in air with excess rare earth additions (Nd₂O₃, La₂O₃, and Sm₂O₃) showed improvements in both magnetization and T_c. The enhanced magnetization is thought to be due to point defect pinning effects caused by rare earth ions being present on Y³⁺ and/or Ba²⁺ sites in the 123 lattice. A more recent examination of Nd-123 additions shows a different behavior than with Nd₂O₃ additions. A specially developed liquid extraction technique revealed that the Nd-123 dissolves more rapidly in the melt than Nd₂O₃, which will affect the extent of substitution of Nd in the 123 phase.

A 3-dimensional computer model of 211 track structures in 123 domains has successfully generated all of the 2-dimensional track structures reported in the literature for polished samples of melt-textured Y-123.

***Processing of Textured Superconducting Oxide/Noble Metal
Microlaminates***

Ken H. Sandhage

The Ohio State University

Paul J. McGinn

University of Notre Dame

Intermagnetics General Corporation*

Plastronics, Inc.*

Ribbon Technology Corporation*

The objective of this research is to produce fracture-tough, high J_c superconducting composites consisting of thin layers of superconducting oxide alternating with thin layers of noble metal.

Previous work has demonstrated that selective external oxidation and post-oxidation annealing can be used to transform mechanically-alloyed, hot rolled metallic precursors into noble-metal-bearing composites containing thin layers of $\text{YBa}_2\text{Cu}_3\text{O}_y$. A new method has been developed for fabricating $\text{YBa}_2\text{Cu}_3\text{O}_y$ /noble metal microlaminates which takes advantage of the malleability of mixtures of Y and Ba powders. Y-Ba powder packed between an inner ingot of Ag-Cu and an outer tube of Ag can be rolled to form a geometrically uniform Y-Ba inner layer, which when oxidized forms $\text{YBa}_2\text{Cu}_3\text{O}_y$ by the concurrent diffusion of Cu from the Ag-Cu core. Efforts to reduce Y-Ba layer thickness to less than 40 microns in order to yield very thin layers of superconductive oxide are underway.

Under an augmentation grant with Plastronics, Inc., the texturing of Ag-Pd-clad $\text{YBa}_2\text{Cu}_3\text{O}_y$ wires by low $p\text{O}_2$ zone melting is being studied. Three difficulties have been encountered: (a) the occurrence of a porous pipe down the center of the textured wires due to the densification of the $\text{YBa}_2\text{Cu}_3\text{O}_y$ core during melting, (b) the reduction of the thermal gradient during zone melting because of the high thermal conductivity of the relatively thick Ag-Pd cladding and (c) liquid flow down the wire due to the temperature gradient which aggravates porosity problems. Corrective strategies to alleviate these problems are under study.

**Anisotropic Grain Growth and Isothermal Grain Alignment of Bulk,
Superconducting Oxides**

Ken H. Sandhage

The Ohio State University

Superconductive Components, Inc.*

The current goals of this program are to develop a better understanding of:

- 1. the influence of solid-state decomposition and reformation reactions on grain growth and grain alignment in bulk Bi(Pb)-Sr-Ca-Cu-O superconductors and*
- 2. grain growth in bulk, solid solution $Nd_{1+x}Ba_{2-x}Cu_3O_y$ superconductors.*

Further work is being conducted with silver-sheathed $Bi_2Sr_2Ca_1Cu_2O_{8\pm\delta}$ tapes to obtain aligned grains through the use of solid state heat treatments involving elevated oxygen pressures. After a two-step heat treatment, resulting in an enhanced c-axis alignment of a reformed 2212 phase, the density of the oxide core is further increased by uniaxially pressing the tapes and then annealing them at 860°C in pure, flowing oxygen at ambient pressure. The critical current densities of tapes processed in this fashion are being evaluated under a collaboration with American Superconductor Corporation.

Work is also proceeding on the processing of $Bi_2Sr_2Ca_1Cu_2O_{8\pm\delta}$ thick films. Spin coating is being used to apply metallo-organic solutions onto MgO substrates. Solution chemistry, spin coating conditions, and heat treatments are being optimized to yield films of uniform thickness for subsequent high-oxygen pressure heat treatments.

Further progress has been made in evaluating the effect of cation non-stoichiometry on the grain growth of $Nd_{1+x}Ba_{2-x}Cu_3O_y$ ($x \leq 0.4$). Annealing for 48 hours at 938°C revealed that the average grain areas of the specimens increased in the order $Nd_{1.1}Ba_{1.9}Cu_3O_y > Nd_{1.2}Ba_{1.8}Cu_3O_y > Nd_{1.3}Ba_{1.7}Cu_3O_y$ (average grain areas were $149.5\mu m^2$, $42.3\mu m^2$, and $3.6\mu m^2$, respectively). Dense bars cut from coarse-grained pellets of these materials will be fractured in-situ within a scanning Auger microprobe at Case Western Reserve University to evaluate their average grain boundary composition.

***The Influence of Oxygen Pressure and Temperature on Oxygen
Stoichiometry***

and Phase Equilibria in the System Bi-Sr-Ca-Cu-O

David Gaskell

Purdue University

The purpose of this project is to conduct a comprehensive study of the influence of oxygen pressure and temperature on the phase equilibrium and distribution of Ca and Sr between equilibrated phases in the system Bi-Sr-Ca-Cu-O.

The oxygen nonstoichiometries and phase stability diagrams for 2212 and 2223 phases in the system Bi-Sr-Ca-Cu-O are being determined by thermogravimetric analysis, electron microprobe analysis, and x-ray diffraction. Although single-phase specimens of 2212 had previously been made with ease, attempts to produce phase-pure 2223 in air or by means of the solid state reaction between Bi_2CuO_4 and $(\text{SrCa})_2\text{CuO}_3$ were not successful. However, when two-phase powders were pressed and sintered in an atmosphere of 12% O_2 at 865°C for 23 hours the specimen transformed to virtually phase-pure 2223 as determined by x-ray diffraction.

The ability to produce phase-pure 2212 and 2223 now permits studying the influence of oxygen pressure and temperature on the oxygen nonstoichiometries and phase stabilities of these compounds. The influence of oxygen pressure and temperature on the partitioning of Ca and Sr between equilibrated 2212-2223 couples will also be studied.

***Effect of Substitutions on Superconducting Properties
of High T_c Materials***

J.M. Honig and J. Spalek

Purdue University

Two questions are being addressed by this project:

- 1. What is the influence on T_c of Ni substitutions for Cu as a function of the Sr concentration in $\text{La}_{2-x}\text{Sr}_x\text{Cu}_{1-y}\text{Ni}_y\text{O}_{4+\delta}$?; and*
- 2. What are the electron states and real space pairing of a statistical spin liquid (SSL) in which double occupancies of the same quasiparticle level are not allowed?*

Work recently completed shows that fluorination leads to significant improvements in the superconducting properties of the La-Sr-Cu-O system. For example the Meissner exclusion for compounds with $x > 0.055$ was significantly enhanced by fluorination. The results imply that fluorination could benefit materials of still higher transition temperatures.

In a separate investigation, it was confirmed that La_2NiO_4 and its Sr-doped derivatives did show signs of superconductivity, as originally proposed. The work is of interest because it shows that lanthanum nickelates containing minor phases of related composition do exhibit properties that have so far been assigned to cuprates in the temperature range above 25K.

Work has been initiated on the ac response of YBCO superconductors in the range up to 13 MHz for which little is known. Recently completed experiments of the real and imaginary parts of the dielectric constants for $\text{Nd}_{1-x}\text{Pr}_x\text{Ba}_2\text{Cu}_3\text{O}_7$ shows dispersion at frequencies above 0.1 MHz in the range 94 to 200K. Cole-Cole plots do not exhibit significant contributions from grain boundaries.

We have formulated a quantitative 3-dimensional model of a high-temperature superconductor as a non-Fermi liquid which is applicable to both mono- and multilayer systems. Explicit calculations of the transition temperature and spatial modulation of the order parameter showed excellent agreement with experiment. The derived formula allows for the prediction of the T_c value within a given family for the number of CuO_2 layers in the group not studied so far experimentally. We have also provided an upper limit of the T_c value for a large number of the CuO_2 planes in the group.

Under a separate effort we have demonstrated that the statistical properties of a non-Fermi liquid differ in some respects from those of an ordinary metal. For example, the overall volume enclosed by the Fermi surface for the Luttinger liquid may be identical with that for the Fermi liquid, but the shape of the photoemission spectrum differs markedly from that for ordinary metals due to the so-called spin-charge separation. We strongly believe that this new approach is needed for a proper description of high-temperature superconductors as two-dimensional metals in the normal phase ($T > T_c$).

Structural Defects and Interfaces in $\text{YBa}_2\text{Cu}_3\text{O}_7$

E.P. Kvam and J.E. Angelo

Purdue University

The objectives of this project are to:

- 1. examine the microstructure, and in particular, the extended defect and intercrystalline boundary structures of textured bulk polycrystals and epitaxial thin films (including bicrystals) of YBCO; and*
- 2. correlate these microstructural aspects with transport property characteristics.*

Recent studies have been made of two series of epitaxial thin films. The first series was $\text{YBa}_2\text{Cu}_3\text{O}_7$ grown by laser ablation on near-(110) oriented (vicinal) SrTiO_3 substrates and the second was $\text{DyBa}_2\text{Cu}_3\text{O}_7$ grown by MBE on (110) SrTiO_3 substrates. In the first series, it was possible for the first time to grow biaxially aligned films with distinctly different in-plane directions by inclining the surface of the substrate 2° or more about the in-plane [001] direction. The films were of high quality and had only small, well-dispersed defective regions which might be associated with pinning sites.

The MBE grown films of $\text{DyBa}_2\text{Cu}_3\text{O}_7$ showed large regions without misfit dislocations, even though threading dislocations were abundant. This showed that strain relaxation by dislocation motion did not take place. Thus, the ability to controllably adjust T_c by selecting substrates that can give positive or negative strains is a real possibility for these types of films. The near-interface quality of the MBE-grown DBCO films was also far better than any we have seen for the YBCO ablation-grown materials.

Solid/liquid melt growth (SLMG) bulk textured YBCO (123) materials prepared by Paul McGinn at the University of Notre Dame were examined by scanning and transmission microscopy. An unexpected aspect of this growth process was that coarsening of the 211 phase by increasing the hold time in the liquid/211 two-phase state actually improved flux pinning. These coarsened materials had notably higher dislocation densities as the holding time was increased. Again, as in our previous studies, the increase in critical current density was directly associated with an increase in dislocation density.

High Temperature Superconducting Tubes for Magnetic Shielding Applications

K.P. Trumble, K.J. Bowman and M.W. McElfresh

Purdue University

IBM Thomas J. Watson Research Center*

Quantum Magnetism/Quantum Design*

The objectives of this research project are to:

- 1. develop processes for fabricating superconducting shield tubes;*
- 2. characterize the texture and properties of the processed tubes; and*
- 3. investigate the effects of annealing conditions on the superconducting properties of BSCCO-silver composites.*

In the third year of this research project a new process for cold isostatic pressing (CIP) of centrifugally slip cast BSCCO tubes was developed, enabling studies on the effects of green density and orientation on microstructural development and magnetic shielding performance. This process yielded significant densification without cracking. Whereas significant grain growth occurred in centrifugally slip cast (CSC) bodies, such grain growth appeared to be inhibited by tighter packing of the BSCCO particles in the CSC-CIP bodies. The higher density of the CSC-CIP tubes is also thought to be responsible for higher trapped fields (5-10 Gauss compared with 1-2 Gauss) and higher critical currents (up to 31,000 A/m² compared with up to 12,000 A/m²) for the CSC-CIP and CSC tubes, respectively.

Initial studies of BSCCO-silver interactions supporting the silver-clad BSCCO tube work have been extended to produce BSCCO-silver composites via *in-situ* colloidal deposition of Ag on suspended BSCCO platelets. A study of interface reactions between silver and BSCCO indicate a decomposition reaction, producing a needle-shaped phase and at least one liquid phase. The needle phase is rich in Sr and Bi and the liquid phase consists primarily of Ca with small amounts of Sr and Bi. These results have been used to construct a phase stability diagram for the thermal decomposition of BSCCO-2223.

Recent measurements of the magnetic phase diagram for CSC BSCCO tube materials show similarities to the same basic phase diagram determined for YBCO polycrystals. It appears that the shielding of the individual grains has a large impact on reducing the J_c of polycrystalline materials.

**Processing and Texture Development in
YBa₂Cu₃O_{7-δ} Films**

G. L. Liedl and Arden L. Bement, Jr.

Purdue University

AT&T Bell Labs*

TRW Superconductivity Research*

The primary objectives of this project are to:

- 1. understand the processing steps involved in the formation of a film from metallo-organic precursors;*
- 2. control the chemistry and microstructure of the film relative to the substrate; and*
- 3. optimize the conditions for the best set of properties to be utilized in applications requiring the superconductivity behavior of the material.*

The metallo-organic deposition (MOD) process has been successfully used to form continuous films of YBCO on single crystal substrates of MgO and SrTiO₃. Film thicknesses of 1 to 2 μm were achieved by multilayering up to 20 layers. The individual layers were pyrolyzed at 500°C for 5 min and the final firing of the multilayer was by rapid thermal processing at varying temperatures ranging from 870° to 980°C in flowing oxygen or oxygen/argon atmosphere.

Characterization of the films revealed that Y-deficient precursors result in the formation of BaCuO₂ and CuO as secondary phases. However, Y-rich precursors yield Y₂BaCuO as a secondary phase, which is believed to be beneficial for achieving higher current density.

The development of three-dimensional texture in the MOD YBCO films on (100) MgO and (100) SrTiO₃ substrates was affected by such process parameters as film thickness, firing treatment, and substrate surface characteristics. Preferred orientation in these films was observed to deteriorate with increasing thickness. Furthermore, lattice- matched SrTiO₃ substrates promoted epitaxial growth in MOD YBCO films at substantially lower firing temperatures than lattice mis-matched MgO substrates. Epitaxy in the films developed by the epitaxial grain growth mechanism, and film orientation was sensitively affected by the interrelationships among grain boundary, surface and interfacial energies. Our results to date have provided us an improved

understanding of the mechanisms of film growth from liquid precursors. Work is continuing to apply MOD processing techniques to other HTSC materials and to hybrid films involving superconductors.

**Area 2: High T_c Superconductor Transport Properties:
Controlling/Limiting Factors**

***Statistical Mechanics of High T_c Superconductors
and Flux Line Liquids***

***A.H. McDonald and S.M. Girvin
Indiana University***

The principle objective of this project is to study the statistical mechanics and transport properties of the mixed state of disordered superconductors centered on two modeling efforts:

- 1. modeling the dependence of the existence of a vortex glass state on dimensionality, and*
- 2. performing studies of Ginzburg-Landau models with random-pinning disorder.*

We have completed work on a Monte Carlo study of the Lawrence-Doniach model for layered superconductors in a strong magnetic field. We have found a first-order melting transition from a three-dimensional vortex-solid state to a vortex liquid state. From the Monte Carlo simulations we construct a universal phase diagram in terms of dimensionless intra-layer and inter-layer couplings which can, for a particular material, be converted into a melting phase diagram in the (H,T) plane using measurable parameters of that material. The latent heat and magnetization jump along the phase boundary are also expressed in terms of measurable parameters of real materials.

We have also developed a technique for determining the absolute time scales for relaxation dynamics near the vortex glass transition. The only input needed is the measured DC resistivity and the current density scale at which non-linear response sets in. Knowledge of the absolute time scale allows the experimentalist to predict the scale of frequency needed to see deviations from the DC response.

We have initiated a program of research to clarify fundamental questions concerning the technologically important "irreversibility line" of type II superconductors in a strong magnetic field. We are interested, for example, in understanding the relationship between the vortex-lattice melting transition in a homogeneous superconductor and the putative "vortex-glass" transition at the irreversibility line.

Polarized Neutron Reflectivity Studies of HTC Superconductors

P.F. Micelli

University of Missouri-Columbia

The purpose of this project is to study the physical properties of flux lines as well as the temperature dependence of the London penetration depth in high T_c superconductors using polarized neutron reflectivity.

To date our studies have centered on the technical infrastructure necessary for neutron reflectivity studies. This includes construction of low-temperature cryostats, magnets, and polarized neutron-beam instrumentation, as well as x-ray reflectivity studies of HTC films to characterize the surface roughness which will be important in the context of our neutron measurements. A specially-designed instrument which permits neutron reflectivity experiments to be performed at low (and variable) temperatures while the sample is in a magnetic field is being constructed and will be delivered near the end of 1995. A second cryostat system is being built which will allow similar operations using an electromagnet for low magnetic field experiments (between 10 and 2000 Gauss).

By employing an x-ray beam of extremely high collimation (angular divergence $< 0.003^\circ$), which dramatically suppresses diffuse scattering, we have studied Pb/YBCO which is used for tunneling experiments by Prof. L.H. Greene's group at UIUC. We have been able to resolve the Pb/air interface roughness of $80 \pm 10 \text{ \AA}$ and the Pb/YBCO interface roughness of $50 \pm 10 \text{ \AA}$. The results indicate significant Pb and YBCO interdiffusion, which is the primary mechanism of junction degradation.

Since our proposed studies of the London penetration depth requires good quality surfaces, we set out to examine the surface roughness of YBCO films deposited on SrTiO₃ substrates. We observed a large surface roughness

(60Å rms, which is ~2% of the film thickness) at the YBCO/air interface. In spite of this, we were able to measure excellent reflectivity curves that are suitable for neutron reflectivity studies. We also observed the presence of an additional thin layer (~40Å) at the film/substrate interface that differs only slightly in composition from YBCO.

Neutron Diffraction and Defect Studies of High T_c Superconductors

W.B. Yelon and J.W. Farmer

University of Missouri-Columbia

The goals of this project are:

- 1. pursue studies of complex high T_c oxide systems in collaboration with leading investigators using neutron diffraction; and*
- 2. understand enhancements in critical current density induced by neutron irradiation.*

Structural studies of $\text{PrBa}_2\text{Fe}_3\text{O}_8$, which has a structure similar to the R123 compounds, but with the basal plane oxygen sites fully occupied, suggest partial occupancy of an additional oxygen site in the Pr plane. That observation suggests that the rapid suppression of T_c in Fe-doped R123 may be due to structural distortions accompanying the Fe doping through the addition of extra oxygen and not necessarily through the magnetic effects of the Fe atoms directly. Magnetic ordering in this compound is quite different from that seen in the Y-analog.

We have compared low field, low temperature flux creep data in as-grown Y123 crystals to the various collective pinning theories. We find that while these theories all predict a pinning potential $U(j) \propto j^{-\mu}$, only Nattermann's theory of collective pinning yields reasonable values for physical parameters. The agreement between theory and experiment in this region of phase space provides a framework for understanding the role of engineered defects in flux pinning.

***Microwave and Optical Studies of High-Temperature Superconductors:
Flux-Lattice Dynamics, Crystal Anisotropy, Flux Pinning and
Photo-Modulated Superconductivity***

H.A. Blackstead

University of Notre Dame

This project studies transport properties of high-temperature superconductors, in particular field-induced changes in the microwave resistance, to derive information on flux-lattice dynamics, crystal anisotropy and flux pinning.

We have identified a "Josephson-vortex resonance" in $Y_{1-x}Pr_xBa_2Cu_3O_7$. This resonance is observed when the applied field is rotated to an orientation parallel to the a-b plane of the sample. To the best of our knowledge, this is the first time dissipation from Josephson vortices has been demonstrated in a HTSC material. Our experiments have demonstrated that these vortices can have an enormous effect on the electromagnetic properties of this layered superconductor.

In cooperation with J. Betanabhatla, we have been studying the impact of Ni and Zn doping of Y124, a material which is very similar to Y123, but which has two Cu-O chains per formula unit as opposed to only one for Y123. The most recent results for Ni and Zn substitution in Y123 show the depression of T_c by these two ions to be almost identical, with $u_c \cong 0.33$ (where u_c is the critical concentration of the impurity that drives T_c to zero). In contrast, we find for Y124 that $u_c(Ni) = 0.29$, while $u_c(Zn) = 0.13$. While the Y124 results are consistent with the spin-fluctuation model, the results for Y123 are consistent with neither this model or the t-J model. The issue of relevance to understanding these data is to know precisely the distribution of impurity ions in the chains and planes.

We have studied the granular aspects of HTSC on a sequence of $Sm_{2-x}Ce_xCuO_4$ samples provided by R.F. Jardim, Universidade de São Paulo. These samples exhibit two resistive transitions; the transition at the highest temperature marks the onset of superconductivity, while the second transition at several degrees lower is attributed to the linking up of superconducting granules to a bulk superconducting state. Our microwave experiments carried out as a function of temperature and applied field conclusively demonstrate that the first transition is a superconducting transition. We also find that the

granule size has an impact on the temperature for which field dissipation is first observed, providing a way to determine the sizes of superconducting granules. We believe that all HTSC materials have two transitions of this type.

In electron spin resonance experiments with several samples of Pr123 which are free from rare earth or Y contamination to ppm levels, we have observed granular superconductivity in both films and bulk samples. We have also just obtained evidence that bulk Pr123 exhibits a semiconducting to metallic transition as the temperature is lowered. These granular materials do not exhibit a bulk Meissner effect, since no percolative path develops. These results are consistent with the B-D model which predicts that superconductivity in Pr123 will be inhomogeneous, and most likely granular in character.

Superconducting Quantum Structures

A.E. Miller and S. Bandyopadhyay

University of Notre Dame

Lake Shore Cryotronics*

The objective of this project is to study the interplay of superconductivity with quantum confinement by electrodepositing a quasi-periodic array of superconducting quantum dots embedded in an insulating matrix.

Thin films of YBCO have been successfully electrodeposited on Ag from an organic flux developed by us. The resulting film has been heat treated in flowing oxygen at 900°C and the resulting stoichiometry has been verified by ESCA. Microwave measurements of the surface resistance of the film has been carried out by H. A. Blackstead. It shows a slightly depressed transition temperature of 88K. The next step is to electrodeposit YBCO selectively within the pores in porous alumina.

Giant magnetoresistance has been observed in a structure consisting of a quasi-periodic array of ferromagnetic quantum dots electrodeposited in alumina pores and then covered with a thin film of copper. The same technique can presumably be used to monitor superconducting transitions in superconducting dots of average diameter ~10 nm and total mass < 1 picogram.

Transport Properties of YBCO Thin Films

S.T. Ruggiero

University of Notre Dame

HYPRES, Inc.*

Jet Propulsion Laboratory*

NIST-Boulder, CO*

Wright Patterson Air Force Base*

The objective of this project is to understand and control the electronic properties of YBCO thin films; in particular, to:

- 1. obtain and study a system with adjustable transport properties,
and*
- 2. study the far-infrared response in such a system as a function of J_C (or intergrain weak-link coupling).*

We have achieved control of J_C in YBCO using Ag underlayers and have identified a narrow Ag underlayer thickness regime with locally enhanced critical currents. While YBCO deposited on Ag layers exhibits an increase in resistivity, there appears to be no systematic reduction in resistivity with Ag thickness. Also, T_C remains unaffected by Ag underlayer thickness. Along with resistivity, critical current is significantly affected by Ag thickness. The critical current decreases with Ag thickness, and at about 9 nm is close to the value for YBCO deposited on bulk Ag. This is consistent with the expectation that complete Ag coverage of the substrate occurs in the vicinity of this thickness. Although there appears to be a real increase in J_C in the vicinity of 7-8 nm, the origin of this increase is unclear.

We have made the first measurement of YBCO weak-link response to 25m (far infrared) radiation. The result is a voltage response from the sample with a rise time comparable to the 200ps rise of the laser current. Work in progress is to map out the magnitude of the response as a function of J_C (or Ag underlayer thickness in YBCO/Ag systems) and bias current.

High T_c Superconducting Composites, Arrays and Crystals

J.C. Garland

The Ohio State University

The objectives of this project are to:

- 1. develop high- T_c machiable Ag/YBCO composites with superconducting fractions ranging from 10-100 percent;*
- 2. develop high- T_c Ag/TBCO weak links and fabricate two-dimensional (2D) Josephson Junction Arrays; and*
- 3. prepare BSCCO single crystals and understand the effects of interplane vortex interactions.*

An analysis of the measured dc magnetization curves of YBa₂Cu₃O₇/Ag composite samples showed that all samples with superconductor volume fractions $0.35 < p < 1.0$ exhibited bulk behavior and excluded small external magnetic fields ($H_{cIJ} < 20$ Oe) at low temperatures ($T < 80$ K). The results for composite samples with superconductor volume fractions $0.7 < p < 1.0$ showed that the "resistively-shunted" inter-grain Josephson coupling gives rise to flux penetration fields H_{cIJ} and critical current densities J_c which are generally higher than those of the pure YBa₂Cu₃O₇ bulk samples.

Large, high- T_c YBa₂Cu₃O₇/Ag weak link arrays (300 x 300) with improved thermal stability and with reproducible characteristics have been fabricated and tested. Although the first array sample, which was fabricated using a modified procedure, showed a broader-than-expected Kosterlitz-Thouless-type transition, its transport properties were reproducible after thermal cycling. Magneto-resistance curves taken in small external magnetic fields ($H < 10$ Oe) also displayed structures that were stable against cycling.

An extensive sample preparation procedure has been developed to attach eight gold wire electrodes to small, high-quality BSCCO single crystals (~ 1.0 mm x 0.5 mm x 5.0 μ m) for transport measurements. The method, which combines crystal cleaving, photolithography and argon-ion etching techniques, produces BSCCO samples that are ideally suited for studying the vortex glass phase in a layered system where the number of Josephson-coupled Cu-O bilayers can be varied. Preliminary results show that the transport properties of the crystals are highly anisotropic with $V_{ab} \gg V_s$ below the transition temperature. This result is consistent with a previous finding by Safar et. al.

indicating that the vortex system in BSCCO is essentially two-dimensional over a large portion of the magnetic phase diagram.

Atomic Beam Studies of Vortex Lattices at Superconductor Surfaces

G. Lafyatis

The Ohio State University

The long-term goals of this project are to measure vortex correlation functions at the surface of superconductors by developing a new atomic beam technique and to use this technique to study the behavior of the vortex lattice in high- T_c materials.

The basic idea of our technique is that as an atom passes over a flux lattice, it feels an oscillating magnetic field whose component frequencies are given by the velocity of the atom divided by the various spatial periodicities of the lattice. If one of the frequencies coincides with that of an atomic hyperfine magnetic resonance transition, the transition is driven.

Presently, we are making fundamental studies of vortex lattices in high quality YBCO samples. The samples are large (~2 mm x 1.5 mm x 0.05 mm) twin-free single crystals that we grow and detwin ourselves. To date we have measured vortex lattices for fields applied perpendicular to the sample's c-axis and also for tilted fields.

We have performed the first study of temperature-driven dynamics in the vortex lattice chain state of our YBCO. We observe a decreasing of the interchain spacing with increasing temperature that is quantitatively consistent with predictions of the anisotropic London model. We also observe the freezing in and melting of the chains as the temperature is lowered and raised. Finally, we see a hysteresis between the freezing and melting.

Device-Related Properties of Doped $\text{YBa}_2(\text{Cu}_{1-x}\text{Mx})_3\text{O}_{7-\delta}$

T.R. Lemberger

The Ohio State University

Superconductive Components, Inc.*

The objective of this project is to understand how the transport properties of high- T_c superconductors can be controlled by atomic substitutions, and to exploit this knowledge in fundamental and applied experiments.

We have discovered a major puzzle. The T-linear term that thermal phase fluctuations contribute to the temperature dependence of the penetration depth, $\lambda(T)$, at low temperatures is much smaller than predicted by three recent theoretical models. Another result from our data is that the T-linear behavior found in some very clean YBCO crystals and films must come from nodes in the order parameter and not from thermal fluctuations as has been suggested.

We have made what we believe to be the first observation of two superconducting transitions in $\lambda(T)$ in a multilayer superconductor. This was done in a film consisting of several alternating layers of Bi2201 and Bi2278, each layer about 23 Å thick, made by Eckstein and Bozovic at the Ginzton Laboratory of the Varian Corp. We were able to determine the density of superconducting electrons in each layer and show that the carriers in the Bi2278 layer reside primarily at its interface with the Bi2201. We observed that the proximity effect between the two layers increases the transition temperature of the Bi2201 layer from 20K to 40K.

NMR Studies of Vortex Dynamics in High T_c Superconductors

C. Pennington

The Ohio State University

The objective of this project is to make NMR measurements on several high T_c samples with the goal of finding situations favorable to the detection and characterization of vortex motion.

We have calculated, with no adjustable parameters, the ^{89}Y transverse relaxation (T_2) contribution in YBCO which results from the ^{89}Y - $^{63,65}\text{Cu}$ magnetic dipole interaction. This relaxation mechanism fully explains normal

state data. By dividing out this known relaxation contribution, we can assess the contribution solely from vortex dynamics, thus making ^{89}Y NMR a highly sensitive and accurate probe of vortex dynamics alone. We find that vortex contributions are present only below the temperature at which the resistance reaches zero (the "irreversibility line"), which is 76K in our 9 Tesla field.

We also measured, for one single crystal of YBCO in a 9 Tesla field (parallel to the crystal c axis), resistivity and ^{63}Cu NMR linewidth as functions of temperature. The ^{63}Cu NMR linewidth does not exceed its normal state value until the temperature is reduced below 76K, the temperature at which the resistance fully reaches zero. Below that temperature the linewidth is in agreement with predictions based on measured penetration depths. These observations indicate motional narrowing of the ^{63}Cu linewidth within the resistive transition region, consistent with a vortex liquid state. The motional narrowing condition implies a lower limit on the vortex diffusion coefficient, and, in conjunction with the resistivity and the Einstein relation $D=\mu KT$, an upper limit on the length scale ($\sim 40\text{nm}$) over which vortex motion is highly correlated.

Dynamical Properties of Josephson-coupled Systems: Application to High-Temperature Superconductors

D.G. Stroud

The Ohio State University

This project is intended to study the structures of various high T_c superconductors, their defects, the correlations between their defects and physical properties, and the control of these defects.

We have successfully carried out the first calculation of the fluctuation magnetization in a high- T_c superconductor (in this case YBCO) in excellent agreement with experiment. We also obtained excellent agreement with the experimental melting curve, and the first calculation of the heat of melting at the flux lattice melting temperature. The calculation is based on a model of Josephson-coupled superconducting layers, each of which is treated in the Lowest Landau Level Approximation. This result is important because it shows that we now have an excellent description of the thermodynamics of flux motion in high- T_c superconductors, especially at high fields.

Using both Monte Carlo and Langevin techniques, we are now calculating a number of experimentally accessible quantities for YBCO. These include the melting curve, the probability distribution of local magnetic fields, and the structure factor in both the liquid and solid phases. We have also confirmed directly, by obtaining the location of the vortices in the presence of the point pins, that the superconducting phase in the presence of point pins really has a glassy structure.

Transport Properties of High T_c Superconductors

G.F. Giuliani

Purdue University

The objectives of this project are to:

- 1. advance the theory of Josephson junctions and the flux dynamics in Type-II superconductors; and*
- 2. characterize the transport properties of artificially manufactured Josephson junctions as a means of better understanding the Josephson effect in layered superconducting structures.*

In collaboration with the McElfresh group, we have developed a theory that provides a microscopic understanding for the interesting effect observed in the critical current as a function of the magnetic field in polycrystalline YBCO samples. The phenomenon is similar to the so-called "fish tail" effect and is related to the dependence of the critical current on the magnetization of the system.

We have recently made substantial progress on a general theory of inhomogeneous Josephson junctions. In particular, we have proposed an exact mapping between the sine-Gordon theory underlying the behavior of a long inhomogeneous Josephson junction and the well-known results of Anderson's localization theory. This has allowed us to provide an understanding for a number of dynamical properties of these junctions. As it turns out a number of possible situations are possible depending on the choice of boundary conditions; i.e., of the measured versus applied quantities in a given experiment.

We have made considerable progress in understanding the effects of inelastic barrier scattering on the critical current I_c of a S-I-S Josephson

junction. In our model the tunneling electrons suffer inelastic scattering due to the presence of thermal phonons in the barrier. This leads to peculiar non-linear effects on the Josephson tunneling rate and consequently on the critical current of the junction.

We have extended our previous leading order study to all orders. We find that the interesting non-monotonic behavior of I_c as a function of temperature appearing in the lowest order analysis, is in fact preserved in the full calculation. The theory predicts that in suitable situations the inelastic scattering can enhance the pair tunneling and lead to a corresponding maximum in the critical current.

Study of Vortex Dynamics and Flux Pinning on Different Length Scales

M. W. McElfresh and E. P. Kvam

Purdue University

American Superconductor Corporation*

DuPont Superconductivity*

IBM Thomas J. Watson Research Center*

Keithley Instruments*

Lake Shore Cryotronics, Inc.*

Quantum Design*

Weizmann Institute*

The purpose of this project is to better understand the distribution of electric currents and the factors influencing critical current densities in films of superconducting YBCO and other Bi- and Tl- based CuO superconductors.

We have shown that the critical scaling coefficients at the vortex-glass transition do not change with the oxygen deficiency δ . We also observed a point in the vortex-glass transition phase boundary in which there was a change in the temperature dependence. We were able to show that this point corresponds to the dimensional crossover field H_0 for YBCO and that H_0 is a function of δ .

We went on to demonstrate that there is a single universal phase diagram for YBCO. Individual phase diagrams (for different δ) can be collapsed onto a single universal diagram by scaling with the dimensional crossover field. The temperature associated with the dimensional crossover field is $\sim 0.5 T_c$ for

YBCO and $\sim 0.6 T_c$ for Tl-2212. These phase diagrams are useful for determining technologically useful areas for superconductor applications and possible strategies for optimizing properties.

In collaboration with Eli Zeldov and John Clem we have shown both experimentally and theoretically, how the demagnetization effects modify the relaxation of magnetic flux in strong pinning superconductors. Using a microscopic Hall sensor the local field was monitored allowing us to infer the changes in current distribution. The distribution of currents is quite different from that expected from the standard Bean Critical State model and as a result the relaxation behavior is different from the expected behavior.

Vortices in Anisotropic Superconductors

P. Muzikar

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The objectives of this project are to study vortex lattices and their instabilities in an effort to find minimum energy configurations and to study the pinning of a vortex line to a defect in a two-dimensional superconducting sheet.

We have continued our work on the penetration depth and its dependence on impurity scattering. In our work, we considered a metal with a fully three dimensional, ellipsoidal Fermi surface. The superfluid density is thus not isotropic for several reasons: (a) the Fermi surface is anisotropic and (b) the order parameter can have complex angular structure in $\mathbf{k}$ -space. We computed and compared the superfluid tensor for two different types of order parameter: (a) a generalized s-wave, in which the magnitude (but not the sign) varies as a function of $\mathbf{k}$ and (b) a d-wave order parameter with the same absolute magnitude as the s-wave but with sign variations.

The two key results are that (a) the anisotropy can be very useful in distinguishing between d-wave order parameters and anisotropic s-wave parameters and (b) for certain types of order parameters the addition of impurity scattering can actually increase the superfluid density in certain directions.

In the current debate over the symmetry of Cooper pairs, a new type of order parameter has emerged as a candidate: it seems that a large fraction of experimental data can be explained if the gap function has the symmetry of the

crystal, but changes sign on the Fermi surface. This sign change means that the net angular average of the order parameter is somewhat reduced, but is not necessarily zero. We have recently computed the density of states for such a situation. In the absence of impurities, the density of states has the usual BCS form with a gap in the spectrum. As impurities are added, the number of low lying states increases and the superconductor eventually becomes gapless. As the density of impurities increases still further, however, a surprising development occurs: the gap in the spectrum is restored. Finally, as the impurity scattering time becomes shorter and shorter, the density of states approaches the usual pure limit BCS form, but with a renormalized gap.

MISCON TALKS and PRESENTATIONS

January 1995 - December 1995

1. "Anisotropic Transport and Superconductivity in Metal/Semiconductor Multilayers", **David V. Baxter**, University of Nebraska, April 28, 1995.
2. "The Mechanistic Role of Water and the Ligand in the Chemical Vapor Deposition of Cu, Cu₂O, and Cu₃N From Bis-(1,1,1,5,5,5-Hexafluoropentane-2,4-Dionato) Copper (II)", **David V. Baxter**, Jiri Pinkas, **Malcolm H. Chisholm**, and **Kenneth G. Caulton**, MRS Spring Mtg., April 17-21, 1995.
3. "Molecular Routes to Metal-oxides, -nitrides, and -carbides", **M. H. Chisholm**, National University of Mexico, Mexico City, November 1995.
4. "Mechanistic Role of H₂O and the Ligand in the CVD of Bis (hexafluoropentane-2,4-dionato) Copper(II)", J. Pinkas, **M. H. Chisholm**, **K. G. Caulton**, and **D. V. Baxter**, 210th ACS National Mtg., Anaheim, CA, April 1995.
5. "Thermodynamics of Superconductors in a Magnetic Field: 1935-1995", **A. H. MacDonald**, University of Missouri, Columbia, MO, November 1995.
6. "Thermodynamics of Superconductors in a Magnetic Field: 1935-1995", **A. H. MacDonald**, University of Texas, Austin, TX, April 1995.
7. "Mixed-state Quasiparticle Spectrum for d-wave Superconductors", Yong Wang and **A. H. MacDonald**, March APS Mtg., San Jose, CA, March 20-24, 1995.
8. "Crossover from BCS Superconductivity to Bose-Einstein Condensation", Rudolf Haussman, March APS Mtg., San Jose, CA, March 20-24, 1995. (**MacDonald Group**)
9. "Disorder in Anisotropic Superconductors", Jun Hu, **A. H. MacDonald**, and **S. M. Girvin**, Bull. Am. Phys. Soc. **40**, 837, 1995.
10. "Just What is Superconductivity Anyway?", **S. M. Girvin**, Univ. of Oklahoma, Norman, OK, September 21, 1995.
11. "Critical Fluctuations in 1D Josephson Junction Arrays", **S. M. Girvin**, Saclay Laboratory, Gif sur Yvette, France, July 1995.
12. "Introduction to Quantum Critical Phenomena", **S. M. Girvin**, Chalmers University, Göteborg, Sweden, June 1995, (A series of 5 lectures).
13. "Superconductivity for Poets", **S. M. Girvin**, Indiana Univ. Phi Beta Kappa Lecture, Bloomington, IN, April 19, 1995.

14. "Spectroscopy of Semiconductors and Superconductors Under Pressure", **M. Chandrasekhar**, Univ. of Notre Dame, Dept. of Elec. Eng., Notre Dame, IN, November 16, 1995.
15. "Optical Spectroscopy in Semiconductors and Superconductors Under Pressure", **M. Chandrasekhar**, Physics Colloquium, University of Missouri, Kansas City, MO, May 5, 1995.
16. "Optical Spectroscopy in Semiconductors and Superconductors Under Pressure", **M. Chandrasekhar**, Physics Colloquium, Texas Tech University, Lubbock, TX, March 9, 1995.
17. "Oxide Superconductor Films: an X-ray Scattering Study", S.-W. Han, J. A. Pitney, **P. F. Miceli**, M. Covington, L. H. Greene, M. J. Godbole, and D. L. Lowndes, 4th Int'l. Conf. on Surface X-ray and Neutron Scattering, June 25-30, 1995.
18. "X-ray Reflectivity Study of Thin Film Oxide Superconductors", S.-W. Han, J. A. Pitney, **P. F. Miceli**, M. Covington, L. H. Greene, M. J. Godbole, and D. L. Lowndes, 4th Int'l. Conf. on Surface X-ray and Neutron Scattering, June 25-30, 1995.
19. "Superconductors, Magnets, and Materials Science", David L. Cowan, University of Missouri, Kansas City, MO, November 30, 1995. (**Yelon Group**)
20. "Neutron Diffraction Studies on $\text{Pr}_{1+x}\text{Ba}_{2-x}\text{Cu}_3\text{O}_{7-y}$ ", S. K. Malik, Ram Prasad, N. C. Soni, K. Adhikary, and **W. B. Yelon**, SCES '95, Goa, India, September 1995.
21. "Structural and Magnetic Studies on $\text{PrBa}_2\text{Fe}_3\text{O}_8$ ", V. P. S. Awana, Latika Menon, S. K. Malik, Apurva Mehta, Sanjay Mishra, and **W. B. Yelon**, SCES '95, Goa, India, September 1995.
22. "Neutron Diffraction Studies on Superconducting $\text{YNi}_2\text{B}_2\text{C}$ at Various Temperatures", **W. B. Yelon**, Z. Hu, M. Paranthaman, W. J. James, Latika Menon, and S. K. Malik, SCES '95, Goa, India, September 1995.
23. "High Temperature Superconductivity: The Promise and the Reality", **J. W. Farmer**, University of Missouri, Columbia, MO, October 19, 1995.
24. "Flux Pinning Studies via Flux Creep Measurements in As-grown and Neutron Irradiated $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Single Crystals", **J. W. Farmer**, X. Ding, D. L. Cowan, and D. Bradford, Midwest Solid State Conf., St. Louis, MO, October 1995.
25. "Flux Pinning in $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Single Crystals", M. Kornecki, **J. W. Farmer**, and D. L. Cowan, 43rd Midwest Solid State Conf., St. Louis, MO, October 13-14, 1995.
26. "Flux Creep in As-grown and Neutron Irradiated Single Crystals of Y123", **J. W. Farmer**, X. Ding, D. L. Cowan, and D. C. Bradford, Bull. of Am. Phys. Soc. **40**, 687, 1995.

27. "Synthesis and Superconductivity of Low Symmetry Bismuth Oxides of Ba-K-Bi-O System", **B. Jayaram** and **J. R. Hardy**, Int'l. Workshop on the Chemistry and Technology of High Temperature Superconductors, Moscow State University, Moscow, Russia, October 7-12, 1995.
28. "Magnetic Susceptibility in $\text{Pr}_x\text{Y}_{1-x}\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$ Single Crystals", **B. Jayaram**, H. Srikanth, B. M. Wanklyn, and Chen Changkang, March APS Mtg., San Jose, CA, March 20-24, 1995.
29. "Magnetism of Fe, Ni, and Zn in $\text{Nd}_{1.85}\text{Ce}_{0.15}\text{CuO}_4$: Comparison of Experiment and Theory", **B. Jayaram**, H. Chen, and J. Callaway.
30. "Zn and Ni in High- T_c Superconductors", **Howard A. Blackstead** and John D. Dow, MRS, Boston, MA, Nov. 27- Dec. 1, 1995.
31. "High-temperature Superconductivity", **Howard A. Blackstead** and John D. Dow, Electrochemical Soc. Mtg., Chicago, IL, October 8-13, 1995.
32. "Predicting Higher T_c ", **Howard A. Blackstead** and John D. Dow, Electrochemical Soc. Mtg., Chicago, IL, October 8-13, 1995.
33. "A Prescription for Superconductivity in all $\text{YBa}_2\text{Cu}_3\text{O}_7$ Homologues", **Howard A. Blackstead** and John D. Dow, Supperlattice Conf., Cincinnati, OH, August 1995.
34. "Experimental Evidence for High-temperature Superconductivity Generated by Charge-reservoir Oxygen", **Howard A. Blackstead** and John D. Dow, Supperlattice Conf., Cincinnati, OH, August 1995.
35. "Superconductivity Associated with Dopant Oxygen in BSCCO", John D. Dow and **Howard A. Blackstead**, March APS Mtg., San Jose, CA, March 1995.
36. "(Rare-earth) $\text{Ba}_2\text{Cu}_3\text{O}_7$ Homologues: Superconductivity and Pair-breaking in the Chains", **Howard A. Blackstead** and John D. Dow, March APS Mtg., San Jose, CA, March 1995.
37. "Charge-transfer in High-temperature Superconductors", David W. Jenkins, **Howard A. Blackstead**, and John D. Dow, March APS Mtg., San Diego, CA, March 1995.
38. "Flux Pinning Enhancement in Melt Processed $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Through Rare Earth Ion Substitutions", C. Varanasi and **P. McGinn**, 1995 International Workshop on Superconductivity, Maui, Hawaii, June 1995.
39. "Effects of Processing Variables on the Y_2BaCuO_5 Size and Magnetic Properties of Melt-processed $\text{YBa}_2\text{Cu}_3\text{O}_x$ ", H. Yang, C. Varanasi, and **P. McGinn**, TMS Annual Meeting, Las Vegas, NV, February 1995.
40. "Reduced Oxygen Pressure Melt Processing of $\text{YBa}_2\text{Cu}_3\text{O}_x$ and $\text{NdBa}_2\text{Cu}_3\text{O}_x$ ", M. A. Black, C. Varanasi, and **P. McGinn**, TMS Annual Meeting, Las Vegas, NV, February 1995.

41. "Texturing of 90Ag-10Pd/Y-123 Composite Wires by Reduced pO₂ Melt Processing", M. A. Black and **P. McGinn**, International Cryogenic Materials Conference, Columbus, OH, 1995.
42. "Texturing of 90Ag-10Pd/Y-123 Composite Wires by Reduced pO₂ Melt Processing", **P. J. McGinn** and M. A. Black, MISCON Group Mtg., Columbus, OH, January 27, 1995.
43. "Flux Pinning by Precipitates in Melt-processed YBa₂Cu₃O_x - A Cavity Model", Donglu Shi, S. Sengupta, C. Varanasi, **P. J. McGinn**, V. Gorin, A. Buzdin, and J. S. Luo, International Cryogenic Materials Conference, Columbus, OH, 1995.
44. "Giant Magnetoresistance due to Remote Spin-dependent Scattering in Ferromagnetic Quantum Dot Arrays Produced by Electrosynthesis", D-F Yue, G. Banerjee, **A. E. Miller**, and **S. Bandyopadhyay**, 188th Mtg. of the Electrochemical Society, Chicago, IL, October 1995.
45. "Electrosynthesis of Quasi-periodic Semiconductor and Ceramic Superconductor Quantum Dot Arrays", G. Banerjee, D-F Yue, **A. E. Miller**, and **S. Bandyopadhyay**, 188th Mtg. of the Electrochemical Society, Chicago, IL, October 1995.
46. "Optical, Magnetic, Electronic and Superconducting Properties of Quasi-periodic Quantum Dot Arrays Synthesized by a Novel Electrochemical Technique", **A. E. Miller**, **S. Bandyopadhyay**, and **M. Chandrasekhar**, 8th Int'l. Conf. on Superlattices and Microstructures, Cincinnati, OH, August 1995.
47. "Giant Magnetoresistance due to Remote Spin-dependent Scattering in Ferromagnetic Quantum Dot Arrays Produced by Electrosynthesis", D-F Yue, G. Banerjee, **A. E. Miller**, and **S. Bandyopadhyay**, 8th Int'l. Conf. on Superlattices, Microstructures, and Microdevices, Cincinnati, OH, August 1995.
48. "Electrosynthesis of Quasi-periodic Semiconductor and Ceramic Superconductor Quantum Dot Arrays", G. Banerjee, D-F Yue, **A. E. Miller**, and **S. Bandyopadhyay**, 8th Int'l. Conf. on Superlattices, Microstructures, and Microdevices, Cincinnati, OH, August 1995.
49. "Artificial Quantum Solids", **S. Bandyopadhyay**, Invited Colloquium, Dept. of Physics, Ball State University, Muncie, IN, November 1995.
50. "Artificial Quantum Solids that Compute: Quantum-mechanical Logic and Neuromorphic Networks", **S. Bandyopadhyay** and V. P. Roychowdhury, Int'l. Conf. on SSDM '95, Osaka, Japan, August 1995.
51. "Artificial Quantum Solids", **S. Bandyopadhyay**, Invited Seminar, University of Cincinnati, Cincinnati, OH, August 1995.

52. "Optical, Magnetic, Electronic and Superconducting Properties of Quasi-periodic Quantum Dot Arrays Synthesized by a Novel Electrochemical Technique", **S. Bandyopadhyay, A. E. Miller, and M. Chandrasekhar**, SPIE's 1995 Int'l. Symposium on Optoelectronic, Microelectronic and Laser Technologies, San Jose, CA, February 4-10, 1995.
53. "Transport and Far-infrared Properties of YBCO Films on Ultra-thin Ag Layers", **S. T. Ruggiero**, MRS Conference, Boston, MA, Nov. 29, 1995.
54. "Growth and Transport Properties of YBCO Films on Ultra-thin Ag Layers", C. Zhong and **S. T. Ruggiero**, Bull. Am. Phys. Soc. **40**, 14, 1995.
55. "High T_c Superconducting Composites, Arrays, and Crystals", **J. C. Garland**, Univ. of Missouri, Columbia, MO, July 12, 1995.
56. "Two-dimensional Phase Transition in Josephson Junction Arrays: An Experimental Overview", **J. C. Garland**, Josephson Junction Arrays Workshop, Jackson, WY, May 23-28, 1995.
57. "Measurements of the Vortex-glass Transition in $\text{Bi}_2\text{Sr}_2\text{Ca}_1\text{Cu}_2\text{O}_{8+y}$ Single Crystals", Sergio M. Ammirata, Hu Jong Lee, S. E. Hebboul, C. D. Keener, and **J. C. Garland**, Bull. Am. Phys. Soc. **40**, 687, 1995.
58. "Magneto-resistance Measurements of High T_c Weak Link Arrays", J. S. Markus, S. T. Herbert, S. E. Hebboul, and **J. C. Garland**, Bull. Am. Phys. Soc. **40**, 68, 1995.
59. "Vortex Coupling Measurements in $\text{Bi}_2\text{Sr}_2\text{Ca}_1\text{Cu}_2\text{O}_{8+y}$ Crystals Using Controlled Sample Geometries", Matthew L. Trawick, C. D. Keener, Hu Jong Lee, S. E. Hebboul, and **J. C. Garland**, Bull. Am. Phys. Soc. **40**, 12, 1995.
60. "Spectral Response and Enhanced Phase-locking of Two-dimensional Superconducting Arrays", S. E. Hebboul, E. B. Harris, J. S. Markus, S. T. Herbert, Y. C. Hui, and **J. C. Garland**, SUPNET Workshop, Frascati, Italy, March 2-5, 1995.
61. "Dramatic Effects of Doping on the Electrodynamics of Superconducting $\text{YBa}_2(\text{Cu}_{1-x}\text{M}_x)_3\text{O}_{7-\delta}$ ", **T. R. Lemberger**, University of Cincinnati, May 1995.
62. "Dramatic Effects of Doping on the Electrodynamics of Superconducting $\text{YBa}_2(\text{Cu}_{1-x}\text{M}_x)_3\text{O}_{7-\delta}$ ", **T. R. Lemberger**, Wayne State University, April 1995.
63. "Magnetic Field and Frequency Dependence of λ (T) Near T_c in $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Thin Films", E. R. Ulm, A. E. Cunningham, K. M. Paget, and **T. R. Lemberger**, Bull. Am. Phys. Soc. **40**, 169, 1995.
64. "Infrared Reflectance of Cobalt-doped $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ ", K. M. Paget, **T. R. Lemberger**, L. Hou, and **M. W. McElfresh**, Bull. Am. Phys. Soc. **40**, 570, 1995.
65. "Using NMR to Investigate Vortex Dynamics in High T_c Superconductors", **C. H. Pennington**, Univ. of North Carolina, Chapel Hill, NC, November 20, 1995.

66. "Using NMR to Investigate Vortex Dynamics in High T_c Superconductors", **C. H. Pennington**, Duke Univ., Durham, NC, November 17, 1995.
67. "Using NMR to Investigate Vortex Dynamics in High T_c Superconductors", **C. H. Pennington**, Indiana University at Indianapolis, Indianapolis, IN, October 25, 1995.
68. "Using NMR to Investigate Vortex Dynamics in High T_c Superconductors", **C. H. Pennington**, Univ. of Missouri, Columbia, MO, October 19, 1995.
69. " ^{63}Cu NMR Spin Echo Investigations of Single Crystal $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ with Applied Transport Current", C. Recchia and **C. H. Pennington**, Bull. Am. Phys. Soc. **40**, 189, 1995.
70. "Elevated Oxygen Pressure Processing of the $\text{Bi}_2\text{Sr}_2\text{Ca}_1\text{Cu}_2\text{O}_8$ -type and $(\text{Bi,Pb})_2\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_{10}$ -type Superconductors", **K. H. Sandhage**, S. M. Allameh, D. H. Chmielewski, and J. J. Gannon, Proc. Fourth European Ceramic Soc. Conf., Riccione, Italy, October 2-6, 1995.
71. "Anisotropic Grain Growth and Isothermal Grain Alignment", **K. H. Sandhage**, D. H. Chmielewski, and S. M. Allameh, MISCON Group Meeting, Ohio State Univ., Columbus, OH, January 1995.
72. "The Synthesis of Superconducting Oxide/Noble Metal Laminates by an Oscillating Oxidation Scheme", **K. H. Sandhage**, V. R. Sitaraman, and T. J. Detrie, European Ceramic Soc. Mtg., Riccione, Italy, October 6, 1995.
73. "The Synthesis of Superconducting Oxide/Noble Metal Laminates by an Oscillating Oxidation Scheme", **K. H. Sandhage**, V. R. Sitaraman, and T. J. Detrie, MISCON Group Mtg., Ohio State Univ., Columbus, OH, January 1995.
74. "Flux Lattice Melting and Magnetization of High-temperature Superconductors", R. Sásik, Los Alamos National Lab., November 14, 1995. (**Stroud Group**)
75. "Shapiro Steps in Josephson Junction Arrays", **David Stroud**, Int'l. Centre for Theoretical Physics, Trieste, Italy, August 7-11, 1995.
76. "Flux Lattice Melting and Magnetization of the High- T_c Superconductors", **D. Stroud**, Int'l. Conf. on Fluctuation Phenomena in High- T_c Superconductors, Trieste, Italy, August 5-8, 1995.
77. "Vortices in Josephson Junction Arrays", **D. Stroud**, Workshop on Vortices in Superconductors and Superfluids, Aspen Center for Physics, July 20, 1995.
78. "Intrinsic Junction Effects in High- T_c Superconductors", **D. Stroud**, MISCON Summer School on Josephson Junctions, Columbia, MO, July 14, 1995.

79. "Flux Lattice Melting in High Temperature Superconductors: Melting Curve and Magnetization", **D. Stroud**, MISCON Summer Group Meeting, Columbia, MO, July 12, 1995.
80. "First Order Vortex Lattice Melting and Magnetization of High- T_c Superconductors", R. Sásik and **D. Stroud**, Conf. on Vortices in High- T_c Superconductors, Lake Forest, IL, June 1995.
81. "Magnetic Field Effects in Two and Three-dimensional Superconducting Arrays", **D. Stroud**, Conference on Josephson Junction Arrays, Jackson, WY, May 23-28, 1995.
82. "Supersolid Phases in Josephson Junction Arrays and Thin Superconducting Films", Eric Roddick, General Motors Research Laboratory, May 3, 1995. (**Stroud Group**)
83. "Flux Lattice Melting in High-temperature Superconductors", **D. Stroud**, University of Kentucky, April 26, 1995.
84. "Supersolid Phases in Underdamped Josephson Arrays: Quantum Monte Carlo Simulations", Eric Roddick and **David Stroud**, Bull. Am. Phys. Soc. **40**, 70, 1995.
85. "Effect of Quantum Fluctuations with Dissipation on a Model High- T_c Superconductor", Eric Roddick and **David Stroud**, Bull. Am. Phys. Soc. **40**, 15, 1995.
86. "Dimensional Crossover in Layered High- T_c Superconductors", R. Sásik and **D. Stroud**, Bull. Am. Phys. Soc. **40**, 11, 1995.
87. "2D-3D Vortex Line Transition in Two-layer Josephson Arrays", Wenbin Yu and **David G. Stroud**, Bull. Am. Phys. Soc. **40**, 10, 1995.
88. "Optical and Electrical Properties of Random Composites", **D. Stroud**, General Colloquium, Dept. of Materials Science and Engineering, Ohio State University, Columbus, OH, February 24, 1995.
89. "Underbarrier Inelastic Processes in Josephson Junctions", **G. F. Giuliani**, Scuola Normale Superiore, Pisa, Italy, July 1995.
90. "Theory of Under Barrier Inelastic Scattering in a Josephson Junction", M. V. Fistul, March APS Mtg., San Jose, CA, March 1995. (**Giuliani Group**)
91. "Time-dependent Properties of a Josephson Junction with Randomly Distributed Abrikosov Vortices", Mikhail Fistul and **Gabriele F. Giuliani**, March APS Mtg., San Jose, CA, March 1995.
92. "Finite Size Effects and Vortex Penetration in Small Josephson Junctions", **Gabriele F. Giuliani** and Mikhail Fistul, March APS Mtg., San Jose, CA, March 1995.
93. "Inhomogeneous Josephson Junctions", **G. F. Giuliani**, MISCON Group Mtg., Ohio State University, Columbus, OH, January 1995.

94. "Physical Properties of the $\text{CuIr}_2\text{S}_{4-x}\text{Se}_x$ System", P. Somasundaram, T. Pekarek, B. C. Crooker, and **J. M. Honig**, MMM Meeting, Philadelphia, PA, November 9, 1995.
95. "Effects of Substitution on Superconducting Properties of High T_c Materials", **J. M. Honig**, MISCON Group Meeting, University of Missouri, Columbia, MO, July 12, 1995.
96. "Fluorination of $\text{La}_{1-x}\text{Sr}_x\text{CuO}_{4-y}$: Enhancement of Superconductivity", V. Bhat and **J. M. Honig**, MISCON Group Meeting, Ohio State University, Columbus, OH, January 26, 1995.
97. "Mott Localization", **J. Spalek** Harvard Univ., Cambridge, MA, October 25, 1995.
98. "Universal Properties of Multilayer High-temperature Superconductors: Transition Temperature and a Spatial Modulation of the Gap", **J. Spalek**, 1st Polish-US Conference on High-temperature Superconductivity, Wroctaw, Poland, September 11-15, 1995.
99. "Fermionic Quantum Liquids and Transitions Between Them", **J. Spalek**, Workshop on Magnetism and Superconductivity, Kudowa, Poland, September 5-9, 1995.
100. "Superconducting Properties of NonFermi Liquid", **J. Spalek**, King's College, London, England, April 23, 1995.
101. "Single Variant Orientational Growth of $\text{YBa}_2\text{Cu}_3\text{O}_x$ on Vicinal (011) SrTiO_3 Substrates", D. S. Linehan, A. L. Vasiliev, **E. P. Kvam**, L. Hou, and **M. W. McElfresh**, MRS, Boston, MA, December 1995.
102. "Characterization and Transport Properties of Thin Epitaxial $\text{DyBaCuO}/\text{LaCaMnO}$ (and $\text{LaSrCuO}/\text{LaSrMnO}$) Multilayers", P. A. Kraus, V. A. Vas'ko, V. S. Achutharaman, C. A. Nordman, A. M. Goldman, Luo Yuan, James E. Angelo, and **Eric P. Kvam**, Am. Vac. Soc., Minneapolis, MN, October 1995.
103. "Interdisciplinary Undergraduate Research in Microelectronic Materials and Processing", C. G. Takoudis, G. W. Neudeck, and **E. P. Kvam**, University-Government-Industry Microelectronics Symposium, Austin, TX, May 1995.
104. "Undergraduate Research in Microelectronic Materials and Processing", **E. P. Kvam**, G. W. Neudeck, and C. G. Takoudis, Am. Soc. of Engineering Education Illinois-Indiana Section Conf., W. Lafayette, IN, March 1995.
105. "Relationships Between Structural Defects and Flux Pinning in $\text{YBa}_2\text{Cu}_3\text{O}_7$ ", **E. Kvam**, University of Nebraska, Lincoln, NE, March 1995.
106. "Relationships Between Structural Defects and Flux Pinning in $\text{YBa}_2\text{Cu}_3\text{O}_7$ ", **E. P. Kvam**, University of Missouri, Columbia, MO, March 1995.

107. "Magnetic and Electrical Transport Properties of High Temperature Superconductors", **M. McElfresh**, Univ. of Vermont, Burlington, VT, November 29, 1995.
108. "Irreversibility Line in High Temperature Superconductors", **M. McElfresh**, Univ. of Alberta, Edmonton, Alberta, Canada, October 27, 1995.
109. "Magnetic and Magnetotransport Measurements Using the Quantum Design PPMS", **M. McElfresh**, Bunkyo Civic Center, Tokyo, Japan, September 7, 1995.
110. "Irreversibility Line in High Temperature Superconductors", **M. McElfresh**, Univ. of Tokyo, Tokyo, Japan, September 6, 1995.
111. "Magnetic and Magnetotransport Measurements Using the Quantum Design PPMS", **M. McElfresh**, Bunkyo Civic Center, Tokyo, Japan, September 5, 1995.
112. "Magnetic and Magnetotransport Measurements Using the Quantum Design PPMS", **M. McElfresh**, Bunkyo Civic Center, Tokyo, Japan, September 4, 1995.
113. "Irreversibility Line in High Temperature Superconductors", **M. McElfresh**, Condensed Matter Phys. Seminar, Univ. of Missouri, Columbia, MO, August 30, 1995.
114. "Magnetic Measurements in Chemistry", **M. McElfresh**, Chem. Dept., Université Pierre and Marie Curie, Paris, France, June 29, 1995.
115. "Dimensional Crossover Field as a Function of Oxygen Stoichiometry in $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Thin Films", J. Deak, L. F. Hou, P. Metcalf, and **M. McElfresh**, March APS Mtg., San Jose, CA, March 1995.
116. "Effect of Fe and Ni Doping on the Magnetic Phase Diagram of $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ ", L. F. Hou, J. Deak, P. Metcalf, and **M. McElfresh**, March APS Mtg., San Jose, CA, March 1995.
117. "Unconventional Superconductivity and Impurity Scattering", **Paul Muzikar**, Umea University (Sweden), June 1995.
118. "London Theory of the Vortex Lattice in Anisotropic Superconductors", **Paul Muzikar**, Umea University (Sweden), June 1995.
119. "Density of States and Penetration Depth in Unconventional Superconductors: the Effects of Nonmagnetic Impurity Scattering", G. Preosti, Argonne National Lab., April 1995. (**Muzikar Group**)
120. "D-wave Superconductivity in Two and Three Dimensional Fermi Liquids", G. Preosti, March APS Mtg., San Jose, CA, March 1995. (**Muzikar Group**)
121. "Oriented Microstructural Development in Ceramics", R. K. Roeder, E. B. Slamovich, **K. P. Trumble**, and **K. J. Bowman**, Am. Cer. Soc. Mtg., New Orleans, LA, November 1995.

122. "Interfacial Decomposition of BSCCO-2223 in Contact with Silver", R. J. Moon, **K. P. Trumble**, and **K. J. Bowman**, MRS Fall Mtg., Boston, MA, November 1995.
123. "Centrifugal Slip Casting of Components with Controlled Microstructures", **K. P. Trumble**, G. A. Steinlage, R. K. Roeder, and **K. J. Bowman**, Am. Cer. Soc., Seattle, WA, November 1995.
124. "Effects of Oriented Platelet-reinforcement on Microstructural Development in Ceramic Composites", R. K. Roeder, E. B. Slamovich, **K. P. Trumble**, and **K. J. Bowman**, Engineering Foundation Conf. on Advanced Composites, Davos, Switzerland, July 1995.
125. "Orientation Selective Processing of Ceramic Materials", R. K. Roeder, G. A. Steinlage, **K. P. Trumble**, and **K. J. Bowman**, ACerS Annual Mtg., Cincinnati, OH, April 1995.
126. "Texture and Microstructure Development in Al_2O_3 -Platelet Reinforced Ce-ZrO₂/ Al_2O_3 Composites", R. K. Roeder, **K. J. Bowman**, and **K. P. Trumble**, ACerS Spring Mtg., Cincinnati, OH, April 1995.
127. "Preventing Segregation During Centrifugal Consolidation of Particulate Suspensions: Particle Drafting", R. K. Roeder, G. A. Steinlage, **K. J. Bowman**, and **K. P. Trumble**, ACerS Annual Mtg., Cincinnati, OH, April 1995.
128. "Microstructural Effects on Magnetically Shielding BSCCO Tubes", G. A. Steinlage, **K. J. Bowman**, and **K. P. Trumble**, ACerS Spring Mtg., Cincinnati, OH, April 1995.
129. "Centrifugal Processing of Ceramic Composites", **K. J. Bowman**, ACerS Annual Mtg., Cincinnati, OH, April 1995.
130. "Tailoring Particle Size and Morphology of Colloidal Ag Powder via Chemical Precipitation", N. W. Medendorp, Jr., **K. J. Bowman**, and **K. P. Trumble**, TMS Annual Mtg., Las Vegas, NV, February 1995.
131. "Processing with Colloidal Ag Particles In Ag-coated BSCCO-2223 Composites", N. W. Medendorp, Jr., **K. J. Bowman**, and **K. P. Trumble**, TMS Annual Mtg., Las Vegas, NV, February 1995.
132. "Aluminate Formation at Metal/ α - Al_2O_3 Interfaces", **K. P. Trumble**, Colorado School of Mines, March 2, 1995.
133. "Reactive Wetting and Infiltration in Metal-ceramic Systems", **K. P. Trumble**, University of Illinois at Urbana-Champaign, February 17, 1995.

MISCON PUBLICATIONS

January 1995 - December 1995

(In Print)

1. "The Mechanistic Role of H₂O and the Ligand in the Chemical Vapor Deposition of Cu, Cu₂O, CuO, and Cu₃N from Bis(1,1,1,5,5,5-hexafluoropentane-2,4-dionato)Copper(II)", Jiri Pinkas, John C. Huffman, **David V. Baxter**, **Malcolm H. Chisholm**, and **Kenneth G. Caulton**, Chem. Mat. **7**, 1589-1596, 1995.
2. "Origin of Different Coordination Polyhedra for Cu[CF₃C(O)CHC(O)CF₃]₂ L(L=H₂O, NH₃)", Jiri Pinkas, John C. Huffman, **Malcolm H. Chisholm**, and **Kenneth G. Caulton**, Inorg. Chem. **34**, 5314-5318, 1995.
3. "Participation-ratio Entropy and Critical Fluctuations in the Thermodynamics of Pancake Vortices", Jun Hu and **A. H. MacDonald**, Phys. Rev. B **52**, 1286-1289, 1995.
4. "Current-voltage Characteristics of Two-dimensional Vortex-glass Models", R. A. Hyman, Mats Wallin, M. P. A. Fisher, **S. M. Girvin**, and A. P. Young, Phys. Rev. B **51**, 15304-15311, 1995.
5. "Magnetic, Thermal, Transport, and Structural Properties of Sr₂RuO_{4+δ}: Enhanced Charge-carrier Mass in a Nearly Metallic Oxide", J. J. Neumeier, M. F. Hundley, M. G. Smith, J. D. Thompson, C. Allgeier, H. Xie, **W. Yelon**, and J. S. Kim, Phys. Rev. B **50**, 17910-17916, 1994.
6. "Flux Creep in Twinned, Untwinned, and Neutron Irradiated YBa₂Cu₃O₇ Single Crystals", **J. W. Farmer**, D. L. Cowan, X. Ding, and D. Bradford, Physica C **235**, 2893-2894, 1994.
7. "Defect Cascades Produced by Neutron Irradiation in YBa₂Cu₃O_{7-δ}", M. C. Frischherz, M. A. Kirk, **J. Farmer**, L. R. Greenwood, and H. W. Weber, Physica C **232**, 309-327, 1994.
8. "Magnetism of Fe, Ni, and Zn in Nd_{1.85}Ce_{0.15}CuO₄: Comparison of Experiment and Theory", **B. Jayaram**, H. Chen, and J. Callaway, Phys. Rev. B **52**, 3742-3747, 1995.
9. "Magnetic Susceptibility Studies on Pr_xY_{1-x}Ba₂Cu₃O_{7-δ} Single Crystals in the Insulating Regime", **B. Jayaram**, H. Srikanth, B. M. Wanklyn, C. Changkang, E. Holzinger-Schweiger, and G. Leising, Phys. Rev. B **52**, 89-92, 1995.
10. "Charge-transfer and the Location of Superconducting Holes in La_{2-β}Sr_βCuO₄", **Howard A. Blackstead** and John D. Dow, J. Phys. Chem. Solids **0**, 1-2, 1995.

11. "Anomalous Charge-transfer in $\text{La}_{2-\beta}\text{Sr}_\beta\text{CuO}_4$ and in $\text{Nd}_{2-z}\text{Ce}_z\text{CuO}_4$ ", **Howard A. Blackstead** and John D. Dow, J. Appl. Phys. **78**, 7175-7180, 1995.
12. "Strained-layer Superlattice Model of Superconductivity in $\text{YBa}_2\text{Cu}_3\text{O}_x$ ", **Howard A. Blackstead** and John D. Dow, Journal of the Electrochemical Society, Proceedings Vol. **94-17**, 419-427, 1995.
13. "High-temperature Superconductivity", **Howard A. Blackstead** and John D. Dow, Journal of the Electrochemical Society, Proceedings Vol. **94-17**, 408-418, 1995.
14. "Constraints Imposed by the Data on a Successful Theory of High-temperature Superconductivity", **Howard A. Blackstead** and John D. Dow, SPIE **2397**, 617-632, 1995.
15. "Phonons in Semiconductor Alloys", John D. Dow, William E. Packard, **Howard A. Blackstead**, and David W. Jenkins, Dynamical Properties of Solids **7**, 349-424, 1995.
16. "Superconductivity in $\text{PrBa}_2\text{Cu}_3\text{O}_7$ ", **H. A. Blackstead**, D. B. Chrisey, John D. Dow, J. S. Horwitz, A. E. Klunzinger, and D.B. Pulling, Phys. Lett. A **207**, 109-112, 1995.
17. "Implications of Abrikosov-Gor'kov Exchange Scattering for Theories of High-temperature Superconductivity", **Howard A. Blackstead** and John D. Dow, Phys. Lett. A **206**, 107-110, 1995.
18. "Location of the Root of Superconductivity in $\text{La}_{2-\beta}\text{Sr}_\beta\text{CuO}_x$ and $\text{Nd}_{2-z}\text{Ce}_z\text{CuO}_x$ ", **Howard A. Blackstead** and John D. Dow, Phil. Mag. B **72**, 529-534, 1995.
19. " $\text{PrBa}_2\text{Cu}_3\text{O}_7$: A New Superconductor", **Howard A. Blackstead** and John D. Dow, J. of Superconductivity **8**, 653-654, 1995.
20. "Interstitial and Substitutional Oxide Superconductors", **Howard A. Blackstead** and John D. Dow, J. of Superconductivity **8**, 613-614, 1995.
21. "Contribution to the Discussion of Exchange Scattering in High-temperature Superconductivity", **Howard A. Blackstead** and John D. Dow, Superlattices and Microstructures **17**, 315-320, 1995.
22. "Pair-breaking by Ba-site Magnetic Dopants in Superconducting $\text{NdBa}_2\text{Cu}_3\text{O}_x$ ", **Howard A. Blackstead** and John D. Dow, Solid State Comm. **96**, 313-316, 1995.
23. "Catastrophic Quenching of Superconductivity in Melt-textured $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ with Second-phase Additions", **H. A. Blackstead**, D. B. Pulling, and **P. J. McGinn**, J. Appl. Phys. **78**, 1866-1870, 1995.
24. "Hole Localization in High-temperature Superconductors", **Howard A. Blackstead** and John D. Dow, Solid State Comm. **95**, 613-617, 1995.

25. "Role of Ba-site Pr in Quenching Superconductivity of $Y_{1-y}Pr_yBa_2Cu_3O_x$ and Related Materials", **Howard A. Blackstead** and John D. Dow, Phys. Rev. B **51**, 11830-11837, 1995.
26. "Field and Temperature-dependent Surface Resistance of Superconducting Polycrystalline Multiple-phase Hg-Ba-Ca-Cu-O: Evidence for Dirty-limit Behavior", **H. A. Blackstead**, D. B. Pulling, M. Paranthaman, and J. Brynstad, Phys. Rev. B **51**, 3783-3790, 1995.
27. "Charge-distributions in $Y_uPr_{1-u}Ba_2Cu_3O_x$ ", **Howard A. Blackstead**, John D. Dow, John F. Federici, William E. Packard, and David B. Pulling, Physica C **235**, 2161-2162, 1994.
28. "Phase Slip and Magnetoresistance of Oxygen Deficient $YBa_2Cu_3O_{7-x}$ ", G. A. Kapustin and **H. A. Blackstead**, Physica C **235**, 1977-1978, 1994.
29. "Evidence of Superconductivity in $PrBa_2Cu_3O_7$ ", **H. A. Blackstead**, D. B. Chrisey, John D. Dow, J. S. Horwitz, A. E. Klunzinger, and D. B. Pulling, Physica C **235**, 1539-1540, 1994.
30. "Depression of T_c Caused by Nd^{+3} Pair-breaking in $NdBa_2Cu_3O_x$ ", **Howard A. Blackstead**, John D. Dow, William E. Packard, and David B. Pulling, Physica C **235**, 1363-1364, 1994.
31. "Flux Pinning Enhancement in Melt Processed $YBa_2Cu_3O_{7-\delta}$ Through Rare-earth Ion (Nd, La) Substitutions", Chakrapani Varanasi, **Paul J. McGinn**, **Howard A. Blackstead**, and David B. Pulling, Appl. Phys. Lett. **67**, 1004-1006, 1995.
32. "Flux Pinning Enhancement in Melt Processed $YBa_2Cu_3O_{7-\delta}$ Through Rare Earth Ion Substitutions", Chakrapani Varanasi and **Paul J. McGinn**, Proceedings of the International Workshop on Superconductivity, 74-77, 1995.
33. "Effects of Processing Parameters on the Levitation Force of Melt-processed $YBa_2Cu_3O_x$ ", C. Varanasi, **P. J. McGinn**, V. Pavate, and **E. P. Kvam**, J. Mater. Res. **10**, 2251-2256, 1995.
34. †"Bulk Processing and Characterization of $YBa_2Cu_3O_{6+x}$ ", **P. McGinn**, Temperature Superconductivity Materials Science and Engineering: New Concepts and Novel Technology, 345-381, 1995.
35. "Magnetization of Oxygen-deficient Y-Ba-Cu-O Domain Prepared by Melt-texture Processing", Chan-Joong Kim and **P. J. McGinn**, J. of Mater. Sci. Lett., **13**, 1703-1705, 1994.
36. "Statics and Dynamics of the Vortex State in Type II Superconductors", S. Sengupta and D. Shi, High Temperature Superconducting Materials Science and Engineering: New Concepts and Novel Technology, ed. by Donglu Shi, (Pergamon, New York.), 131-197, 1995. (**McGinn Group**)

37. *"Processing of Large $\text{YBa}_2\text{Cu}_3\text{O}_x$ Domains for Levitation Applications by a $\text{Nd}_{1+x}\text{Ba}_{2-x}\text{Cu}_3\text{O}_y$ -Seeded Melt-growth Technique", V. R. Todt, S. Sengupta, Donglu Shi, P. R. Sahm, **P. J. McGinn**, R. B. Poeppel, and J. R. Hull, *JEM* **23**, 1127-1130, 1994.
38. *"Progress in the Melt Texturing of RE-123 Superconductors", **Paul J. McGinn**, *JOM*, 31-33, 1994.
39. "Optical, Electronic, Magnetic and Superconducting Properties of Quasi-periodic Quantum Dot Arrays Synthesized by a Novel Electrochemical Technique", **S. Bandyopadhyay**, **A. E. Miller**, and **M. Chandrasekhar**, *SPIE* **2397**, 12-30, 1995.
40. "Transport Properties of YBCO Films on Ultra-thin Ag Layers", C. Zhong, **S. T. Ruggiero**, R. Fletcher, and E. Moser, *IEEE Trans. on Applied Superconductivity* **5**, 1529-1532, 1995.
41. *"Vortex Lattice Autocorrelation Function Studied by an Atomic Beam Technique", H. Hauglin, S. Dapore-Schwartz, N. G. Woodard, and **G. P. Lafyatis**, *Physica C* **235**, 2697-2698, 1994.
42. "Magnetic Penetration Depth in Ni- and Zn-doped $\text{YBa}_2(\text{Cu}_{1-x}\text{M}_x)\text{O}_7$ Films", Eric R. Ulm, Jin-Tae Kim, **Thomas R. Lemberger**, Steve R. Foltyn, and Xindi Wu, *Phys. Rev. B* **51**, 9193-9198, 1995.
43. *"The Midinfrared Conductivity Determined from the Infrared Reflectance of $\text{YBa}_2(\text{Cu}_{1-x}\text{Ni}_x)\text{O}_{7-\delta}$ Films", Jin-Tae Kim, Eric R. Ulm, and **Thomas R. Lemberger**, *Physica B* **194**, 1535-1536, 1994.
44. "Vortex Dynamics in Single-crystal $\text{YBa}_2\text{Cu}_3\text{O}_7$ Probed by ^{63}Cu Nuclear Spin Echo Measurements in the Presence of Transport Current Pulses", C. H. Recchia, **C. H. Pennington**, H. Hauglin, and **G. P. Lafyatis**, *Phys. Rev. B* **52**, 9746-9750, 1995.
45. "Effect of High-temperature, High-Oxygen-Fugacity Annealing on the Stability of the $(\text{Bi,Pb})_2\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_{10\pm\delta}$ -type Compound", Seyed M. Allemeh and **Kenneth H. Sandhage**, *J. Am. Ceram. Soc.* **78**, 2513-2520, 1995.
46. "Stability of $\text{Bi}_2\text{Sr}_2\text{Ca}_1\text{Cu}_2\text{O}_{8\pm\delta}$ Thick Films at Elevated Oxygen Pressures and Temperatures", David H. Chmielewski and **Kenneth H. Sandhage**, *J. Am. Ceram. Soc.* **78**, 2504-2512, 1995.
47. "First-order Vortex Lattice Melting and Magnetization of $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ ", R. Sásik and **D. Stroud**, *Phys. Rev. Lett.* **75**, 2582-2585, 1995.
48. "Three-dimensional to Two-dimensional Crossover in Layered High- T_c Superconductors", R. Sásik and **D. Stroud**, *Phys. Rev. B* **52**, 3696-3701, 1995.
49. "Supersolid Phases in Underdamped Josephson Arrays: Quantum Monte Carlo Simulations", Eric Roddick and **David Stroud**, *Phys. Rev. B* **51**, 8672-8675, 1995.

50. "Propagating Photonic Modes Below the Gap in a Superconducting Composite", W. M. Lee, P. M. Hui, and **D. Stroud**, Phys. Rev. B **51**, 8634-8637, 1995.
51. "2D-3D Vortex-line Transition in Two-layer Josephson Arrays", Wenbin Yu and **D. Stroud**, Phys. Rev. B **51**, 3725-3730, 1995.
52. "Phase Coherence in Two-Dimensional Type-II Superconductors", R. Sásik, **D. Stroud**, and Z. Tesanovic, Phys. Rev. B **51**, 3042-3046, 1995.
53. "Effect of Phase Fluctuations on the Low-temperature Penetration Depth of High- T_c Superconductors", Eric Roddick and **David Stroud**, Phys. Rev. Lett. **74**, 1430-1433, 1995.
54. "Underdamped Josephson Junction Arrays with an Offset Voltage: Monte Carlo Simulations and Mean Field Theory", Eric Roddick and **David Stroud**, Physica C **235**, 3335-3336, 1994.
55. "Linear Temperature-dependence of Penetration Depth Due to Phase Fluctuations", Eric Roddick and **David Stroud**, Physica C **235**, 1799-1800, 1994.
56. *†"Critical Currents and Critical Fields in Composite Al-Ge Films", Yinon Ashkenazy, Ralph Rosenbaum, and **David Stroud**, J. Phys.: Condens. Matter **6**, 7993-8014, 1994.
57. "Magnetotransport Behavior of Polycrystalline YBa₂Cu₃O₇: A Possible Role for Surface Barriers", Shi Li, M. Fistul, J. Deak, P. Metcalf, **G. F. Giuliani**, **M. McElfresh**, and D. L. Kaiser, Phys. Rev. B **52**, 739-742, 1995.
58. "Theory of Finite-size Effects and Vortex Penetration in Small Josephson Junctions", Mikhail V. Fistul and **Gabriele F. Giuliani**, Phys. Rev. B **51**, 1090-1095, 1995.
59. "Fluorination of La_{2-x}Sr_xCuO_{4+δ}: Exhibition of Superconductivity for $x \leq 0.05$ ", V. Bhat and **J. M. Honig**, Materials Research Bulletin **30**, 1253-1261, 1995.
60. "Low-temperature Electron Transport Properties of La_{2-x}Sr_xNiO₄ with $0.5 \leq x \leq 1.3$ ", K. Sreedhar and **J. M. Honig**, J. of Solid State Chem. **111**, 147-150, 1994.
61. †"Magnetic Properties of Almost Localized Fermions", **J. Spalek** and W. Wójcik, J. of Magnetism and Magnetic Mats. **140-144**, 1199-1200, 1995.
62. †"Superconducting Instabilities in the Finite U Anderson Lattice Model", Jan Karbowski and **Jozef Spalek**, Physica B **206 & 207**, 716-718, 1995.
63. "Universality Classes, Statistical Exclusion Principle, and Properties of Interacting Fermions", Krzysztof Byczuk and **Jozef Spalek**, Phys. Rev. B **51**, 7934-7937, 1995.

64. "Almost Localized Fermions and Mott-Hubbard Transitions at Non-Zero Temperature", **J. Spalek** and W. Wójcik, Springer Series in Solid-State Sciences **119**, 41-65, 1995.
65. "Spin-split Masses and Metamagnetic Behavior of Almost-localized Fermions", P. Korbel, **J. Spalek**, W. Wójcik, and M. Acquarone, Phys. Rev. B **52**, 2213-2216, 1995.
66. *†"Electronic Structure and Real Space Pairing for Statistical Spin Liquid in Two Dimensions", K. Byczuk, **J. Spalek** and W. Wójcik, Physica C, **235-240**, 2347-2348, 1994.
67. "Evidence for Two Vortex Phase Transitions in $Tl_2Ba_2CaCu_2O_8$ Thin Films", J. Deak, **M. McElfresh**, D. W. Face, and W. L. Holstein, Phys. Rev. B **52**, 3880-3883, 1995.
68. "Critical Scaling of the Transport Behavior and the Magnetic Phase Diagram of Polycrystalline $YBa_2Cu_3O_7$ ", Shi Li, M. Fistul, J. Deak, P. Metcalf, and **M. McElfresh**, Phys. Rev. B **52**, 747-750, 1995.
69. "Local Time-dependent Magnetization of Superconducting Films in the Presence of a Transport Current", **M. McElfresh**, E. Zeldov, John R. Clem, M. Darwin, J. Deak, and L. Hou, Phys. Rev. B **51**, 9111-9117, 1995.
70. "Dimensional Crossover Field as a Function of Oxygen Stoichiometry in $YBa_2Cu_3O_{7-\delta}$ Thin Films", J. Deak, Lifang Hou, P. Metcalf, and **M. McElfresh**, Phys. Rev. B **51**, 705-708, 1995.
71. *"Single Electron Tunneling in $TlBa_2(Ca_{0.8}Y_{0.2})Cu_2O_7$ Thin Films at 10K", T. G. Miller, R. Reifenberger, **M. McElfresh**, D. W. Face, and W. L. Holstein, J. Low Temperature Phys. **94**, 239-247, 1994.
72. *"Evidence for a Vortex-solid Phase Transition in $Tl_2Ba_2CaCu_2O_8$ Thin Films", J. Deak, **M. McElfresh**, D. W. Face, and W. L. Holstein, Physica C **235**, 1615-1616, 1994.
73. "Penetration-depth Anisotropy in Unconventional Superconductors", Gianfranco Preosti and **Paul Muzikar**, Phys. Rev. B **51**, 15634-15637, 1995.
74. "Preventing Segregation During Centrifugal Consolidation of Particulate Suspensions: Particle Drafting", Ryan K. Roeder, Greg A. Steinlage, **Kevin P. Trumble**, and **Keith J. Bowman**, J. Am. Ceram. Soc. **78**, 2367-2373, 1995.
75. "Processing with Colloidal Ag Particles in Hot Forged Ag-coated BSCCO -2223 Composites", Nicholas W. Medendorp, Jr., **Keith J. Bowman**, and **Kevin P. Trumble**, J. of Electronic Mats. **24**, 1903-1905, 1995.

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(Accepted for Publication)

1. "X-ray Reflectivity Study of Thin Film Oxide Superconductors", S.-W. Han, J. A. Pitney, **P. F. Miceli**, M. Covington, L. H. Greene, M. J. Godbole, and D. H. Lowndes, accepted by Physica B.
2. "Neutron Diffraction Studies on $\text{Pr}_{1-x}\text{Ba}_2\text{O}_{7-\delta}$ ", S. K. Malik, Ram Prasad, N. C. Soni, K. Adhikary, and **W. B. Yelon**, accepted by Physica B.
3. "Structural and Magnetic Studies on $\text{PrBa}_2\text{Fe}_3\text{O}_8$ ", V. P. S. Awana, Latika Menon, S. K. Malik, Apurva Mehta, Sanjay Mishra, and **W. B. Yelon**, accepted by Physica B.
4. "Neutron Diffraction Studies on Superconducting $\text{YNi}_2\text{B}_2\text{C}$ at Various Temperatures", **W. B. Yelon**, Z. Hu, M. Paranthaman, W. J. James, Latika Menon, and S. K. Malik, accepted by Physica B.
5. "Magnetic and Heat Capacity Measurements on Zn- and Ga-doped $\text{PrBa}_2\text{Cu}_3\text{O}_{7-\delta}$ ", S. K. Malik, H. Jhans, S. K. Dhar, **W. B. Yelon**, J. J. Rhyne, Ram Prasad, and N. C. Soni, accepted by Physica B.
6. "Evidence for Superconductivity in the Bi-O Layers and Not in the Cuprate Planes of $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_8$," **Howard A. Blackstead** and John D. Dow, accepted by Superlattices and Microstructures.
7. "Incompatibility of Hole-filling and Pair-breaking in $\text{RBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Superconductors", **Howard A. Blackstead** and John D. Dow, accepted by Superlattices and Microstructures.
8. "Implications of Magnetic Pair-breaking in $\text{YBa}_2\text{Cu}_3\text{O}_7$ Homologues", **Howard A. Blackstead** and John D. Dow, accepted by J. of the Electrochemical Soc.
9. "On the Size Reduction of Silver Inclusions in Melt Textured $\text{YBa}_2\text{Cu}_3\text{O}_x$ Superconductors", C. Varanasi, M. Hauck, **P. J. McGinn**, accepted by Superconductor Science and Technology.
10. "The Demonstration of Y_2BaCuO_5 Particle Segregation in Melt Processed $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ Through a Computer Visualization Model", C. Varanasi, M. A. Black, and **P. J. McGinn**, accepted by J. Mater. Res.
11. "Giant Magnetoresistance in an Electrochemically Synthesized Regimented Array of Nickel Quantum Dots", D-F Yue, G. Banerjee, **A. E. Miller**, and **S. Bandyopadhyay**, accepted by Superlattices and Microstructures.
12. "Simulations of Shapiro Steps in Josephson Junction Arrays", **D. Stroud**, I.-J. Hwang, S. Ryu, accepted by Physica B.
13. "Dynamics of an Underdamped Josephson Junction Ladder", Seungoh Ryu, Wenbin Yu, and **D. Stroud**, accepted by Phys. Rev. E.

14. "Screening in Josephson-junction Ladders", Ing-Jye Hwang, Seungoh Ryu, and **D. Stroud**, accepted by Phys. Rev. B.
15. "Universal Properties of Multilayer High-temperature Superconductors: Transition Temperature and a Spatial Modulation of the Gap", **Jozef Spalek** and Krzysztof Byczuk, accepted by Springer Verlag.
16. "Electron States, Real Space Pairing and Cooper-pair Tunneling Between the Superconducting Planes", **Jozef Spalek**, Krzysztof Byczuk, and Włodzimierz Wójcik, accepted by Mol. Physics Reports.
17. "Thermodynamic Properties of Particles with Intermediate Statistics", Geoffrey S. Joyce, Sarben Sarkar, **Jozef Spalek**, and Krzysztof Byczuk, accepted by Phys. Rev. B.
18. "Transition Temperature and a Spatial Dependence of the Superconducting Gap for Multilayer High-temperature Superconductors", Krzysztof Byczuk and **Jozef Spalek**, accepted by Phys. Rev. B.
19. "Relationships Between Dislocations, Second Phases, and Pinning in Y-Ba-Cu-O", **E. P. Kvam**, V. Pavate, C. Varanasi, and **P. J. McGinn**, accepted by JEM.
20. "Single Variant Orientational Growth of $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ on Vicinal (011) SrTiO_3 Substrates", A. L. Vasiliev, D. S. Linehan, **E. P. Kvam**, L. Hou, and **M. W. McElfresh**, accepted by MRS.
21. "Spin Correlations for an Anderson Impurity in Conventional and Unconventional Superconductors", Heesang Kim and **Paul Muzikar**, accepted by J. Low Temp. Phys.
22. "Tailoring Particle Size and Morphology of Colloidal Ag Particles via Chemical Precipitation for Ag-BSCCO Composites", N. W. Medendorp, Jr., **K. J. Bowman**, and **K. P. Trumble**, accepted by Mater. Sci. Eng. A.
23. "A Review of Mechanical Modeling for Cold Roll Bonding Metal Laminates", Greg A. Steinlage, **Keith J. Bowman**, and **Kevin P. Trumble**, accepted by Int'l. Mats. Revs.

(Submitted for Publication)

1. "A YBa₂ Cluster Based on Simple Ligands (O^tBu)", Björn Borup, William E. Strieb, and **Kenneth G. Caulton**, submitted to Chemische Berichte.
2. "First Order Superconductor to Insulator Transition", Erik S. Sørensen and Eric Roddick, submitted to Phys. Rev. Lett. (**MacDonald/Girvin Group**)
3. "Universal Phase Diagram for Vortex States of Anisotropic Superconductors in Strong Magnetic Fields", Jun Hu and **A. H. MacDonald**, submitted to Phys. Rev. B.
4. "Structural, Magnetic and Heat Capacity Studies on Zn and Ga Substituted PrBa₂Cu₃O_{7-δ} System", S. K. Malik, H. Jhans, S. K. Dhar, V. P. S. Awana, **W. B. Yelon**, J. J. Rhyne, Ram Prasad, and N. C. Soni, submitted to Phys. Rev. B.
5. "Structural Aspects and Superconductivity in Y_{1-x}Ca_xBa₂Cu₃O_{7-y} (y=0) System: A Neutron Diffraction Study", V. P. S. Awana, S. K. Malik, and **W. B. Yelon**, submitted to Physica C.
6. "C-axis Oriented (Hg, Tl)-based Superconducting Films with T_c>125K", F. Foong, B. Bedard, Q. L. Xu, and **S. H. Liou**, submitted to Applied Phys. Lett.
7. "Evidence for Superconductivity in the Bi₂O₃ Layers and Not in the CuO₂ Planes of Bi₂Sr₂CaCu₂O₈", **Howard A. Blackstead** and John D. Dow, submitted to Phys. Rev. B.
8. "Catastrophic Quenching of Superconductivity in Melt-textured YBa₂Cu₃O_{7-δ} with Second Phase Additions", **H. A. Blackstead**, D. B. Pulling, and **P. J. McGinn**, submitted to Applied Physics Letters.
9. "Reduced pO₂ Melt Processing of YBa₂Cu₃O_{6+x}", M. A. Black and **P. J. McGinn**, submitted to Advances in Cryogenic Engineering.
10. "Nd Substitution in Y/Ba Sites in Melt Processed YBa₂Cu₃O_{7-δ} Through Nd₂O₃ Additions", Chakrapani Varanasi, **Paul J. McGinn**, **Howard A. Blackstead**, and David B. Pulling, submitted to Journal of Electronic Materials.
11. "Effects of Processing Variables on the Y₂BaCuO₅ Size and Magnetic Properties of Melt-processed YBa₂Cu₃O_x", H. F. Yang, C. Varanasi, and **P. J. McGinn**, submitted to Journal of Electronic Materials.
12. "Artificial Quantum Solids that Compute: Quantum-mechanical Logic Gates and Neuromorphic Networks", **S. Bandyopadhyay** and V. P. Roychowdhury, submitted.

13. "Effects of Oxygen Partial Pressure on the Crystallization of Amorphous Bi-Sr-Ca-Cu-O and Bi-Sr-Ca-Cu-O + Ag", M. J. Kramer, L. Margulies, S. R. Arrasmith, K. W. Dennis, J. C. Lang, **P. K. Gallagher**, and R. W. McCallum, submitted.
14. "Influence of Oxygen Partial Pressure on the Crystal Growth and Texture Formation of Some High- T_c Superconductors", T. Iwagoshi and **P. K. Gallagher**, submitted.
15. "Magnetization Jumps and Irreversibility in $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_8$ ", D. E. Farrell, E. Johnston-Halperin, L. Klein, P. Fournier, A. Kapitulnik, E. M. Forgan, A. I. M. Rae, T. W. Li, M. L. Trawick, R. Sasik (**Stroud Group**), and **J. C. Garland**, submitted to Phys. Rev. B.
16. "An Atomic Beam Study of a Superconductor's Magnetic Vortex Lattice", Samuel Dapore-Schwartz, Nathan G. Woodard, and **Gregory P. Lafyatis**, submitted to Phys. Rev. Lett.
17. "Thermodynamics and Critical Fields of $\text{YBa}_2(\text{Cu}_{1-x}\text{Ni}_x)\text{O}_{7-\delta}$ from a d -wave Model of Superconductivity", Eric R. Ulm and **Thomas R. Lemberger**, submitted to Phys. Rev. B.
18. "Numerical Modeling of a Two-coil Apparatus for Measuring the Magnetic Penetration Depth in Superconducting Films and Arrays", Stefan J. Turneaure, Eric R. Ulm, and **Thomas R. Lemberger**, submitted to J. Appl. Phys.
19. "Thermal Phase Fluctuations and the Low-temperature Behavior of the ab -plane Penetration Depth $\lambda(T)$ in $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ ", Eric R. Ulm and **Thomas R. Lemberger**, submitted to Phys. Rev. Lett.
20. "Vortex Pinning in the Frozen Vortex Lattice in $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ Films", Dimitrios G. Xenikos, Anne E. Cunningham, **Thomas R. Lemberger**, L. Hou, and **Michael McElfresh**, submitted.
21. "Gaussian Approximation Formalism for Evaluating Decay of NMR Spin-echoes", Charles H. Recchia, K. Gorny, and **Charles H. Pennington**, submitted to Phys. Rev. B.
22. "Finite U Effects in the Periodic Anderson Model: The Kondo-lattice Limit", Jan Karbowski and **Jozef Spalek**, submitted.
23. "Spin-charge Separated Luttinger Liquid in Arbitrary Spatial Dimensions", Krzysztof Byczuk and **Jozef Spalek**, submitted.
24. "Fermi-nonFermi Liquid Transition in a Magnetic Field: Comparison with Experiment", **Jozef Spalek**, Pawel Korbel, and W. Wójcik, submitted.
25. "Melting Curve of Condensed ^3He as a Mott-Hubbard Localization Boundary for He Atoms: Elementary Analysis and Comparison with Experiment", **J. Spalek**, submitted.

26. "Electronic Structure and Pairing of Strongly Correlated Fermions: Fermi Liquid Versus Spin Liquid", K. Byczuk, J. Karbowski, **J. Spalek** and W. Wójcik, submitted.
27. "Biaxially Aligned (013) YBa₂Cu₃O_{7-δ} Films on Vicinal (011) SrTiO₃", Daniel S. Linehan, **Eric P. Kvam**, Lifang Hou, and **Mike McElfresh**, submitted to Applied Phys. Lett.
28. "Single Variant Epitaxial YBa₂Cu₃O_{7-δ} Films on Vicinal (011) SrTiO₃", Daniel S. Linehan, **Eric P. Kvam**, Lifang Hou, and **Mike McElfresh**, submitted to Applied Phys. Lett.
29. "Superconducting Order Parameters with Sign Changes: the Density of States and Impurity Scattering", Gianfranco Preosti and **Paul Muzikar**, submitted to Phys. Rev. B.

MISCON THESES - 1995

MASTERS THESES

- "A Study of Effects of Processing Variables on the Y_2BaCuO_5 Distribution and Magnetic Properties of Melt Processed $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ ", Haifeng Yang, Department of Chemical Engineering, University of Notre Dame, August 1995, **(McGinn Group)**
- "Growth of Single Variant Epitaxial $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Thin Films on Vicinal (011) SrTiO_3 Substrates", Daniel S. Linehan, Department of Materials Engineering, Purdue University, August 1995, **(Kvam Group)**
- "Microstructural Evolution in Ag-BSCCO-2223 Superconductor Composites", Nicholas W. Medendorp, Jr., Department of Materials Engineering, Purdue University, May 1995, **(Trumble/Bowman/McElfresh Group)**

PH.D. THESES

- "Structural and Electronic Transport Studies of Oxide and Multilayered Materials", Wen-Chung Chiang, Department of Physics, Indiana University, April 1995, **(Baxter/Caulton/Chisholm Group)**
- "Flux Creep and Critical Currents in the Organic Superconductor $\kappa - (\text{ET})_2\text{Cu}(\text{NCS})_2$ ", David C. Bradford, University of Missouri-Columbia, **(Yelon/Farmer Group)**
- "Electrochemically Synthesized Nanostructures on Aluminum", Duo-Feng Yue, Department of Chemical Engineering, University of Notre Dame, June 1995, **(Miller/Bandyopadhyay Group)**
- "Penetration Depth Studies in Ni and Zn Doped $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ ", Eric Ulm, Department of Physics, Ohio State University, Summer Quarter, 1995, **(Lemberger Group)**
- "Superconducting Transitions and Vortex Dynamics of $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$ ", Yue Min Wan, Department of Physics, Ohio State University, March 1995, **(Garland Group)**
- "Quantum Effects in Josephson Arrays and High- T_c Superconductors", Eric Roddick, Department of Physics, Ohio State University, July 1995, **(Stroud Group)**

"The Magnetic-Field-Temperature Phase Diagram of High-Temperature Superconductors", Jim Deak, Department of Physics, Purdue University, June 1995, **(McElfresh/Kvam Group)**

"Penetration Depth and Density of States in Unconventional Superconductors: the Effects of Impurities", Gianfranco Preosti, Department of Physics, Purdue University, August 1995, **(Muzikar Group)**

"Effects of Colloidal and Deformation Processing on the Properties of Silver-clad BSCCO Tubes", Gregory Alan Steinlage, Department of Materials Engineering, Purdue University, December 1995, **(Trumble/Bowman/McElfresh Group)**

APPENDIX I

Research Program Listing

Area I: New and Improved High T_c Superconducting Materials: Phase Relations, Reactions, Synthesis and Processing

PI	Univ	Title	Funding	Affiliations	Students & Professionals	Status
D. V. Baxter K. G. Caulton M. H. Chisholm	IU	Low Temperature Routes to Processing of High-Temperature Superconductors	110,250		Wen-Chung Chiang C. Minear B. Borup J. Pinkas	Ph.D. awarded 1995 Ph.D. expected 1998 Ph.D. expected 1996 Postdoctoral Associate
M. Chandrasekhar	UM-Col	Optical Studies of New -123 and -124 Materials	74,885		Dale J. Payne Gingrui Cai	Ph.D. expected 1996 Ph.D. expected 1998
S. Liou	UN-L	Hg- and Tl-Based Superconducting Films	85,000		Fatt Foong Hanging Li Jon Ebmeier Steve Whalen G. L. Xu	Ph.D. expected 1996 Ph.D. expected 1998 Undergrad Undergrad Visitor
J. Betanabhatla J. R. Hardy R. R. Berlner	UN-O UN-L UM-Col	Investigation of Structure and Superconducting Properties Relationship in Copper-free Bismuth Oxides	90,331		Priya Ramachandran Apurva Mehta John Ulanday Randy Kasal	M.S. expected Postdoctoral Associate Undergrad Undergrad
P. J. McGinn	ND	Microstructural Dependence of Critical Current Density in Melt Textured YBa ₂ Cu ₃ O _{6+x} Superconductors	130,000	Superconductive Components, Inc. Plastronics, Inc.	H. Yang H. Balwada S. Yeung V. Chakripani A. Banerjee S. Einloth K. Johnson B. Conrad	M.S. awarded 8/95 M.S. expected 8/96 Ph.D. expected 12/97 Postdoctoral Associate Postdoctoral Associate Undergrad Undergrad Undergrad
K. H. Sandhage P. J. McGinn	OSU ND	Processing of Textured Superconducting Oxide/Noble Metal Microlaminates	94,500	Intermagnetics General Corp Ribbon Technology Corporation	M. Black S. Vilayannur	Ph.D. expected 12/95 Ph.D. expected 1/96

PI	Univ	Title	Funding	Affiliations	Students & Professionals	Status
K. H. Sandhage	OSU	Anisotropic Grain Growth and Isothermal Grain Alignment of Bulk, Superconducting Oxides	104,050	Superconductive Components, Inc.	R. Rogenski J. Gannon	M. S. expected 10/96 Ph.D. expected 10/97
D. R. Gaskell	PU	The Influence of Oxygen Pressure and Temperature on Oxygen Stoichiometry and Phase Equilibria in the System Bi-Sr-Ca-Cu-O	79,775		N. Medendorp, Jr.	Ph.D. anticipated 1998
J. M. Honig J. Spalek	PU	Effect of Substitutions on Superconducting Properties of High T_c Materials	83,365		P. A. Metcalf P. Somasundaram F. Chudnovskii K. Byczuk W. Wojcik	Professional Professional Visitor Visitor Visitor
G. L. Liedl Arden L. Bement, Jr.	PU	Processing and Texture Development in $YBa_2Cu_3O_{7-\delta}$ Films from Metallo-Organic Precursors	190,523		S. Mansour	Professional
E. P. Kvam	PU	Structural Defects and Interfaces in High T_c Superconducting Compounds	186,900		Y. Luo R. Zhu D. S. Linehan J. Dawley T. Brent M. VanEaton L. Williams D. L. Perry A. L. Vassiliev	M.S. anticipated 1996 M.S. anticipated 1997 M.S. Awarded 8/95 Undergrad Undergrad Undergrad Undergrad Professional Professional
K. P. Trumble M. W. McElfresh K. J. Bowman	PU	High Temperature Superconducting Tubes for Magnetic Shielding Applications	149,553		N. Medendorp, Jr. Robert Moon Greg Steinlage Shi Li T. Kanaby F. Loeffler P. Metcalf	M.S.E. awarded 1995 M.S.E. anticipated 1996 Ph.D. awarded 1995 Ph.D. anticipated 1996 Undergrad Undergrad Professional

PI	Univ	Title	Funding	Affiliations	Students & Professionals	Status
Area II: High T_c Superconductor Transport Properties: Controlling/Limiting Factors						
A. H. MacDonald S. M. Girvin	IU	Statistical Mechanics of High T _c Superconductors and Flux Line Liquids	90,000		Ross Hyman Erik Sørensen Ryusuke Ikeda Daijiro Yoshioka	Ph.D. anticipated 1996 Postdoctoral Associate Visitor Visitor
P. F. Miceli	UM-Col	Polarized Neutron Reflectivity Studies of High Temperature Superconductors	70,156		San Wook Han John Pitney	Ph.D. anticipated 1996 Grad Assistant
W. B. Yelon J. W. Farmer	UM-Col	Neutron Diffraction and Defect	86,826		D. Bradford M. Kornecki S. K. Malik D. L. Cowan	Ph.D. awarded 1995 Ph.D. expected 1997 Visitor Investigator
H. A. Blackstead	UND	Microwave and Optical Studies of High-Temperature Superconductors: Flux-Lattice Dynamics, Crystal Anisotropy, Flux Pinning and Photo-Modulated Superconductivity	114,000		A. Klunzinger P. Beeli D. B. Pulling	Ph.D. expected 1997 Ph.D. expected 1997 Professional
A. E. Miller S. Bandyopadhyay	ND	Superconducting Quantum Structures	102,743		G. Banerjee D. F. Yue D. Zimmerman	Postdoctoral Associate Postdoctoral Associate Undergrad
S. T. Ruggiero	ND	Transport Properties of YBCO Thin Films	62,651	HYPRES, Inc. WPAFB Jet Propulsion Lab NIST	C. Zhong	Grad Assistant
J. C. Garland	OSU	High T _c Superconducting Composites, Arrays and Crystals	136,883		J. S. Markus Y. M. Wan M. L. Trawick S. M. Ammirata C. Keener S. E. Hebboul H. J. Lee	M.S. expected 1996 Ph.D. awarded 1995 Ph.D. expected 1997 Ph.D. expected 1997 Postdoctoral Associate Professional Visitor

PI	Univ	Title	Funding	Affiliations	Students & Professionals	Status
G. P. Lafyatis	OSU	Atomic Beam Studies of Vortex Lattices at Superconductor Surfaces	79,800		H. Hauglin T. Barrett	Ph.D. expected 1996 Ph.D. expected 1996
T. R. Lemberger	OSU	Device-Related Properties of Doped YBa ₂ (Cu _{1-x} M _x) ₃ O _{7-δ} Films	80,576	Superconductive Components, Inc.	E. Ulm K. Paget S. Turneaure	Ph.D. awarded 1995 Ph.D. expected 1997 Ph.D. expected 1998
C. Pennington	OSU	NMR Studies of Vortex Dynamics in High T _c Superconductors	75,698		C. Hamm C. H. Recchia	M.S. expected 1996 Ph.D. expected 1996
D. G. Stroud	OSU	Dynamical Properties of Josephson-coupled Systems: Application to High-Temperature Superconductors	66,150		Eric Roddick Ing-Jye Hwang Roman Sasik K. Harbaugh A. Rozhkov Seungoh Ryu	Ph.D. awarded 1995 Graduate Student Graduate Student Graduate Student Graduate student Postdoctoral Researcher
G. F. Giuliani	PU	Transport Properties of High T _c Superconductors	73,500		M. Fistul	Postdoctoral Researcher
M. McElfresh E. Kvam	PU	Study of Vortex Dynamics and Flux Pinning on Different Length Scales	113,470	American Superconductor DuPont Superconductivity IBM Keithley Instruments Weizmann Institute Quantum Design	D. S. Linehan J. Deak Lifang Hou Victor Souw Weiyang Ding Katerina Moloni Mark Friesen Greg Fiete Burke Minsley Patti Metcalf	M.S. awarded 8/1995 Ph.D. awarded 6/1995 Ph.D. anticipated 1996 Graduate Student Graduate Student Postdoctoral Researcher Postdoctoral Researcher Undergrad Undergrad Professional
P. Muzikar	PU	Vortices in Anisotropic Superconductors	54,430		G. Presti Mark Friesen	Ph.D. awarded 8/95 Postdoctoral Associate

APPENDIX II

Cooperative Laboratory Interactions January 1995 - December 1995

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
SEMINAR AND GUEST SPEAKERS		
Sungkit Yip Northwestern University Evanston, IL	Invited Seminar Speaker	Purdue University
Erik Sorensen Indiana University	Invited Seminar Speaker	Ohio State University
Dierk Rainer University of Bayreuth Germany	Invited Seminar Speaker	Purdue University
Eric Kvam Purdue University	Invited Seminar Speaker	University of Missouri-Col
Supriyo Bandyopadhyay University of Notre Dame	Invited Seminar Speaker	University of Missouri-Col
David V. Baxter Indiana University	Invited Seminar Speaker	University of Nebraska-Lin
Mark Friesen University of Minnesota Minneapolis, MN	Invited Seminar Speaker	Purdue University
Katerina Moloni University of Minnesota Minneapolis, MN	Invited Seminar Speaker	Purdue University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Elia Zeldov Weizmann Institute of Science Rehovot, Israel	Invited Seminar Speaker	Purdue University
Alex Gurevich Applied Superconductivity Center University of Wisconsin-Madison	Invited Seminar Speaker	Purdue University
David Larbalestier Applied Superconductivity Center University of Wisconsin	Group Meeting Speaker	Holiday Inn Columbia, MO
Alan W. Kleinsasser Jet Propulsion Laboratory Pasadena, CA	Summer School Speaker	Holiday Inn Columbia, MO
Dale J. VanHarlingen University of Illinois Urbana-Champaign, IL	Summer School Speaker	Holiday Inn Columbia, MO
Laura H. Greene University of Illinois Urbana-Champaign, IL	Summer School Speaker	Holiday Inn Columbia, MO
David Stroud Ohio State University	Summer School Speaker	Holiday Inn Columbia, MO
David Rudman National Institute of Standards and Technology Boulder, CO	Summer School Speaker	Holiday Inn Columbia, MO
Mike McElfresh Purdue University	Invited Seminar Speaker	University of Missouri-Col
S. Lance Cooper University of Illinois Urbana-Champaign, IL	Invited Seminar Speaker	University of Missouri-Col

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Charles Pennington Ohio State University	Invited Seminar Speaker	University of Missouri-Col
Ken H. Sandhage Ohio State University	Invited Seminar Speaker	University of Notre Dame
Allan MacDonald Indiana University	Invited Seminar Speaker	University of Missouri-Col
PROGRAMMATIC EXCHANGE PROGRAM		
Erik Sorensen Givln/MacDonald Group Indiana University	Quantum Effects in Granular Superconductors	David Stroud Group Ohio State University
NIST Boulder, CO	Weak-Link Junctions and Nanoprobe Imaging Technology	Sy-Hwang Liou and Hanging Li University of Nebraska-Lin
Mike Kornecki Yelon/Farmer Group University of Missouri-Col	Crystal Growth Run	Greg Lafyatts Ohio State University
PARTNERSHIP AUGMENTATION GRANT		
Michael J. Tomsic Plastronics, Inc. Troy, Ohio	Processing of Textured Superconducting Oxide/Noble Metal Microlaminates	P. J. McGinn University of Notre Dame and K. H. Sandhage Ohio State University
Suvankar Sengupta Superconductive Components, Inc. Columbus, Ohio	Growth of Large NdBa ₂ Cu ₃ O _x Domains for Bearing Applications	P. J. McGinn University of Notre Dame
Elie K. Track HYPRES Corporation Elmsford, NY	Transport Properties of YBCO Thin Films	Steven Ruggiero University of Notre Dame

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
James R. Gaines, Jr. Superconductive Components, Inc. Columbus, Ohio	Development of Sputtering Targets of $Y_{1-x}Pr_xBa_2Cu_3O_7$, $YBa_2(Cu_{1-x}M_x)_3O_7$, and Related Materials	Thomas R. Lemberger Ohio State University
Alexis P. Malozemoff American Superconductor Corporation Westborough, MA	Effect of ac Magnetic Fields on Superconducting ac Currents	Mike McElfresh Purdue University
W. Barry Lindgren Quantum Design San Diego, CA	Automated Measurements of Superconducting Properties	Mike McElfresh Purdue University
CO-OP EFFORTS/COLLABORATIONS		
Eric Roddick Stroud Group Ohio State University	Collaboration	Erik Sørensen MacDonald/Girvin Group Indiana University
Mike McElfresh Purdue University	Discussions/Collaboration	A. H. MacDonald and S. M. Girvin Indiana University
Paul Miceli University of Missouri-Columbia	Discussions	A. H. MacDonald and S. M. Girvin Indiana University
A. Peter Young UCSC Santa Clara, CA	Vortex Glass Transition in 2D	S. M. Girvin Indiana University
M. P. A. Fisher UCSB Santa Barbara, CA	Vortex Glass Transition in 2D	S. M. Girvin Indiana University
Jun Hu National Magnet Lab Florida State University Tallahassee, FL	Monte Carlo Studies of the Random- pinning Ginzburg-Landau Models	S. M. Girvin and A. H. MacDonald Indiana University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Prof. J. Schilling Washington University St. Louis, MO	Experiment on Pressure Dependencies of Raman Modes in Ti 2201 Under Pressure	M. Chandrasekhar University of Missouri-Col
Dr. H. Chen Cray Research, Inc. Eagan, MN	Study of the Magnetism of Fe, Ni, and Zn Ions in Nd _{1.85} CeO _{1.5} CuO ₄ and their Role in the Suppression of Superconductivity	Betanabhatla, Hardy, and Berliner Group University of Nebraska-Lin
Prof. Howard Blackstead University of Notre Dame	Microwave Dissipation Studies	Betanabhatla, Hardy, and Berliner Group University of Nebraska-Lin
Paul McGinn University of Notre Dame	Collaborations	H. A. Blackstead University of Notre Dame
A. Miller and S. Bandyopadhyay University of Notre Dame	Collaborations	H. A. Blackstead University of Notre Dame
J. Farmer and W. Yelon University of Missouri-Col	Collaborations	H. A. Blackstead University of Notre Dame
J. Betanabhatla University of Nebraska-Omaha	Collaborations	H. A. Blackstead University of Notre Dame
K. Sandhage Ohio State University	Collaborations	H. A. Blackstead University of Notre Dame
J. Hong Purdue University	Collaborations	H. A. Blackstead University of Notre Dame
Doug Chrisey and J. Horwitz Naval Research Lab Washington, DC	Collaborations	H. A. Blackstead University of Notre Dame
Randy Treece Superconducting Core Technologies	Collaborations	H. A. Blackstead University of Notre Dame

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
J. Clem Iowa State University Ames, IA	Collaborations	H. A. Blackstead University of Notre Dame
Dan Oates MIT Cambridge, MA	Collaborations	H. A. Blackstead University of Notre Dame
J. Federici New Jersey Institute of Technology	Collaborations	H. A. Blackstead University of Notre Dame
Tim Peterson Wright Lab Wright Patterson Air Force Base	Collaborations	H. A. Blackstead University of Notre Dame
Jack Dow Arizona State University Tempe, AZ	Collaborations	H. A. Blackstead University of Notre Dame
Dr. R. E. Ricker NIST Gaithersburg, MD	Collaboration	A. E. Miller and S. Bandyopadhyay University of Notre Dame
Dr. J. A. Eastman Argonne National Laboratory Argonne, IL	Collaboration	A. E. Miller and S. Bandyopadhyay University of Notre Dame
Dr. Meera Chandrasekhar University of Missouri-Columbia	Optical Characterization	A. E. Miller and S. Bandyopadhyay University of Notre Dame
Dr. H. A. Blackstead and Dr. E. Wolf University of Notre Dame	Microwave Surface Resistance Measurements	A. E. Miller and S. Bandyopadhyay University of Notre Dame
Dr. Frank L. Madarasz and Dr. Partha Banerjee University of Alabama	Collaboration	A. E. Miller and S. Bandyopadhyay University of Notre Dame

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Dr. John Moore Colorado School of Mines Golden, CO	Collaboration	A. E. Miller and S. Bandyopadhyay University of Notre Dame
Alan Kleinsasser Jet Propulsion Laboratory Pasadena, CA	Collaborative Weak-link Studies	S. T. Ruggiero University of Notre Dame
Michael Kornecki J. Farmer Group University of Missouri-Columbia	Discussion of Techniques for Growing Large YBCO Crystals	G. Lafyatis Ohio State University
Drs. Eckstein and Bozovic Varian Palo Alto, CA	Collaborations	T. R. Lemberger Ohio State University
John Talvacchio Westinghouse Pittsburgh, PA	Discussions	T. R. Lemberger Ohio State University
Mike McElfresh Purdue University	Loan of rf Power Supply and matching network for rf Sputtering	T. R. Lemberger Ohio State University
Garland Group Ohio State University	Interactions on Interpreting Data on Magnetization of High-T _c Composites and on High-T _c Junctions and Arrays	D. Stroud Ohio State University
Pennington Group Ohio State University	Interaction on Interpreting Data on Vortex Diffusion in YBCO at High Magnetic Fields	D. Stroud Ohio State University
Lemberger Group Ohio State University	Interactions in Understanding Inverse Kinetic Inductance Measurements in High-T _c Materials	D. Stroud Ohio State University
MacDonald and Girvin Group Indiana University	Interactions in Developing Theory of Superconductor-Insulator Transition in Films with Long Range Coulomb Interactions	D. Stroud Ohio State University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Dr. M. B. Maple UCSD San Diego, CA	Theories of Magnetization in High- T_c Composites	D. Stroud Ohio State University
D. Farrell Case-Western Reserve University Cleveland, OH	Magnetization Jumps in High- T_c Materials	D. Stroud Ohio State University
A. Kapitulnik Stanford University Stanford, CA	Theories of IV Characteristics of Thin Superconducting Films	D. Stroud Ohio State University
S. Doniach and A. Kapitulnik Applied Superconductivity Group Stanford University Stanford, CA	Collaborations During Visit	D. Stroud Ohio State University
General Motors Research Laboratories Warren, MI	Discuss Theories of Supersolid Phases in Superconducting Films	E. Roddick Stroud Group Ohio State University
Research Personnel Los Alamos National Lab Los Alamos, NM	Visit and Discussions of Theories of Magnetization and Flux Lattice Melting in High- T_c Materials	R. Sasik Stroud Group Ohio State University
K. Sandhage Ohio State University	Film Preparations	Bement/Liedl Group Purdue University
K. Sandhage Ohio State University	X-ray Pole Figures	Bement/Liedl Group Purdue University
M. McElfresh Purdue University	Collaboration/Discussions	G. Giullani Purdue University
Dr. C. Carter NIST Gaithersburg, MD	Collaboration	E. Kvam Purdue University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Prof. A. Goldman University of Minnesota Minneapolis MN	Collaboration	E. Kvam Purdue University
Dr. U. Balachandran Argonne National Laboratory Argonne, IL	Collaboration and Student Exchange	E. Kvam Purdue University
Dr. C. E. Oberly Wright Patterson Air Force Base Wright Patterson, OH	Collaboration	E. Kvam Purdue University
John R. Clem Ames Lab Ames, IA	Collaboration	M. McElfresh Purdue University
Jerry Woodall Purdue University	Collaboration	M. McElfresh Purdue University
Mike Melloch Purdue University	Collaboration	M. McElfresh Purdue University
Ron Sager Quantum Design San Diego, CA	Collaboration	M. McElfresh Purdue University
Dean Face DuPont Central Research & Development Wilmington, DE	Collaboration	M. McElfresh Purdue University
Tom Lemberger Ohio State University	Collaboration	M. McElfresh Purdue University
Greg Lafyatis Ohio State University	Collaboration	M. McElfresh Purdue University
Kevin Shambrook Magnetic Power, Inc. Sebastopol, CA	Collaboration	M. McElfresh Purdue University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Alex Gurevich University of Wisconsin Madison, WI	Collaboration	M. McElfresh Purdue University
John Farmer University of Missouri-Col	Collaboration	K. Trumble, K. Bowman and M. McElfresh Purdue University
Stuart Bernon IBM T. J. Watson Research Center Yorktown Heights, NY	Collaboration	K. Trumble, K. Bowman and M. McElfresh Purdue University
Mike McHenry Carnegie-Mellon University Pittsburgh, PA	Collaboration	K. Trumble, K. Bowman and M. McElfresh Purdue University
Ross Muenchausen Los Alamos National Laboratory Los Alamos, NM	Collaboration	K. Trumble, K. Bowman and M. McElfresh Purdue University
Debra Kaiser NIST Gaithersburg, MD	Collaboration	K. Trumble, K. Bowman and M. McElfresh Purdue University
SAMPLE EXCHANGE/COLLABORATIONS		
Prof. P. Boolchand University of Cincinnati Cincinnati, OH	Y-124 Samples	M. Chandrasekhar University of Missouri-Col
Dr. M. Paranthaman Oak Ridge National Labs Oak Ridge, TN	Tl 2201 Samples	M. Chandrasekhar University of Missouri-Col
Prof. S. Bandyopadhyay University of Notre Dame	Raman Studies of Quantum Dots and Wires	M. Chandrasekhar University of Missouri-Col
J. Betanabhatla University of Nebraska	Samples of (Y,Pr) 124 and Ni and Zn Doped 124	M. Chandrasekhar University of Missouri-Col

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Prof. L. H. Greene Univ. Illinois Urbana-Champaign, IL	YBCO Films	P. F. Miceli University of Missouri-Col
Dr. D. H. Lowndes Oak Ridge National Laboratory Oak Ridge, TN	YBCO Films	P. F. Miceli University of Missouri-Col
Dr. E. Fullerton Argonne National Laboratory Argonne, IL	Metallic Films	P. F. Miceli University of Missouri-Col
M. Kramer and W. McCallum Ames Lab Ames, IA	PrBa _{2-x} La _x Cu ₃ O _{7-y} EuBa _{2-x} Pr _x Cu ₃ O _{7-y}	W. B. Yelon University of Missouri-Col
M. Paranthaman Oak Ridge National Lab Oak Ridge, TN	YNi ₂ B ₂ C(B-11 isotope)	W. B. Yelon University of Missouri-Col
S. H. Liou University of Nebraska	Hg/TlBa ₂ Ca ₂ Cu ₃ O _{8+d}	W. B. Yelon University of Missouri-Col
J. Schilling Washington University St. Louis, MO	PrSr ₂ Cu ₂ NbO ₈	W. B. Yelon University of Missouri-Col
H. Blackstead University of Notre Dame	Nd _{1+x} Ba _{2-x} Cu ₃ O _{8+d}	W. B. Yelon University of Missouri-Col
Prof. Meera Chandrasekhar University of Missouri-Col	Raman Spectroscopy Measurements	Betanabhatla, Hardy, and Berliner Group University of Nebraska-Lin
Prof. Eric Kvam Purdue University	(Hg, Tl) ₁ Ba ₂ Ca ₂ Cu ₃ O _{8+δ} Films for Microstructure Study	Sy-Hwang Liou University of Nebraska-Lin

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Prof. W. B. Yelon University of Missouri-Col	(Hg, Tl) ₁ Ba ₂ Ca ₂ Cu ₃ O _{8+δ} Films for Neutron Diffraction Study	Sy-Hwang Liou University of Nebraska-Lin
Prof. Mike McElfresh Purdue University	Tl ₂ Ba ₂ Ca ₂ Cu ₃ O _x and Tl ₁ Ba ₂ Ca ₂ Cu ₃ O _x Films for AC Magnetic Measurements	Sy-Hwang Liou University of Nebraska-Lin
Dr. Felix A. Miranda NASA-Lewis Research Center	Study of Microwave Properties of Tl Based Superconducting Films	Sy-Hwang Liou University of Nebraska-Lin
Drs. David Rudman, Ronald H. Ono, and John Moreland NIST Boulder, CO	Study of Grain Boundaries of Tl and Hg-Based Superconducting Films	Sy-Hwang Liou University of Nebraska-Lin
Prof. Robert Snyder Alfred University Alfred, NY	Sample Exchange and Joint Project	P. J. McGinn University of Notre Dame
Dr. John Hull Argonne National Laboratory Argonne, IL	Sample Measurements (Levitation Force Measurements)	P. J. McGinn University of Notre Dame
Dr. R. C. Tucker Praxair Indianapolis, IN	Evaluation of Anodized Template Samples	A. E. Miller and S. Bandyopadhyay University of Notre Dame
Tim Peterson and Eric Moser Wright Patterson Air Force Base Wright Patterson, OH	AFM Measurements of YBCO-on-Ag Systems	S. T. Ruggiero University of Notre Dame
David Rudman NIST Boulder, CO	Laser Ablated YBCO Thin Films and S/N/S Weak-Link Systems for FIR Measurements	S. T. Ruggiero University of Notre Dame
Elle Track HYPRES, Inc. Elmsford, NY	Transport Studies of YBCO Thin Films	S. T. Ruggiero University of Notre Dame

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Greg Firpo, Albert Cardona, Erik Smith Superconductor Technologies, Inc. Santa Barbara, CA	YBCO Preparation Techniques	S. T. Ruggiero University of Notre Dame
M. McElfresh Purdue University	YBCO Crystal	G. Lafyatis Ohio State University
James R. Gaines Superconductive Components, Inc. Columbus, Ohio	Optimization of Bulk Powders of Doped High-T _c Superconductors	T. R. Lemberger Ohio State University
Carmen C. Almasan Kent State University Kent, OH	High T _c Composite Magnetization Measurements	J. C. Garland Ohio State University
David E. Farrell Case Western Reserve University Cleveland, OH	Bi ₂ Sr ₂ CaCu ₂ O _{8-y} Crystals	J. C. Garland Ohio State University
Russell W. Giannetta University of Illinois Urbana-Champaign, IL	Bi ₂ Sr ₂ CaCu ₂ O _{8-y} Crystals	J. C. Garland Ohio State University
Howard A. Blackstead University of Notre Dame	Bi ₂ Sr ₂ CaCu ₂ O _{8-y} Crystals	J. C. Garland Ohio State University
Charles Pennington Ohio State University	Bi ₂ Sr ₂ CaCu ₂ O _{8-y} Crystals	J. C. Garland Ohio State University
Thomas R. Lemberger Ohio State University	YBa ₂ Cu ₃ O ₇ /Ag Arrays	J. C. Garland Ohio State University
Dale Van Harlingen University of Illinois Urbana-Champaign, IL	Bi ₂ Sr ₂ CaCu ₂ O _{8-y} Crystals	J. C. Garland Ohio State University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
National Nanofabrication Facility Cornell University Ithaca, NY	High T _c Array Fabrication	J. C. Garland Ohio State University
Jim Smith and W. L. Hults Los Alamos National Lab Los Alamos, NM	¹⁷ O Enriched Powder Samples of YBa ₂ Cu ₃ O ₇	C. H. Pennington Ohio State University
Dr. James Eckstein Varian, Inc. Palo Alto, CA	Bi ₂ Sr ₂ CaCu ₂ O ₈ and Related Bi-based films	T. R. Lemberger Ohio State University
Dr. Igor Trofimov Prof. Peter Lindenfeld's Group Rutgers University Piscataway, NJ	La _{2-x} Sr _x CuO ₄ Films	T. R. Lemberger Ohio State University
Dr. John Talvacchio Westinghouse Corp. Pittsburgh, PA	YBa ₂ (Cu _{1-x} Co _x) ₃ O _{7-δ} and Y _{1-x} Pr _x Ba ₂ Cu ₃ O _{7-δ} Films	T. R. Lemberger Ohio State University
Prof. Sy-Hwang Liou University of Nebraska-Lincoln Lincoln, NE	T _V -based films	T. R. Lemberger Ohio State University
Farida Mohiuddin-Jacobs Michigan State University Lansing, MI	Samples	J. Honig Group Purdue University
Paul J. McGinn University of Notre Dame	Samples and Collaboration	E. Kvam Purdue University
INDUSTRIAL CONTACTS		
J. Abbott and I. Abbott Nimet, Inc. South Bend, IN	Development of Joint Research Proposal to be submitted to MISCON and SBIR	A. E. Miller and S. Bandyopadhyay University of Notre Dame

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
INDUSTRIAL AFFILIATES		
American Superconductor Corporation Alex Malozemoff Westborough, MA	Written Agreement	M. W. McElfresh Purdue University
AT&T Bell Labs Dr. David J. Bishop Murray Hill, NJ	Written Agreement	MISCON Researchers
DuPont Superconductivity Dr. Dean W. Face Wilmington, DE	Written Agreement	M. W. McElfresh Purdue University
HYPRES, Inc. Elie K. Track Elmsford, NY	Written Agreement	S. Ruggiero University of Notre Dame
IBM Thomas J. Watson Research Center Dr. Stuart Berman Yorktown Heights, NY	Written Agreement	M. W. McElfresh Purdue University
Intermagetics General Corporation Dr. Pradeep Halder Guilderland, NY	Equipment Access	K. Sandhage, P. McGinn Ohio State University University of Notre Dame
Jet Propulsion Laboratory Alan Kleinsasser Pasadena, CA	Written Agreement	Steven Ruggiero University of Notre Dame
Keithley Instruments Cleveland, OH	Written Agreement	M. W. McElfresh, A. L. Bement, Jr. Purdue University
Lake Shore Cryotronics, Inc. B. C. Dodrill Westerville, OH	Written Agreement	MISCON Researchers

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
NIST David Rudman Boulder, CO	Written Agreement	Steven T. Ruggiero University of Notre Dame
Plastronics, Inc. Michael J. Tomsic Troy, OH	Written Agreement	Paul J. McGinn University of Notre Dame
Quantum Design Dr. Ronald E. Sager and Dr. Barry Lindgren San Diego, CA	Written Agreement	M. W. McElfresh Purdue University
Ribbon Technology Corporation Dr. Tom Gaspar Gahanna, OH	Equipment Access	K. Sandhage, P. McGinn Ohio State University University of Notre Dame
Edward R. Funk Superconductive Components, Inc. Columbus, Ohio	Written Agreement	K. Sandhage Ohio State University
TRW Superconductivity Research Stephen M. Schwarzbek Redondo Beach, CA	Written Agreement	MISCON Researchers
Dr. Ella Zeldov The Weizmann Institute of Science Rehovot, Israel	Written Agreement	M. W. McElfresh Purdue University
Wright Patterson AFB Wright Patterson, OH	Written Agreement	S. Ruggiero University of Notre Dame
FOREIGN INTERACTIONS		
Mats Wallin Royal Institute of Technology Stockholm, Sweden	Statistical Mechanics of Vortices in High T_c Materials	S. M. Girvin Indiana University
S. K. Malik Tata Inst.	Pr123 Related Compounds $Y_{1-x}Pr_xBa_{2-y}Sr_yCu_3O_{7-z}$	W. B. Yelon University of Missouri-Col

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Prof. Barbara Wanklyn National Crystal Growth Center University of Oxford, England	Single Crystals	Betanabhatla, Hardy, and Berliner Group University of Nebraska
Prof. G. Leising Technische Universitat Graz, Austria	Crystals	Betanabhatla, Hardy, and Berliner Group University of Nebraska
Dr. Chaillout Laboratoire de Crystallographie Grenoble, France	TEM Studies	Betanabhatla, Hardy, and Berliner Group University of Nebraska
R. Jardim University of São Paulo Brazil	Collaborations	H. A. Blackstead University of Notre Dame
Dr. Atit Bhargava Uniquist Limited University of Queensland Brisbane, Australia	SLMG Samples	P. J. McGinn University of Notre Dame
Dr. Chan-Joong Kim Superconductivity Research Laboratory Korean Atomic Energy Research Institute Taejon, Korea	Sample Exchange	P. J. McGinn University of Notre Dame
Dr. Vladimir Dneprovskii and Dr. E. Zhukov Institute of Physics Moscow State University	Collaboration	A. E. Miller and S. Bandyopadhyay University of Notre Dame
Hu Jong Lee Pohang Institute of Science and Technology South Korea	$\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8-y}$ Crystals Transport Measurements	J. C. Garland Ohio State University
Magneto-optic Imaging Group University of Oslo	YBCO Crystals	G. Lafyatis Ohio State University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
R. Jardim University of São Paulo Brazil	Discussions on Theories of Magnetization in High-T _c Composites	D. Stroud Ohio State University
R. Jardim University of São Paulo Brazil	Visited OSU and Discussed Joint Work	D. Stroud Ohio State University
Prof. P. M. Hui Chinese University Hong Kong	Collaborations on Various Properties of Superconducting Composites	D. Stroud Ohio State University
Prof. D. J. Bergman Tel Aviv University	Collaborations on Transport Properties of Superconducting Composites	D. Stroud Ohio State University
Dr. Luca Viviani Centro Studi Nucleari Enrico Fermi Cesnef, Italy	Samples	J. Honig Group Purdue University
M. Pieper University of Hamburg Germany	Samples	J. Honig Group Purdue University
C. Sood Indian Institute of Science Bangalore, India	Samples	J. Honig Group Purdue University
Dr. Paolo Mutti Politecnico di Milano Italy	Samples	J. Honig Group Purdue University
Felix Chudnovskii Physical Technical Institute Russia	Samples	J. Honig Group Purdue University
Alvaro Sanchez Universitat Autònoma de Barcelona Barcelona, Spain	Collaboration	M. McElfresh Purdue University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Coryn Haugue Universite Pierre and Marie Curie Paris, France	Collaboration	M. McElfresh Purdue University
Eli Zeldov Weizmann Institute Rehovot, Israel	Collaboration	K. Trumble, K. Bowman and M. McElfresh Purdue University

APPENDIX III

Partnership Augmentation Grants

NAME/UNIVERSITY	PROJECT TITLE	COLLABORATION
Paul J. McGinn University of Notre Dame	Growth of Large $\text{NdBa}_2\text{Cu}_3\text{O}_x$ Domains for Bearing Applications	Suvankar Sengupta Superconductive Components, Inc.
Mike McElfresh Purdue University	Automated Measurements of Superconducting Properties	W. Barry Lindgren Quantum Design
Paul J. McGinn University of Notre Dame	Processing of Textured Superconducting Oxide/Noble Metal Microlaminates	Michael Tomsic Plastronics, Inc.
Steven T. Ruggiero University of Notre Dame	Transport Properties of YBCO Thin Films	Elie K. Track HYPRES Corporation
Thomas R. Lemberger Ohio State University	Development of Sputtering Targets of $\text{Y}_{1-x}\text{Pr}_x\text{Ba}_2\text{Cu}_3\text{O}_7$, $\text{YBa}_2(\text{Cu}_{1-x}\text{M}_x)_3\text{O}_7$, and Related Materials	James R. Gaines, Jr. Superconductive Components, Inc.
Mike McElfresh Purdue University	Effects of ac Magnetic Fields on Superconducting ac Currents	Alex Malozemoff American Superconductor

APPENDIX IV
ORGANIZATION

January 1, 1995 - December 31, 1995

Name	Location	Telephone Number
A. SPONSOR		
Robert Gottschall	Division of Materials Sciences Office of Basic Energy Sciences U.S. Department of Energy	301-353-3428
B. OFFICE OF THE DIRECTOR		
Arden L. Bement, Jr. Director	Purdue University	317-494-5567
Michael McElfresh Assistant Director	Purdue University	317-494-5567
Rebecca Herr Assistant to the Director	Purdue University	317-494-5567
C. COMMITTEES		
a. Steering Committee:		
Luis M. Proenza Vice President for Research	Purdue University	317-494-2604
George E. Walker Vice President for Research and Dean of the Graduate School	Indiana University	812-855-6394
Ronald J. Turner Special Assistant to the President	University of Missouri-Columbia	314-882-2011
James B. Milliken Vice President for External Affairs	University of Nebraska	402-472-3906
Nathan O. Hatch Vice President for Advanced Studies	University of Notre Dame	219-239-6291
Richard S. Stoddard Special Assistant to the President for Research	The Ohio State University	614-292-1582
Gerald L. Liedl Ex Officio Member	Purdue University	317-494-5567
Arden L. Bement, Jr. Director and Ex Officio Member	Purdue University	317-494-5567

<u>Name</u>	<u>Location</u>	<u>Telephone Number</u>

b. Program Committee:

Gerald L. Liedl Chair	Purdue University	317-494-5567
Arden L. Bement, Jr. Director	Purdue University	317-494-5567
Michael McElfresh Assistant Director	Purdue University	317-494-5567
Paul McGinn Leader, Group I	University of Notre Dame	219-239-6151
James C. Garland Leader, Group II	The Ohio State University	614-292-7277
David V. Baxter	Indiana University	812-855-8337
Meera Chandrasekhar	University of Missouri - Columbia	314-882-2619
David Sellmyer	University of Nebraska	402-472-2407
Jurgen M. Honig	Purdue University	317-494-5279
John Mundy Program Manager	Division of Materials Sciences Office of Basic Energy Sciences Department of Energy	301-353 3428
Rebecca Herr Assistant to the Director (non-voting member)	Purdue University	317-494-5567

D. PRINCIPAL INVESTIGATORS:

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Steven M. Girvin	Indiana University	812/855-3735
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John W. Farmer	University of Missouri - Columbia	573/882-5249
Paul F. Miceli	University of Missouri - Columbia	573/882-8328
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Ronald R. Berliner	University of Missouri - Columbia	314/882-4211
John R. Hardy	University of Nebraska - Lincoln	402/472-2772
Sy-Hwang Liou	University of Nebraska - Lincoln	402/472-2405
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Paul J. McGinn	University of Notre Dame	219/631-6151
Albert E. Miller	University of Notre Dame	219/631-8307
Supriyo Bandyopadhyay	University of Notre Dame	219/631-5693
Steven T. Ruggiero	University of Notre Dame	219/631-7463
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Ken H. Sandhage	Ohio State University	614/292-6731
David G. Stroud	Ohio State University	614/292-8140
David Gaskell	Purdue University	317/494-7703

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Mike McElfresh	Purdue University	317/494-6605
Paul F. Muzikar	Purdue University	317/494-3046
Kevin P. Trumble	Purdue University	317/494-4114
Keith J. Bowman	Purdue University	317/494-6316