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Midwest Superconductivity Consortium

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SUMMARY

The mission of the Midwest Superconductivity Consortium, MISCON, is to advance the science and understanding of high T_c superconductivity. Programmatic research focuses upon key materials-related problems; principally, synthesis and processing and properties limiting transport phenomena. During the past year, twenty six (26) projects produced over one-hundred and thirty-three (133) talks and one-hundred and thirteen (113) publications. Two (2) Master's Degrees and one (1) Doctor's of Philosophy Degree were granted to students working on MISCON projects.

Group activities and interactions involved two (2) MISCON group meetings (held in July and January), twenty (20) external speakers, thirty-six (36) collaborations, ten (10) exchanges of samples and/or measurements, and one (1) gift of equipment from industry.

Research achievements this past year expanded our understanding 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, the magnetic shielding properties of a superconducting tube were measured.

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 tunneling conductance from pulsed laser deposited films of $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ revealed a rich fine structure in both the sub-gap and near-gap regions, which corresponds to the density of electronic states on the different layered planes (T.G. Miller, M. McElfresh and R. Reifenberger, Purdue University).
- Monte Carlo simulations of vortex dynamics yielded a superfluid-density spatial correlation function which advances the understanding of the flux-lattice melting transition (A.H. MacDonald and S.M. Girvin, Indiana University).
- The influence of vortices upon the transmission and reflection coefficients for infrared radiation incident upon high-temperature superconductors was theoretically described (W.J. Tomasch and E. Moser, University of Notre Dame, and J.R. Clem and V.G. Kogan, Iowa State University).
- A new class of ligand was developed, based on " β -diketonate" class of ligands, which encapsulates YBCO metals for use as precursors for the low-temperature processing of high-temperature superconductors (D.V. Baxter, K.G. Caulton and M.H. Chisholm, Indiana University).
- A novel "oscillating oxidation" process yielded superconducting microlaminates composed of alternating $\text{YBa}_2\text{Cu}_3\text{O}_y$ -rich and Ag-rich layers (K.H. Sandhage, Ohio State University and P.J. McGinn, University of Notre Dame).
- A leadless nondestructive microwave technique was developed for the quantitative evaluation of high-temperature superconductors in the presence of substantial d.c. magnetic fields (W.J. Tomasch and J.K. Furdyna, University of Notre Dame).

PROGRAM OVERVIEW

The Midwest Superconductivity Consortium, MISCON, in its third year of operation, has further developed its mission to advance the science and understanding of high T_c superconductivity. The goals of the organization were modified to reflect the current state of knowledge in the field and the unique capabilities of the institutions involved. An emphasis on group efforts was strengthened, and the foundations for industrial involvement coupled with technology transfer were expanded. Activities of the participants during the past year illustrate an interactive and high level of performance.

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-eight (38) principal investigators. The research projects involve seven (7) undergraduate students, forty-five (45) graduate students and thirteen (13) postdoctoral associates. In the past year, these participants have published fifty-two (52) papers. Eight (8) more papers are in press and an additional fifty-three (53) have been submitted. Further, the participants have given over one-hundred and thirty-three (133) talks or conference presentations. During this past year, two (2) Master's Degrees and one (1) Doctor's of Philosophy degree were granted to students working on MISCON projects.

Group activities and interactions with others were again a major strength of the operation. 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 reviewed the goals and programmatic research. A revision of each was instituted to provide the framework for the new focus of the program. Coupled with the group meetings, the participants were very active in cooperative interactions with other organizations. Among these activities were twenty (20) external speakers, thirty-six (36) collaborations, ten (10) exchanges of samples and/or measurements, and one (1) gift of equipment from industry.

Group activities are fostered by three 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. Finally, a special capital equipment competition addresses group needs as the primary requirement. Cost sharing realized over \$290K worth of equipment, that was selected to provide new capabilities to the consortium, with less than \$133K of MISCON funds invested.

The extensive nature of industrial and national laboratory interactions made it important that a more formal structure be implemented. Such a procedure, which is now operational, makes all participants more aware of these activities and better enables technology transfer through a more efficient flow of information. Seven (7) written agreements and two (2) equipment access agreements were formalized this year with nine (9) different industry and national laboratory groups. Three (3) additional formal agreements are pending.

Two program reviews were conducted during the year. The first, conducted by an independent expert panel commissioned by MISCON, reviewed proposed research projects. The panel was comprised of representatives from academia, industry, and a federal laboratory. The second review was conducted by an independent panel commissioned by the Department of Energy (DOE), and used a methodology developed by the DOE Office of Program Assessment. The results of this review was consistent with the initial reviews of the project by MISCON commissioned panels. Both reviews rated approximately 40% of the projects as strong or very good (or better). Two projects were identified as requiring close reevaluation by program management. Appropriate actions in response to these reviews are being taken by the MISCON Administration.

RESEARCH PROGRAM THRUSTS

MISSION: The basic mission of the Consortium is to advance the science and understanding of high- T_c superconductivity and to promote the development of new materials and improved processing technology for 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: High-Temperature 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: Transport Properties of High-Temperature Superconductors:
Optimization of Critical Currents, Magnetic Screening,
Dynamical Behavior and Other 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. Six (6) 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: High-Temperature Superconducting Materials: Phase Relations, Reactions, Synthesis and Processing

Low Temperature Routes to Processing Superconducting Materials: Phase Relations, Reactions, Synthesis and Processing

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

Indiana University

Advanced Technology Materials, Inc.*

The objectives of this research project are:

- 1. To elucidate the mechanisms through which molecular precursors are transformed into superconducting materials; and*
- 2. To use this knowledge to improve the design of new generations of precursors.*

The bulk of our activity over the last six months has been devoted to the construction of our CVD reactor and to the study of Ba and Cu precursor chemistry. Construction of our remote PECVD chamber is complete.

We have also developed a new class of ligand in which to encapsulate YBCO metals for use as precursors. These ligands result from applying some chemical "tuning" to the commonly employed " β -diketonate" class of ligands.

***Crystallization of REBa₂Cu₃O_{7-x} High Temperature Superconducting
Materials from the Solidified Melt***

R. W. McCallum, M. J. Kramer, and L.S. Chumbley

Iowa State University

The goal of this project is to study the crystallization of RE123 phase materials formed from highly disordered (i.e., amorphous) material.

Using a novel melt-spinning technique, we have been able to produce both amorphous and nanocrystalline NdBa₂Cu₃O_{7-x} and GdBa₂Cu₃O_{7-x} materials. Samples melt-spun in O₂ consist of nanocrystals with the tetragonal 123 structure, while those processed in N₂ show an amorphous matrix with small amounts of crystalline BaCu₂O₂, as shown by XRD and TEM studies. The differences are due to the strong dependence of the phase relations on the O₂ partial pressure. Superconductivity can be fully restored by heating above 1000°C followed by a 450°C anneal in O₂. High temperature XRD studies show that the 123 phase crystallizes directly from the amorphous matrix below 800°C. Poor superconducting properties for samples heated below 1000°C are attributed to disorder on the heavy metal sites.

Crystallization of High Temperature Superconducting Filaments

A. I. Goldman, D. K. Finnemore, and L. S. Chumbley

Iowa State University

The objectives of this research project are:

- 1. To develop a science-base for melt texturing and the crystallization of Bi (2212) and related systems; and*
- 2. To understand how to manipulate processing parameters during melt-textured growth in order to maximize texturing, introduce secondary phases that act as flux pinning centers, and incorporate Ag into the system to produce strain-tolerant conductors.*

Crystallization studies of Bi (2212) have been carried out in order to study the reaction kinetics of the growth of Bi (2212) from the liquid as a function of oxygen partial pressure and temperature. In-situ high temperature x-ray studies of the decomposition of $(\text{Bi-Pb})_2\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_{7-\delta}$ show that the compound transforms to Bi (2201) plus Ca_2PbO_4 plus $(\text{Ca}_2\text{Sr})_2\text{O}_3$ plus liquid as it decomposes. This is an indication that Bi (2201) may be a preferred starting material for the formation of Bi (2223). It has generally been thought that Bi (2212) was the best starting material for tapes because its mechanical properties give good grain alignment.

Microstructural Dependence of Critical Current Density in Melt Textured

$\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ Superconductors

P. J. McGinn

University of Notre Dame

The goal for this project is to extend the understanding of the fundamental process occurring during melt texturing of YBCO in order to improve its properties and processability.

Studies were performed on 211 doped wires processed by zone melt texturing. Some key results are:

- Externally added 211 acts as a nucleation site for 211 formation during melt texturing.
- PtO_2 additions to melt textured 123 refine the 211 and align the fine (1 micron) 211 particles in tracks within the melt textured crystals.
- An alternative texturing technique to quench processing, using precursors of Y_2O_3 plus prereacted barium cuprate, has been developed. Very fine 211 precipitates are formed and excellent magnetic properties are observed.

Processing of Textured Superconducting Oxide/Noble Metal Microlaminates

Ken H. Sandhage

Ohio State University

P.J. McGinn

University of Notre Dame

Intermagnetics General Corporation*

Ribbon Technology Corporation*

The objective of this research program is to produce fracture-tough, high J_c superconducting composites.

Initial results of this first year project include:

- Sufficient lowering of $p\text{O}_2$ permits melting of Y-123 at temperatures below the melting point of silver.
- A special thermogravimetric apparatus capable of monitoring weight changes during oscillating oxidation heat treatments has been designed.
- An inert atmosphere melt spinning apparatus for preparing rapidly solidified Y-Ba-Cu-X (X=Ag, Ag-Pd) alloys has been constructed and is operational.

- Preliminary oscillating oxidation experiments, using melt-spun ribbon obtained from American Superconductor Corporation, are underway.

***Improved Synthetic Techniques for High- T_c Superconductors with
Deliberate Additions of a Second Phase***

Patrick K. Gallagher

Ohio State University

The objectives of this research project are:

- 1. To adapt two chemical synthetic methods, which have proven successful in the Ba-Y-Cu-O high T_c systems, to produce reactive powders in the Ba-Sr-Ca-Cu-O systems; and*
- 2. To introduce additions of ultimately insoluble impurities to provide well distributed sites to cluster and nucleate second phase formation. These sites will serve for flux pinning and raising the current carrying capacity of the superconductor.*

Two chemical synthetic methods, the "clean oxalate" precipitation approach and the "anionic oxidation-reduction" process, are under study. Samples prepared with the direct addition of either a colloidal suspension of ZrO_2 or zirconium nitrate to stoichiometric amounts of Ba, Y, and Cu in an oxalic acid precipitation media produced multiphase samples. The magnetic susceptibility of the porous pellets indicated the onset of superconductivity between 90 and 95°C; the onset was reasonably sharp at low magnetic field (<0.01 Tesla). The amount of superconducting phase decreases and the transition broadens as the magnetic field is increased to 1 Tesla. We also investigated the distribution of second phases obtained via the "anionic oxidation-reduction" processing of stoichiometric 123 additions of zirconium and barium nitrates, or alternatively, magnesium nitrate sufficient to form 2 vol% of $BaZrO_3$ or MgO , respectively, in the calcined product. The initial measurements on both powders and sintered pellets are encouraging. Only the desired second phase appears in the calcine powders with the additions. However, the magnetic susceptibility measurements do not show as sharp

nor as high a temperature superconducting transition as the oxalate materials. Incomplete oxygen annealing is expected to be the cause of this broad transition.

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

Ken H. Sandhage

The Ohio State University

The goals of this research program are:

- 1. To understand the influence of various processing parameters (temperature, composition, oxygen partial pressure) on the grain growth of superconducting oxides; and*
- 2. To tailor the growth of superconducting oxide grains to allow for isothermal grain alignment.*

Results during the year include:

- Dense, fine-grained $\text{YBa}_2\text{Cu}_3\text{O}_y$ and $\text{Nd}_{1+x}\text{Ba}_{2-x}\text{Cu}_3\text{O}_y$ pellet specimens have been produced by hot isostatic pressing of sol-gel-derived powders. Isothermal grain growth experiments are underway.
- $\text{Ba}_2\text{Sr}_2\text{Ca}_1\text{Cu}_2\text{O}_y$ thick films have been produced by spray pyrolysis of nitrate solutions. Experiments aimed at determining the effects of oxygen partial pressure, composition, and temperature on phase evolution and grain alignment during melt processing of these films are underway.

***High Temperature Superconducting Tubes for Magnetic Shielding
Applications***

***K. P. Trumble, M.W. McElfresh, and K.J. Bowman
Purdue University
Quantum Magnetcs****

The objectives of this research project are:

- 1. To develop processes for building superconductivity shield tubes;*
- 2. To characterize the texture of the processed tubes; and*
- 3. To study the properties of superconducting shield tubes.*

Progress has been made in three main areas of this first year project: tube processing, texture characterization and magnetic shielding measurements. In the initial phase of the project, our efforts have resulted in the constructing of a centrifugal slip casting apparatus, building a system to study shielding properties of superconducting shield tubes, and measuring the ac and dc magnetic shielding of polycrystalline YBCO tube. The tube was found to shield only 15 Oe at 77K because of the very low current densities of polycrystalline YBCO. Little frequency dependency was observed over the narrow range of frequencies studied.

***Study of Compositional Modulation in High-Temperature Superconductor
Structures***

and Its Influence on Their Superconducting Properties

K. M. Choudhary and S. T. Ruggiero

University of Notre Dame

The objectives of this project are to study the fabrication and characterization of HTSC composites, multilayers, modulated structures, thin films, and other useful structures employing the following specific approaches:

- 1. Development of newly discovered ErBaCuO compounds;*
- 2. Productions of HTSC/AMnO₃ multilayers; and*
- 3. Introduction of controlled defects to pin flux and thereby increase J_c .*

In our efforts on composition modulations there have been three areas of accomplishments. First, two new high- T_c superconductor materials in thin film form have been synthesized by molecular beam deposition. These materials are Er₅Ba₇Cu₁₂O_y and Er₄Ba₅Cu₉O_y ($T_c=93-95K$). Second, superconductivity in Dy_{1+x}Ba_{2-x}Cu₃O_y and Er_{1+x}Ba_{2-x}Cu₃O_y ($x=0$ to 0.42) thin films have been studied. Third, epitaxial DyMnO₃ and BiAlO₃ insulator thin films have been made.

In our research on structural modulation of YBCO thin films by defects, (S.T. Ruggiero) we demonstrated an increase in critical current on c-axis oriented Y₁Ba₂Cu₃O_{7- δ} (YBCO) films using 75 Å Ag particles on LaAlO₃ substrates compared with YBCO on virgin substrates (from 2×10^4 to 1×10^5 A/cm²).

High T_c Superconducting Composites/Films

J. C. Garland

The Ohio State University

The objectives of this project are:

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

A. High- T_c Ag/YBa₂Cu₃O₇ Superconducting Composites: We have developed a bulk superconducting composite material which combines the mechanical advantages of normal metals, i.e., high thermal conductivity, machinability, and low normal state resistivity, along with the superconducting properties of high- T_c oxide superconductors. The Ag/YBCO composite is superconducting at 90K with as little as 16% volume fraction of superconductor. Since it is readily machined, the composite is perfectly suitable for applications which do not require very high critical densities. Possible applications include superconducting enclosures, shields, partitions, high-Q tuned cavities, and superconducting bonding materials.

B. Transport Properties of Bi₂Sr₂CaCu₂O₈ Single Crystals:

(i) Two-Stage Zero-Field Resistive Transition Bi₂Sr₂CaCu₂O₈ single crystals (0.5x1.0x0.03mm), which were grown using a standard solid state melt process, displayed unusual behavior near the superconducting transition. The ab-plane and the c-axis resistivities, as well as current vs. voltage in zero applied magnetic field, showed that these layered crystals are characterized by two distinct resistive transition temperatures. The ab-plane transition temperature, T_c^{ab} =84.3K, corresponds to a Kosterlitz-Thouless type vortex-antivortex unbinding temperature, whereas the c-axis transition temperature, T_c^c =86.5K, is associated with the onset of a critical current.

(ii) Inter-Plane Josephson Coupling of Thermally Excited Vortices The implications of a sequential zero-field resistive transition on thermally excited vortices and correlations were investigated in $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_8$ single crystals. Our "flux-transformer" measurements in a zero applied magnetic field showed that the Josephson interaction couples free vortices and antivortices on adjacent CuO_2 bi-layers in the temperature range $T_c^{\text{ab}} < T < T_c^{\text{c}}$. The results were in good agreement with a model based on the interplay of the c-axis Josephson interaction and the ab-plane free vortex dynamics.

Superconducting Characteristics of $\text{La}_{2-x}\text{Sr}_x\text{Cu}_{1-y}\text{Ni}_y\text{O}_4$ Systems: Effect of Substitutions on the Stability of the Superconducting Phase

J. M. Honig and J. Spalek

Purdue University

The two questions being addressed by this project are:

- 1. What is the influence on T_c of Ni substitutions for Cu as a function of the Sr concentration in $\text{La}_{2-x}\text{Sr}_x\text{Cu}_{1-y}\text{Ni}_y\text{O}_{4+\delta}$?*
- 2. What is the influence on T_c of fluorine insertion into $\text{La}_{2-x}\text{Sr}_x\text{Cu}_{1-y}\text{Ni}_y\text{O}_{4+\delta}$?*

Electrical resistivity and magnetization measurements have been carried out on the $\text{La}_{2-x}\text{Sr}_x\text{Cu}_{1-y}\text{Ni}_y\text{O}_4$, ($0.05 \leq x \leq 0.25$, $0 \leq y \leq 0.04$) system. Samples with $x = 0.05$ do not become superconducting, but show an upturn in $\rho(T)$ at low temperatures, which becomes larger with increasing substitution of Ni. The T-dependent resistivity at low temperatures of these samples closely follows a variable-range, hopping-type mechanism rather than an exponentially activated condition. Superconducting transitions were observed for $x > 0.05$. With an increase in y , a decrease in T_c is observed over the entire composition range studied. This rate of suppression of T_c with Ni substitution decreases with an increase in the Sr content. By comparing the resistivity data of the low and high Sr content samples, it is seen that a relatively large Ni concentration is necessary to induce electron

localization. Our magnetization results show that the effect of Ni substitution is to decrease both the T_C as well as the Meissner fraction.

Study of Naturally Modulated High T_C Superconducting Compounds

H. Sato

Purdue University

The objective of this project is to use controlled changes in the natural crystal structure modulation of the high-temperature superconductors to understand superconductivity and guide improvements of materials.

A peculiar type of pseudo twin has been found in $\text{Bi}_2\text{Sr}_2\text{Ca}_{n-1}\text{Cu}_n\text{O}_{2n+4+\delta}$ superconductors with $n=2$ obtained by annealing compounds from amorphous precursors quenched from the melt. The twin plane corresponds to the (015) plane, if the incommensurate modulation ($b \approx 4.75b_a$) in the b-direction can be disregarded. The fact that the modulation period is close to 5 makes the pseudo (015) twin appear.

This type of twin is commonly found in material obtained from amorphous precursors, but has not been found in sintered materials. Instead, in sintered materials, the (110) twin similar to the (110) twin in the 123 compound appears. The importance of the observation thus lies in the following two facts. The (015) pseudo twins are growth twins and appear because the period of modulation in the b-direction is close to 5 so that the (015) plane can almost serve as the twin plane. On the other hand, the (110) twins in sintered materials correspond to mechanical twins due to the existence of stress during the recrystallization process (like those which accompany the tetragonal-orthorhombic phase transformation in the 123 compound).

The closeness of the period of the incommensurate modulation to 5 introduces a discommensuration process in the (015) twin plane. The discommensuration is found to relieve the strain accompanying the mismatch of the (0 1 4.75) and the (015) planes. This discommensuration process is expected to enhance the flux pinning at the twin boundary.

***Processing and Texture Development of Films from Metallo-organic
Precursors***

***Gerald L. Liedl and Arden L. Bement, Jr.
Purdue University***

The objectives of this research project are:

- 1. To achieve rapid thermal processing of 123 films on suitable substrates employing metallo-organic precursors; and*
- 2. To characterize the attainment of texture in the films.*

As expected, Y-rich films heat treated around 1000° C for a few minutes exhibited a maximum orthorhombic splitting and the best metallic normal resistance properties along with a platelet-type microstructure.

A high degree of c-axis texture is observed in films with very few layers, and the texture is lost gradually with increasing film thickness. In the case of very thin films, there is evidence for in-plane texture (epitaxy). There are two domains, and these can be understood in terms of a modified coincidence site lattice theory.

**Area 2: Transport Properties of High-Temperature
Superconductors: Optimization of Critical Currents,
Magnetic Screening, Dynamical Behavior and Other
Limiting Factors**

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

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

The objectives of this project are:

- 1. To clarify how superconductivity coexists with very intense magnetic fields at low temperatures in the limit when the effects of Landau quantization becomes important;*
- 2. To investigate the quantum phase diagram of superconductivity in two-dimensional systems (e.g., thin films) in the presence of magnetic fields and/or disorder; and*
- 3. To numerically simulate how columnar defects pin vortices in the high T_c superconductors.*

In collaboration with A. Peter Young and Erik Sørensen (UC Santa Cruz), we (Mats Wallin, Min Chul Cha and S.M. Girvin) have completed a very difficult quantum Monte Carlo calculation of the universal conductivity at the superconductor-insulator transition in thin films. We predict $\sigma^* \approx (0.55 \pm 0.1) (2e)^2/h$ for the experimentally relevant universality class. Work is underway to test this prediction in several laboratories around the world. We have recently begun work on the technically more demanding problem of the magnetic-field-tuned transition.

We have made major progress in Monte Carlo studies of the vortex glass/Bose glass transition. We have performed the first Monte Carlo simulations of vortex dynamics in the presence of columnar defects and have

obtained excellent scaling curves over many decades for the non-linear I-V characteristics at the glass point.

We (Jun Hu and A.H. MacDonald) have studied the intrinsic flux-lattice melting transition in the two-dimensional regime using both Monte Carlo simulations and high-temperature perturbation theory expansions. Much of the previous work on this topic was performed in the London limit, which applies only when the melting transition occurs at magnetic fields many times smaller than the mean-field-theory upper critical field, H_{c2} . In our work we use the full Ginzburg-Landau free-energy density expression. We believe that we have made a qualitative advance in understanding the flux-lattice melting transition by introducing a new quantity which plays the central role in our study. We have defined a superfield-density spatial correlation function; it is the development of (quasi-)long range order in this quantity which signals the onset of true superconductivity. We have been able to make an accurate estimate of the effective reduced temperature at which flux-lattice melting occurs.

Thermally Activated Flux Motion and Anisotropy in High-Temperature Superconductors

J. R. Clem and V. G. Kogan

Iowa State University

AT&T Bell Labs*

The objective of this project is to develop a complete theory for the electrodynamic behavior and the thermally activated flux motion in high-temperature superconductors subjected to magnetic fields.

We have theoretically examined the entropy contribution (S_f) of thermally fluctuating two-dimensional vortices ("pancakes") to the entropy of a dense vortex system in layered Josephson-coupled superconductors ... and, therefore, to the free energy (F_0) of the unperturbed system. The magnetization (M) evaluated with the help of the free energy $F=F_0-TS_f$ has a conspicuous feature: at a certain temperature T^* (a few Kelvins below the mean-field critical temperature T_{c0} for Bi- and Tl-based superconductors) all curves $M(T)$ for

different fixed fields should cross. In other words, $M(T^*)$ is *field independent*. This property has been observed by several groups.

Our theory (published recently in Phys. Rev. Lett. **68**, 3773, (1992)) predicts a simple relation for the crossing point. Using experimental values for M^* and T^* , we evaluate $s \approx 15\text{\AA}$ in good agreement with structural data (the cell size in the c direction of Bi-2212 is $\approx 30\text{\AA}$; each cell has two double CuO_2 layers). The theory of vortex fluctuations has far reaching implications for magnetic properties of layered high- T_c materials, as well as for other layered Josephson-coupled superconductors.

Microwave Dissipation in High Temperature Superconductors: Flux-Lattice Dynamics, Crystal Anisotropy, and Flux Pinning

H. A. Blackstead

University of Notre Dame

This project studies transport properties of high-temperature superconductors, in particular microwave dissipation, lending to information on flux lattice dynamics, crystal anisotropy and flux pinning.

An analysis of published field-and temperature-dependent resistivity and "critical current" data revealed that the Tinkham formula for phase-slip resistivity, while providing an accurate description of the temperature and field dependence of the phase-slip resistivity in the less anisotropic 123 materials, failed to describe the experimental results on BSCCO. The phase-slip resistivity is given by:

$$\rho_{ps} = \rho_n / [I_0(\gamma^\beta/2)]^2$$

where I_0 is a modified Bessel function.

Through efforts to fit the data, it was noticed that with $\beta=1/3$, accurate rendition of the BSCCO data was achieved. In collaboration with J.C. Phillips, we have proposed a generalized form which extends to HTSC materials and provides an explanation for the power law.

***Far Infrared and Microwave Magneto-Dissipation in High T_c
Superconductors***

W. J. Tomasch and J. K. Furdyna

University of Notre Dame

NIST*

TRW Superconductivity Research*

The objectives of this research project are:

- 1. To study the dynamic properties of the flux lattice in highly anisotropic high temperature superconductors; and*
- 2. To utilize laser and microwave magneto reflection and transmission measurements to obtain quantitative determinations of the important material parameters that are of basic interest and appropriate for high frequency applications.*

We have developed a leadless nondestructive microwave technique for quantitative evaluation of high temperature superconductors in the presence of substantial dc magnetic fields (0-7 Tesla). By measuring the magneto transmission and reflection of mm microwaves, we are able to quantitatively infer important material parameters for microwave applications. These include: complex surface impedance, upper critical field, and complex penetration depth.

Comparisons of our microwave data with a recent theory, by MISCON scientists Mark W. Coffey and John R. Clem, indicate that flux pinning in YBCO films is unimportant at 35GHz.

Our microwave and far-infrared transmission data ($H=0$) show significant deviations from both standard mean-field and fluctuation paraconductivity.

Atomic Beam Studies of Vortex Lattices at Superconductor Surfaces
Gregory Lafyatis and Thomas Lemberger
The Ohio State University

The long-term goal of this work is 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.

We have run the atomic beam experiment and yet have been unable to observe the flux lattice produced by a 10 G field in our PbBi sample.

We decided to proceed by working towards higher sensitivity, and are completing several modifications of the apparatus that should give us orders of magnitude improved sensitivity.

Measurement of the Bernoulli Potential and Surface-Charging Effects in Oxide Superconducting Films
Thomas R. Lemberger
The Ohio State University

The objective of this project is to develop a better understanding of transport properties of superconductors through measurements of the kinetic inductance and Bernoulli potential in YBCO films.

We tuned our new apparatus for determining the magnetic penetration depth $\lambda(T)$ from the kinetic inductance of films of oxide superconductors to where it is currently the most sensitive apparatus we know. Primary results demonstrating this high sensitivity, based on a study of the very-low- T behavior of $\lambda(T)$, have been submitted for publication. This work addresses the fundamental issue of the symmetry of the superconducting order parameters, which must be determined before accurate models can be constructed for important things like the Josephson supercurrent through grain boundaries and twin planes.

NMR Studies of Vortex Dynamics in High T_c Superconductors

Charles 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.

Our initial research has been confined to the setup of our NMR spectrometer and the preparation of high T_c samples.

We recently finished the design and construction of the NMR probe which permits varying the orientation of single crystals and oriented powder samples with respect to the applied magnetic field.

We have prepared, in collaboration with the Brian Maple group at UCSD, ^{17}O enriched powder and single crystal samples of $\text{YBa}_2\text{Cu}_3\text{O}_7$ and $\text{YBa}_2\text{Cu}_3\text{O}_{6.6}$. ^{17}O should prove to be a very sensitive probe of vortex dynamics because its lineshape is much narrower than that of ^{63}Cu .

Transport Properties of High T_c Superconductors

G.F. Giuliani

Purdue University

The objectives of this project are:

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

Our research efforts have led to a number of interesting and fundamental results:

- We have formulated a microscopic theory for the temperature dependence of the critical Josephson current density $j_c(T)$ flowing

through an insulating barrier situated between two layered superconductors.

- We have studied the effect of an applied magnetic field (H_{ext}) on the critical current (I_C) of a lateral S-I-S Josephson junction between layered superconductors. Through our results we have identified a regime in which the equations governing the Josephson phase and the corresponding value of the total magnetic field can be mapped onto the standard map.

Electrical and Optical Investigations of Pristine and Doped $\text{YBa}_2\text{Cu}_4\text{O}_8$

Meera Chandrasekhar

University of Missouri-Columbia

The objective of this project is to study the role of Zn and Fe doping in $\text{YBa}_2\text{Cu}_4\text{O}_8$ (Y124). The first experiment is to study the softening of the in-plane phonon modes at T_C via Raman scattering for different dopant concentrations of Fe and Zn, thereby establishing whether the effect of the weak links is a minimum at a critical nominal concentration, as in Y123.

In these first few months of the project, our work has been preliminary in nature and has involved instrument upgrading to facilitate efficient data taking. We have studied the Raman spectra of Y123's as the first stage, as well as those of powder samples of Y124 and the Bi compounds. We have loaded a Y124 sample in a diamond anvil cell and will study the pressure dependence of its Raman modes.

Neutron Diffraction and Defect Studies of High T_C Superconductors

W. B. Yelon and J. W. Farmer
University of Missouri-Columbia

The major current objective of this project is to model current-voltage characteristics, critical currents, phase boundaries, and other properties in granular and otherwise disordered high- T_C superconductors, principally using networks of Josephson junctions.

We have completed a comprehensive study of the role of defects in flux pinning which demonstrates for the first time that the primary irradiation defects are not the dominant pinning centers that produce the enhanced critical currents. These studies indicate that further enhancement of critical currents are possible, while at the same time underlining the fact that such enhancement results from additional pinning centers which are formed by complex defect interactions.

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

David 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.

During the last several months, we have been emphasizing the study of pinning in high-temperature superconductors. Our interest has been both to find the types of pinning centers which would best increase the superconducting transition temperature in a magnetic field and to most effectively maximize the critical current at a given temperature and field. We have had some success in our simulations and have recently submitted a paper (in collaboration with S.M. Girvin) in which our recent results are described.

We find that random line defects considerably increase the critical current at a given temperature and field, and also raise the superconducting/normal phase boundary relative to an equivalent number of point defects. The effectiveness of the line defects seems to be greatest when their density equals the flux density.

Structural Defects and Interfaces in $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Films

Eric P. Kvam

Purdue University

The objectives of this project are:

- 1. To examine the microstructure, and in particular, the extended defect and intercrystalline boundary structures of textured bulk polycrystals and epitaxial thin films (including bicrystals) of $\text{YBa}_2\text{Cu}_3\text{O}_7$; and*
- 2. To correlate these microstructural aspects with transport property characteristics.*

In the last year, notable accomplishments have been made in three areas. First, the microstructural cause of high current-carrying abilities of directionally solidified YBCO wires has been substantially identified as interconnecting paths, which are lacking in most other textured YBCO materials. These interconnecting paths circumvent weak link grain boundaries and explain the high currents which these wires can carry.

A new theory for the pinning of flux lines by dislocations in the new oxide high- T_c superconductors has been developed and applied to the case of the partial dislocations.

A third area of accomplishment has been in showing the effectiveness of YBCO as a combined electrical contact and growth template for ferroelectric PZT grown on (001) Si substrates.

Intrinsic and Induced Weak Link Behavior in YBa₂Cu₃O_{7-δ} Films

M. W. McElfresh and R. G. Reifenberger

Purdue University

IBM Thomas J. Watson Research Center*

Public Service Indiana*

The objectives of this project are:

- 1. To fabricate and characterize high-temperature superconducting thin films; and*
- 2. To optimize material properties through better understanding of the order parameter and weak-link behavior in high-temperature superconductors.*

Studies of the distribution of electronic currents, the factors influencing critical current densities, and their relation to properties of high T_C materials are being made over a wide range of length scales.

Highlights of our research during the past year include:

- The identification and elimination of a surface layer of contaminants that prevents reliable STM scans of YBaCuO laser ablated thin films.
- STM scans of high- T_C materials as a function of temperature between 4K and 100K. The resolution is good enough to observe the well-known terraced structure in c-axis films at 4K.
- Non-linear current versus voltage data taken at 4K which shows structure similar to that expected for superconducting energy gap. Energy gap values of 16-17 meV are obtained.
- Using improved signal-averaging techniques, the tunneling conductance from pulsed laser deposited films of YBa₂Cu₃O_{7-δ} reveals a rich fine structure in both the sub-gap and near-gap regions. A comparison of this structure to calculations by Tachiki *et al* yields

excellent agreement and indicates the origin of the fine structure is the density of electronic states on the different layered planes of this high T_C material.

Our research has also explained:

- The physical phenomena responsible for the first and third harmonic ac-susceptibility responses in high- T_C materials. Neither response measures the onset of irreversibility but rather both are a measure of ac flux penetration.
- The differences between measurements of the vortex glass transition by dc magnetization and by magnetotransport.
- Why dc magnetic measurements of the vortex glass transition using the combination of zero-field-cooled and field-cooled (FC) results requires that the FC data be collected as the sample is actually cooled and not on warming, as is frequently the case.

MISCON TALKS and PRESENTATIONS

1992

1. MISCON Meeting, Ohio State University, **K. G. Caulton**, January 1992.
2. Washington University, St. Louis, MO, **K. G. Caulton**, February 1992.
3. Tokyo University, Japan, **K. G. Caulton**, March 1992.
4. Waseda University, Japan, **K. G. Caulton**, March 1992.
5. National Chemical Laboratory for Industry, Tsukuba, Japan, **K. G. Caulton**, March 1992.
6. Mitsubishi Petroleum Company, Yokohama, Japan, **K. G. Caulton**, March 1992.
7. Kinki University, Japan, **K. G. Caulton**, March 1992.
8. Chemical Society of Japan National Meeting, **K. G. Caulton**, March 1992.
9. Tokyo Institute of Agriculture and Technology, **K. G. Caulton**, March 1992.
10. Sumitomo Chemical Company, Tsukuba, Japan, **K. G. Caulton**, March 1992.
11. University of Hawaii, **K. G. Caulton**, March 1992.
12. Texas A & M University, College Station, Texas, **M. H. Chisholm**, March 1992.
13. National ACS Meeting, San Francisco, **K. G. Caulton**, April 1992.
14. Materials Research Society, San Francisco, **K. G. Caulton**, April 1992.
15. Ohio State University, **K. G. Caulton**, 1992.
16. National ACS Meeting, San Francisco, **M. H. Chisholm**, April 1992.
17. Materials Research Society, San Francisco, **M. H. Chisholm**, April 1992.
18. "Universal Conductivity at the Superconductor-Insulator Transition in 2D Films", **S. M. Girvin**, AT&T Bell Labs, March 3, 1992.
19. "Landau Quantization and Type-II Superconductivity", AT&T Bell Labs, **A. H. MacDonald**, March 10, 1992.
20. "Universal Conductivity of Dirty Bosons", M. Wallin, **S. M. Girvin**, E.S. Sørensen, and A. P. Young, March APS Meeting, Indianapolis, IN, March 1992.
21. "Universal Properties of the Superconductor to Insulator Transition in 2D Charged Boson Films", E.S. Sørensen, A. P. Young, M. Wallin, and **S. M. Girvin**, March APS Meeting, Indianapolis, IN, March 1992.
22. "Universal Conductivity of 2D Films at the Field-Tuned Superconductor-Insulator Transition", M. Cha, M. Wallin, and **S. M. Girvin**, March APS Meeting, Indianapolis, IN, March 1992.
23. "Exact Mean Field Solutions for Flux Lattice States", M. R. Norman, H. Aker, and **A. H. MacDonald**, March APS Meeting, Indianapolis, IN, March 1992.

24. "Universal Conductivity at the Superconductor-Insulator Transitions", **S.M. Girvin**, M. Wallin, M. Cha, M.P.A. Fisher, and A. P. Young, International Conference on Quantum Phase Transitions, Institute for Theoretical Physics, Santa Barbara, CA, July 1, 1992.
25. "Universal Properties of the Superconductor to Insulator Transition in 2D Charged Boson Films", E.S. Sørensen, A.P. Young, M. Wallin, and **S.M. Girvin**, March APS Meeting, Indianapolis, IN March 1992.
26. "Universal Conductivity at the Superconductor-Insulator Transition", **S.M. Girvin**, International Conference on Quantum Phase Transitions, Institute for Theoretical Physics, Santa Barbara, CA, July 1, 1992.
27. "Universal Conductivity at the Superconductor-Insulator Transition", **S.M. Girvin**, Summer Condensed Matter Physics Workshop, Center for Physics, Aspen, CO, July 9, 1992.
28. "Vortex Lattices in Superconducting Films", D. P. Arovas, K. Mullen, **S. M. Girvin** and **A. H. MacDonald**, March APS Meeting, Indianapolis, IN, March 1992.
29. "Quantum Mechanics and Superconductivity in a Magnetic Field", **A.H. MacDonald**, Gordon Godfrey Workshop, University of New South Wales, Sydney, Australia, July 1992.
30. "Monte Carlo Simulations of the Vortex Glass Transition with Columnar Defects", **S.M. Girvin**, Meeting on Superconductors in Magnetic Fields, Argonne National Laboratory, August 27, 1992
31. "Quantum Mechanics and Superconductivity in a Magnetic Field", **A.H. MacDonald**, Conference on Superconductors in Magnetic Fields, Argonne National Laboratory, August 27, 1992.
32. "Why Do the High- T_c Cuprates Become Worse Superconductors As They Become More Two-Dimensional?" **J.R. Clem**, Seminar, Department of Physics and Astronomy, University of Kentucky, Louisville, Kentucky, February 24, 1992.
33. "2D Pancake Vortices, Josephson Strings and Flux Pinning in Highly Anisotropic High-Temperature Superconductors", **J.R. Clem**, Superconductivity Seminar, School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota, February 26, 1992.
34. "2D Pancake Vortices, Josephson Strings and Flux Pinning in Highly Anisotropic High-Temperature Superconductors" **J.R. Clem**, Rare Earth's Symposium: Sources, Science, Technology, and Applications V, 1992 TMS Annual Meeting, San Diego, California, March 3, 1992.
35. "High Temperature Superconductors: Fundamental Properties That Set Bounds on Applications", **J.R. Clem**, Symposium on High- T_c Superconductivity in Bulk III, Flux Pinning, 1992 TMS Annual Meeting, San Diego, California, March 3, 1992.
36. "Two Dimensional Pancake Vortices in Weakly Coupled Superconductors", **J.R. Clem**, Workshop on Flux Dynamics in High T_c Superconductors, Argonne National Laboratory, Argonne, IL, March 14, 1992.
37. "Unified Theory of Effects of Vortex Pinning and Flux Creep Upon the rf Surface Impedance of Type-II Superconductors", **J.R. Clem**, 1992 March Meeting of the American Physical Society, Indianapolis, IN, March 17, 1992.
38. "2D Pancake Vortices, Josephson Strings and Flux Pinning in Anisotropic High-Temperature Superconductors" **J.R. Clem**, P-10 Seminar, Los Alamos National Laboratory, Los Alamos, New Mexico, March 30, 1992.

39. "Effects of Flux Flow, Flux Pinning, and Flux Creep on $Z(\omega)$ ", **J.R. Clem**, Second Symposium on High Temperature Superconductors in High Frequency Fields, Santa Fe, New Mexico, April 1, 1992.
40. "Flux Lines in High-Temperature Superconductors", **J.R. Clem**, Keynote paper at the International Conference on Critical Currents in High- T_c Superconductors, Vienna, Austria, April 22, 1992.
41. "Magnetic Structure and Flux Pinning in the High-Temperature Superconductors", **J.R. Clem**, 1992 Spring Meeting of the Materials Research Society, San Francisco, California, April 27, 1992.
42. AT&T Bell Labs, on Fluctuations of Vortices and Decoration, **V.G. Kogan**, May, 1992.
43. "Magnetic Field Dependence of ac Permeability and rf Surface Impedance in Type-II Superconductors: Effects of Flux Flow, Flux Pinning, and Flux Creep", **J.R. Clem**, Argonne National Laboratory Workshop on Superconductors in a Magnetic Field, Argonne National Laboratory, Argonne, Illinois, August 27, 1992.
44. "Effects of Granularity in the High- T_c Superconductors", **J.R. Clem**, Seminar, University of Alberta, Edmonton, Alberta, Canada, October 1, 1992.
45. "Why Do the High- T_c Cuprates Become Worse Superconductors as They Become More Two-Dimensional?" **J.R. Clem**, Physics Colloquium, University of Alberta, Edmonton, Alberta, Canada, October 2, 1992.
46. "Two-Dimensional Pancake Vortices, Josephson Strings, and Flux Pinning in Anisotropic High-Temperature Superconductors", **J.R. Clem**, U.S./Japan Workshop on Superconductivity, Tsukuba, Japan, November 10, 1992.
47. "Vortex Structure in Highly Anisotropic High-Temperature Superconductors", **J.R. Clem**, International Workshop on Fluctuations in Superconductors and Other Systems, Hakone, Japan, November 13, 1992.
48. A&M University at College Station, TX, **V.G. Kogan**, November, 1992.
49. Texas Center for Superconductivity, Houston, TX, **V.G. Kogan**, November, 1992.
50. "2D Pancake Vortices, Josephson Strings, and Flux Pinning in Anisotropic High-Temperature Superconductors" **J.R. Clem**, American Superconductor Corporation, Watertown, Massachusetts, December 1, 1992.
51. "Flux Pinning by Neutron Irradiation Induced Defects", **J. W. Farmer**, Gordon Conference on Superconductivity, Oxnard, CA, January 1992.
52. "Structural, Transport, and Magnetic Properties of $\text{Bi}_2\text{Sr}_{2-x}\text{La}_x\text{CuO}_y$ ", J. Diederichs, J. S. Schilling, A. Schlögl, J. J. Neumeier, C. Allgeier, and **W. Yelon**, March APS Meeting, Indianapolis, IN, March 1992.
53. "Lattice Parameter Changes in Neutron Irradiated $\text{YBa}_2\text{Cu}_3\text{O}_7$ ", X. Ding and **J. W. Farmer**, March APS Meeting, Indianapolis, IN, March, 1992.
54. "Growth of CaO Precipitates in Superconducting $(\text{Bi-Pb})_2\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_{7-\delta}$ ", M. Xu, J. Polanka, **A.I. Goldman**, and **D.K. Finnemore**, IEEE Trans. on Magn. (submitted).
55. "Crystalline Phases During the Melting of $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_x$ ", M. Xu, J. Polonka, **A.I. Goldman**, **D.K. Finnemore**, Q. Li, and F.C. Laabs, MRS Fall Meeting, 1992.
56. "Residual Resistance in High-Temperature Superconductors", **H. A. Blackstead**, Physics Dept. Seminar, University of Wisconsin, Madison, WI, March 3, 1992.

57. "Microwave Dissipation in High-Temperature Superconductors: Crystal Anisotropy and Flux Pinning", **H. A. Blackstead**, Condensed Matter and Radiation Sciences Division Seminar, Naval Research Lab, Washington, DC, March 31, 1992.
58. "Flux Flow, Flux Pinning, and Phase Transitions", **D. Stroud**, Meeting of the American Physical Society, March 22-26, 1992.
59. "Catastrophic Breakdown of Melt-Textured Y-Ba-Cu-O with Ba-Sn-O Additions", **H. A. Blackstead**, D. B. Pulling, and **P. J. McGinn**, Bull. Am. Phys. Soc. **37**, No. 1, 537, March 16-20, 1992.
60. "Flux-Flow and Phase-Slip Dissipation in Two Phase Polycrystalline Bi-Pb-Sr-Ca-Cu-O", D. B. Pulling, **H. A. Blackstead**, and **H. Sato**, Bull. Am. Phys. Soc. **37**, No. 1, 229, March 16-20, 1992.
61. "Growth of $\text{Dy}_1\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$ (001) and $\text{Dy}_{1+x}\text{Ba}_{2-x}\text{Cu}_3\text{O}_6$ (001) High-Temperature Superconductor Thin Films by Molecular Beam Epitaxy", **K. M. Choudhary**, SC GLOBAL 92 - Fifth Annual International Superconductor Applications Convention, January 29-31, 1992, San Diego, CA.
62. "Study of Compositional Modulation in High-Temperature Superconductor Structures and its Influence on Their Superconducting Properties", **K.M. Choudhary**, DOE Review, Washington, DC, October 20, 1992.
63. "Surface Morphology of $\text{Dy}_1\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$ (001) and $\text{Y}_1\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$ (001) Thin Films", J. Bae, P. Seshadri, T. Ekkens, M. Honkannen, C. Zhong, **S. T. Ruggiero**, and **K. M. Choudhary**, Bull. Amer. Phys. Soc. **37**, 333, 1992; Presented at the March Meeting of the American Physical Society, Indianapolis, Indiana, 1992.
64. "Molecular Beam Deposition of Epitaxial NdMnO_3 (100) Buffer Layer for $\text{Dy}_1\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$ (001) Thin Films", P. Seshadri, J. Bae, and **K. M. Choudhary**, Bull. Amer. Phys. Soc. **37**, 124, 1992; presented at the March Meeting of the American Physical Society, Indianapolis, Indiana, 1992.
65. "Molecular Beam Deposition of Epitaxial $\text{Er}_1\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$ (001) and $\text{Er}_{1+x}\text{Ba}_{2-x}\text{Cu}_3\text{O}_y$ (001) Thin Films", **K. M. Choudhary**, J. Bae, and P. Seshadri, Bull. Amer. Phys. Soc. **37**, 124, 1992; presented at the March Meeting of the American Physical Society, Indianapolis, Indiana, 1992.
66. "The Discovery of $\text{Er}_5\text{Ba}_7\text{Cu}_{12}\text{O}_y$ and $\text{Er}_4\text{Ba}_5\text{Cu}_9\text{O}_y$ New High-Temperature Superconductor Materials", **K.M. Choudhary**, High- T_c Update, **6**, 15, August 1, 1992.
67. " $\text{Er}_1\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$ (001), $\text{Er}_5\text{Ba}_7\text{Cu}_{12}\text{O}_y$ (001) and $\text{Er}_4\text{Ba}_5\text{Cu}_9\text{O}_y$ (001) High-Temperature Superconductor Thin Films ($T_c=93-95\text{K}$): Photoemission Spectroscopy Studies", **K.M. Choudhary**, J. Bae, and P. Seshadri, MRS Fall Meeting 1992.
68. "Studies of (001) Oriented $\text{Er}_1\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$ (001), $\text{Er}_5\text{Ba}_7\text{Cu}_{12}\text{O}_y$ (001) and $\text{Er}_4\text{Ba}_5\text{Cu}_9\text{O}_y$ (001) High-Temperature Superconductor Thin Films by Photoemission Spectroscopy", **K.M. Choudhary**, J. Bae, and P. Seshadri, Abstracts of the 1992 SRC Users Group Meeting, pp. 104-105, Synchrotron Radiation Center, University of Wisconsin - Madison, 1992.
69. " $\text{Er}_5\text{Ba}_7\text{Cu}_{12}\text{O}_y$ (001) and $\text{Er}_5\text{Ba}_5\text{Cu}_9\text{O}_y$ (001) New High-Temperature Superconductor Thin Films ($T_c=93-95\text{K}$)", **K.M. Choudhary**, J. Bae, and P. Seshadri, presented at the Fall Meeting of the Materials Research Society, Boston, MA, 1992.
70. "Annealing Effects on the Magnetization of Zone Melt Textured $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ ", **P. McGinn**, W. Chen, N. Zhu, C. Varanasi, and S. Sengupta, Ohio State University, MISCON Group Meeting, January 22, 1992.

71. "The Effect of Second Phase Additions on the Microstructure and Magnetic Properties of Zone Melt Textured $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ ", **P. J. McGinn**, D. Balkin, C. Varanasi, and M. Black, TMS Annual Meeting, San Diego, CA, March 3, 1992.
72. "The Effect of Second Phase Additions on the Microstructure and Magnetic Properties of Zone Melt Textured $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ Microstructure", **P. J. McGinn**, D. Balkin, C. Varanasi, and M. Black, MRS Spring Meeting, San Francisco, CA, April, 1992.
73. "Effect of $(\text{RE})_2\text{BaCuO}_5$ Additions on Melt Textured $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ ", D. Balkin, C. Varanasi, M. Black, and **P. J. McGinn**, American Ceramic Soc. Annual Meeting, Minneapolis, MN, April 1992.
74. "The Effect of Second Phase Additions on the Microstructure and Properties of Zone Melt Textured $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ ", C. Varanasi, D. Balkin, and **P. J. McGinn**, American Ceramic Soc. Annual Meeting, Minneapolis, MN, April 1992.
75. Zone Melt Texturing of $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ ", **P. McGinn**, Workshop on Bulk Processing and Critical Current Density of High T_c Superconductors, Argonne National Laboratory, April, 1992.
76. "The Effect of $\text{Er}_2\text{BaCuO}_5$ Additions on the Microstructure and Magnetic Properties of Zone Melt Textured $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ Wires", D. Balkin, C. Varanasi, and **P. McGinn**, Intr. Wrksp. on Superconductivity, Honolulu, June 23-26, 1992.
77. "The Effect of Second Phase Additions on the Microstructure and Magnetic Properties of Zone Melt Textured $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ ", **P. J. McGinn**, D. Balkin, C. Varanasi, and M. Black, Iowa State University, MISCON Group Meeting, August 1992.
78. "Effect of $(\text{RE})_2\text{BaCuO}_5$ Additions on Melt Textured $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ ", D. Balkin, C. Varanasi, M. Black, and **P. J. McGinn**, TMS Fall Meeting, Chicago, IL, November, 1992.
79. "A Study of 211 Coarsening in $\text{YBa}_2\text{Cu}_3\text{O}_x$ ", C. Varanasi, D. Balkin, and **P. J. McGinn**, TMS Fall Meeting, Chicago, IL, November, 1992.
80. "Transmission and Reflection of Superconducting $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ Films at 35 GHz", E. K. Moser, **W. J. Tomasch**, M. J. McClorey, **J. K. Furdyna**, G. Karczewski, S. M. Schwarzbek, and C. L. Pettiette-Hall, March APS Meeting, Indianapolis, IN, March 1992.
81. "Transmission and Reflection of Superconducting $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ Films at 35 GHz", E. K. Moser, **W. J. Tomasch**, **J. K. Furdyna**, M.W. Coffey, and **J. Clem**, Presented at the Chicago Applied Superconductivity Conference by Eric K. Moser (August, 1992).
82. "The Scattering Inversion Problem: Inferring the Magneto Surface Impedance From Microwave Magneto Transmission and Reflection Data", E.K. Moser and **W.J. Tomasch**, National Institute for Standards and Technology, Boulder, Colorado, October 19, 1992, invited.
83. "The Scattering Inversion Problem: Inferring the Magneto Surface Impedance From Microwave Magneto Transmission and Reflection Data", E.K. Moser and **W.J. Tomasch**, TRW Corp. Corporate Laboratory, Redondo Beach, California, October 21, 1992, invited.
84. "Characterizing High- T_c Superconducting Films by Means of Magneto Transmission and Reflection Measurements - an Overview", E.K. Moser and **W.J. Tomasch**, Cal Tech Jet Propulsion Laboratory, Pasadena, California, October 22, 1992.
85. "High T_c Superconducting Composites/Films", Ohio State University, **J.C. Garland**, January 23, 1992.

86. "Superconducting Nanostructures", **J. C. Garland**, AAAS Annual Meeting (invited), February 9, 1992.
87. "Transport Properties of Electron-Doped $\text{Sm}_{2-x}\text{Ce}_x\text{CuO}_{4-y}$ Superconductors", Y. M. Wan, J. J. Calabrese, S. E. Hebboul, **J. C. Garland**, E. A. Early, Y. Dalichaouch, M. C. DeAndrade, R. F. Jardim, and M. B. Maple, March Meeting of the Am. Phys. Soc., 1992.
88. "Measurement of Novel High T_c Proximity Coupled Josephson Junctions", S. T. Herbert, D. C. Harris, S. E. Hebboul, and **J. C. Garland**, APS March 1992 Meeting.
89. "Radio Frequency Response of Josephson Junction Arrays", S. E. Hebboul, Univ. of Michigan, Ann Arbor. April 21, 1992. (**Garland group**).
90. "What's So Interesting About Josephson Junction Arrays?", **J. C. Garland**, Iowa State University, April 21, 1992.
91. "Interlayer Vortex Interactions in $\text{Bi}_2\text{Sr}_2\text{CaCu}_3\text{O}_8$ Single Crystals", **J.C. Garland**, Ohio State University, May 6, 1992.
92. "High T_c Superconducting Composites/Films", Iowa State University, **J.C. Garland**, July 9, 1992.
93. "High T_c Superconducting Composites/Films", U.S. Department of Energy, Review of Research Projects in the Superconducting and Ceramic Materials Research Program, Bethesda, Maryland, **J.C. Garland**, September 2, 1992.
94. "The Odd Electrical Properties of Bismuth-based High Temperature Superconductors", Center for Materials Research, Ohio State University, **J.C. Garland**, October 8, 1992.
95. "Measurement of the Bernoulli Voltage and Kinetic Inductance in $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ ", J. Y. Lee and **T. R. Lemberger**, Bull. Am. Phys. Soc., **37**, 478 (1992).
96. "The Processing of Oxide Superconductors by the Oxidation of Metallic Precursors", **K.H. Sandhage**, TMS Fall Meeting, Chicago, IL, November 2, 1992.
97. "Dynamics of Josephson Networks", **D. Stroud**, Condensed Matter Seminar, Indiana University, Bloomington, IN, January 17, 1992.
98. "Critical Currents for Vortex Depinning in the Presence of Line and Point Defects", **D. Stroud**, K. H. Lee, and **S. M. Girvin**, March APS Meeting, Indianapolis, IN, March 1992.
99. "Dynamical Properties of Josephson Junction Networks", **D. Stroud**, Condensed Matter Seminar, University of California, San Diego, CA, October 24, 1992.
100. "Dynamical Properties of Josephson Junction Networks", **D. Stroud**, Condensed Matter Seminar, AT&T Bell Laboratories, Murray Hill, New Jersey, September, 16, 1992.
101. "Flux Flow Resistivity in Three-Dimension Josephson Junction Arrays", **D. Stroud**, Bull. Am. Phys. Soc. **37**, 279, 1992.
102. "Magnetic Impurities in Superconductors", **G.F. Giuliani**, Midwest Superconductivity Center (MISCON), The Ohio State University, Columbus, Ohio, January, 1992.
103. "Josephson Effect in Layered Superconductors", **G.F. Giuliani**, The Scuola Normale Superiore, Pisa, Italy, March, 1992.

104. "New Results on the Josephson Effect in Layered Superconductors", **G.F. Giuliani**, Midwest Superconductivity Consortium (MISCON), Iowa State University, Ames, Iowa, July, 1992.
105. "Vortex Dynamics in Superconductors", **G.F. Giuliani**, International Centre for Theoretical Physics, Trieste, Italy, July, 1992.
106. "Pinning of Fluxons by Structure of Abrikosov Vortices in Long Josephson Tunnel Junction", V.N. Gubankov, M.P. Lisitskii, I.L. Serpuchenko, M.V. Fistul, 1992 Applied Superconductivity Conference (ASC), Chicago, IL, August 23-28, 1992. (**Giuliani Group**)
107. "Interaction of a Long Josephson Junction with Abrikosov Vortices", M.V. Fistul, **G.F. Giuliani**, 1992 Midwest Solid State Theory Conference, Madison, WI, October 23-24, 1992.
108. "Critical Current of a Josephson Junction in Layered Superconductors", M.V. Fistul, **G.F. Giuliani**, 1992 Midwest Solid State Theory Conference, Madison, WI, October 23-24, 1992.
109. "Normal Properties, Magnetism, and Onset of Superconductivity in $\text{La}_{2-x}\text{Sr}_x\text{NiO}_{4+\delta}$ and $\text{La}_{2-x}\text{Sr}_x\text{Cu}_y\text{Ni}_{1-y}\text{O}_4$ Systems", **J.M. Honig**, MISCON Consortium Meeting, The Ohio State University, Columbus, OH, January 23, 1992.
110. "Elusive Superconductivity in Lanthanum Nickelates", **J. M. Honig**, SC GLOBAL 92 - Fifth Annual International Superconductor Applications Convention, January 29-31, 1992, San Diego, CA.
111. "Elusive Superconductivity in Lanthanum Nickelates and Related Compounds", **J.M. Honig**, Department of Physics, Notre Dame University, Notre Dame, Indiana, April 24, 1992. (Invited).
112. "Normal Properties, Magnetism, and Onset of Superconductivity in $\text{La}_{2-x}\text{Sr}_x\text{NiO}_{4+\delta}$ and $\text{La}_{2-x}\text{Sr}_x\text{Cu}_y\text{Ni}_{1-y}\text{O}_4$ Systems", **J.M. Honig**, MISCON Consortium Meeting, Iowa State University, Ames, Iowa, July 9, 1992.
113. "Magnetic Properties and Pairing of Strongly Correlated and Hybridized Electrons", **J. Spaček**, International School on Theoretical Physics: Narrow-Band Phenomena, Szczyrk, September 16-22, 1992, invited.
114. "Physical Properties and Indications of Superconductivity in the La_2NiO_4 System", **J.M. Honig**, A.F. Ioffe Institute, St. Petersburg, Russia, October 15, 1992, invited.
115. "Exchange Mediated Pairing: from Kondo Lattice to Kondo Pairing", **J. Spaček**, Condensed Matter Seminar, University of Maryland, College Park, MD, December 3, 1992, invited.
116. "Low Temperature Properties of the Metallic Perovskite LaNiO_3 : Evidence for Almost Localized Behavior of Electrons", K. Sreedhar, B. Crooker, **M. McElfresh**, D. Darwin, J. Xu, **J. Spaček**, and **J.M. Honig**, American Physical Society Meeting, Indianapolis, IN, March 18, 1992.
117. "Low Temperature Properties of the Metallic Perovskite LaNiO_3 : Evidence for Almost Localized Behavior of Electrons", K. Sreedhar, B. Crooker, D. Darwin, J. Xu, **M. McElfresh**, **J. Spaček**, and **J.M. Honig**, 203rd National Meeting, American Chemical Society, San Francisco, CA, April 9, 1992.
118. "Low Temperature Properties of the Metallic Perovskite LaNiO_3 : Evidence for Almost Localized Behavior of Electrons", K. Sreedhar, B. Crooker, D. Darwin, J. Xu, **M. McElfresh**, **J. Spaček**, and **J.M. Honig**, 94th Annual Meeting of the American Ceramic Society, April 13, 1992.

119. "Synthesis and Characterization of Ni_3S_2 Simple Crystals", P. Metcalf, P. Fanwick, Z. Kakol, B. Crooker, **M. McElfresh**, N. Otsuka, and **J.M. Honig**, 204th National Meeting of the American Chemical Society, Washington, DC, August 26, 1992.
120. "Synthesis of $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Films from Metallo-Organic Precursors", C. Venkatraman, **G.L. Liedl**, and **A.I. Schindler**, TMS - March 1992 in San Diego, CA.
121. "Fabrication of Superconducting Films Using the MOD Process", **G.L. Liedl**, SAMPE Electronic Materials and Processes Conference, June, 1992.
122. "Future and Role of University Consortia in High Temperature Superconductivity Research and Development" **G.L. Liedl**, Third International Conference and Exhibition World Congress on Superconductivity, Munich, German, Sept. 14-18, 1992.
123. "Microstructures of Directionally Solidified YBCO Wires", A. Zanota, **E. P. Kvam**, D. L. Perry, and **P. J. McGinn**, presented at TMS Fall Meeting, 1992.
124. "Flux Line Pinning Mechanisms at Dislocations", **E. P. Kvam**, presented at TMS Fall Meeting, 1992.
125. "Influence of Surface Contamination on STM Scans of YBCO Films", T.G. Miller, L. Hou, **M. McElfresh**, and R. Reifenberger, Poster at 1992 MRS Meeting, Boston, MA, December, 1992.
126. "Reversible and Irreversible Magnetic Behavior in High T_c Materials", **M. McElfresh**, AMS/TMS Meeting, Chicago, IL, October, 1992.
127. "Reversible and Irreversible Magnetic Behavior in High T_c Materials", **M. McElfresh**, IUPUI, Indianapolis, IN, September, 1992.
128. "Irreversibility in High Temperature Superconductors", **M. McElfresh**, Ecole Polytechnique, Palaiseau, France, June, 1992 (invited).
129. "Reversible and Irreversible Magnetic Behavior in High T_c Materials", **M. McElfresh**, Notre Dame University, Notre Dame, IN, April, 1992.
130. "Magnetization Studies of Irradiation Modified Single Crystal $\text{YBa}_2\text{Cu}_3\text{O}_7$ Superconductors: Flux Creep and Annealing Effects", J.R. Thompson, Y.R. Sun, D.K. Christen, H.R. Kerchner, A.P. Malozemoff, L. Civale, A.D. Marwick, L. Krusin-Elbaum, **M.W. McElfresh**, and F. Holtzberg, Physics and Materials Science of High Temperature Superconductors -11, R. Kossowsky, ed., B. Raveau, and S. Patapis, (NATO Advanced Studies Institute Series), Kluwer Academic Publishers, Dordrecht, The Netherlands, 1992.
131. "A Universal Relationship between Te and Hole Content in P-Type Copper Oxide Superconductors", H. Zhang and **H. Sato**, APS, Indianapolis, March 20, 1992.
132. "Broad Superconducting Transitions in $\text{Bi}_2\text{Sr}_2\text{Ca}_1\text{Cu}_2\text{O}_{8,\delta}$ ", M. Sankararaman, N. Ohnishi, Z.P. Zhang, H. Zhang, and **H. Sato**, presented at the TMS Fall Meeting, Chicago, IL, November 2, 1992.
133. "Texture and Anisotropy in Structural Ceramic", **K.J. Bowman**, 1992 Ceramic Science and Technology Congress, San Francisco, CA.

MISCON PUBLICATIONS

January 1992 - December 1992

(In Print)

1. "Synthesis and Thermal Decomposition of Copper(I) Silyloxy Complexes. X-Ray Crystal Structures of $[\text{Cu}(\text{OSiPh}_3)]_4$ and $[\text{Cu}(\text{OSiPh}_3)(\text{PMe}_2\text{Ph})]_2$ ", M.J. McGeary, R.C. Wedlich, P.S. Coan, K. Folting and **K.G. Caulton**, *Polyhedron* **11**, 19, 2459-2473, 1992.
2. "Strategy for Synthesis of an Yttrium/Copper (I) Complex with an Oxo Ligand Environment", P.S. Coan, J.C. Huffman and **K.G. Caulton**, *Inorg. Chem* **31**, 4207-4209, 1992.
3. "Landau Quantization and Particle-Particle Ladder Sums in a Magnetic Field", **A.H. MacDonald**, H. Aker and M.R. Norman, *Phys. Rev. B* **45**, 17, 10147-10150, 1992.
4. "Mean-Field Superconductivity in a Strong Magnetic Field", M.R. Norman, H. Aker and **A.H. MacDonald**, *Physica C* **196**, 43-47, 1992.
5. "Universal Conductivity of Dirty Bosons in Two Dimensions", **S.M. Girvin**, M. Wallin, E.S. Sørensen and A.P. Young, *Physica Scripta* **42**, 96-101, 1992.
6. "Universal Conductivity of Dirty Bosons at the Superconductor-Insulator Transition", E.S. Sørensen, M. Wallin, **S.M. Girvin** and A.P. Young, *Physical Review Letters* **69**, 5, 828-831, 1992.
7. "Universal Conductivity at the Superconductor-Insulator Transition in Two-Dimensions", **S.M. Girvin**, M. Wallin, M. Cha, M.P.A. Fisher and A.P. Young, *Prog. Theoretical Physics* **107**, p. 135-194, 1992.
8. "Theory of High-Frequency Linear Response of Isotropic Type-II Superconductors in the Mixed State", M.W. Coffey and **J.R. Clem**, *Phys. Rev. B* **46**, 18, 11757-11764, 1992.
9. "Distorted Vortex in Josephson-Couple Layered Superconductors" L.N. Bulaevskii, M. Ledvij and **V.G. Kogan**, *Phys. Rev. B* **46**, 18, 11807-11812, 1992.
10. "Magnetization Scaling of Single-Crystal $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_8$ Below T_c ", J.H. Cho, Z. Hao and D.C. Johnston, *Phys. Rev. B* **46** (Rapid Communication), 8679-8682, 1992. (**Clem/Kogan Group**)
11. "Penetration of Vortices into Anisotropic Magnetic Superconductors", A. Y. Simonov and M. Yu. Moiseev, *Phys. Rev. B* **46**, 9, 5556-5560, 1992. (**Clem/Kogan Group**)
12. "Coupled Nonlinear Electrodynamics of Type-II Superconductors in the Mixed State", M.W. Coffey, *Phys. Rev. B* **46**, 1, 567-570, 1992. (**Clem/Kogan group**)
13. "Fundamentals of Vortices in the High-Temperature Superconductors", **J.R. Clem**, Critical Currents, Proceedings of the 6th International Workshop on Critical Currents, Cambridge, UK, July 7-11, 1991, J.E. Evetts, ed. (Hilger, Bristol, 1992) *Supercond. Sci. Technol.* **5**, S33-40, 1992.
14. "Vortex Near the Surface of an Anisotropic Superconductor: Implication for Decoration", **V.G. Kogan**, M. Ledvij and L.N. Bulaevskii, *Phys. Rev. B* **46**, 13, 8425-8428, 1992.
15. "Fluctuations of Vortices in Layered High- T_c Superconductors", L.N. Bulaevskii, M. Ledvij and **V.G. Kogan**, *Phys. Rev. Lett.* **68**, 25, 3773-3776, 1992.
16. "Vortices in Layered Superconductors with Josephson Coupling", L.N. Bulaevskii, M. Ledvij and **V.G. Kogan**, *Phys. Rev. B* **46**, 1, 366-380, 1992.

17. "Superconducting Properties of Atomic S/N and S/S' Superstructures", A.I. Buzdin, V.P. Darnjanovic and A.Y. Simonov, *Physica C* **194**, 109-118, 1992. (**Clem/Kogan group**)
18. "Proximity Effect in YBa₂Cu₃O₇/Y_{0.6}Pr_{0.4}Ba₂Cu₃O₇/YBa₂Cu₃O₇ Junctions", **V.G. Kogan** and A.Y. Simonov, *Phys. Rev. Lett.* **68**, 13, 2106, 1992.
19. "Theory of rf Magnetic Permeability of Isotropic Type-II Superconductors in a Parallel Field", M.W. Coffey and **J.R. Clem**, *Phys. Rev. B* **45**, 17, 9872-9881, 1992.
20. "Theory of rf Magnetic Permeability of Type-II Superconductors in Slab Geometry with an Oblique Applied Static Magnetic Field", M.W. Coffey and **J.R. Clem**, *Phys. Rev. B* **45**, 18, 10527-10535, 1992.
21. "Melting of the Abrikosov Flux Lattice in Anisotropic Superconductors", R.G. Beck, D.E. Farrell, J.P. Rice, D.M. Ginsberg and **V.G. Kogan**, *Phys. Rev. Lett.* **68**, 10, 1594-1596, 1992.
22. "Model for the Low-Temperature Transport of Bi-based High-Temperature Superconducting Tapes", L.N. Bulaevskii, **J.R. Clem**, L.I. Glazman and A.P. Malozemoff, *Phys. Rev. B* **45**, 5, 2545-2548, 1992.
23. "Melting and Freezing of Bi-Sr-Ca-Cu-O Compounds", J. Polonka, M. Xu, **A.I. Goldman**, **D.K. Finnemore** and Q. Li, *Superconductor Sci. Tech.* **5**, S157-S159, 1992.
24. "Defect Size Dependence of Critical Current Density Enhancement for Irradiated YBa₂Cu₃O_{7- δ} ", J. Bechtold, Y.Y. Xue, Z.J. Huang, E.V. Hungerford, P.H. Hor, C.W. Chu, X.K. Maruyama, H. Backe, F.R. Buskirk, S.M. Connors, D.D. Snyder, Y.C. Jean and **J.W. Farmer**, *Physica C* **191**, 199-204, 1992.
25. "Renormalized Non-Linear Flux-Flow and Phase-Slip Resistivity in Polycrystalline Bi-Sr-Ca-Cu-O", **H.A. Blackstead**, D.B. Pulling, D.G. Keiffer, M. Sankararaman and **H. Sato**, *Physics Letters A* **170**, 130-136, 1992.
26. "Phase-Slip Resistivity in High-Temperature Superconductors: a Manifestation of Intrinsic Nano-Granularity", **H.A. Blackstead**, *Journal of Superconductivity* **5**, 1, 67-74, 1992.
27. "Chemical Studies of (001)-Oriented Er₁Ba₂Cu₃O_{7- δ} , Er₅Ba₇Cu₁₂O_y, and Er₄Ba₅Cu₉O_y High-Temperature Superconductor Thin Films by Photoemission Spectroscopy", **K.M. Choudhary**, J. Bae and P. Seshadri, *Journal of Solid State Chemistry* **100**, 388-392, 1992.
28. "Er₅Ba₇Cu₁₂O_y and Er₄Ba₅Cu₉O_y: New High-Temperature Superconductor Thin Films with Critical Transition Temperature in the 93-95K Range", **K.M. Choudhary**, J. Bae, P. Seshadri and M. Sankararaman, *Journal of Solid State Chemistry* **100**, 379-382, 1992.
29. "X-ray Diffraction Studies of Dy_{1.1}Ba_{1.9}Cu₃O_{7- δ} (001) and Dy_{1.3}Ba_{1.7}Cu₃O_y(001) High-Temperature Superconductor Thin Films", **K.M. Choudhary**, P. Seshadri and J. Bae, *Phys. Rev. B* **45**, 9, 4892-4896, 1992.
30. "Grain Boundary Junctions from Anisotropic Etching of LaAlO₃ Substrates", **S.T. Ruggiero**, A.H. Cardona and L.C. Bourne, *Physica C* 185-189, 2605-2606, 1991.
31. "Molecular Beam Deposition of Dy₁Ba₂Cu₃O_{7- δ} (001) High-Temperature Superconductor Thin Films", J. Bae, P. Seshadri and **K.M. Choudhary**, *J. Vac. Sci. Tech. A* **10**, 281-283, 1992.
32. "Effect of Y₂BaCuO_x Precipitates on Flux Pinning in Melt-Processed YBa₂Cu₃O_x", S. Sengupta, D. Shi, Z. Wang, A.C. Biondo, U. Balachandran and K.C. Goretta, *Physica C* **199**, 43-49, 1992. (**McGinn Group**).

33. "Current Density Dependence of the Activation Energy in Type II Superconductors", S. Sengupta, D. Shi, S. Salem-Sugul, Jr., Z. Wang, **P.J. McGinn** and K. DeMoranville, J. Appl. Phys. **72** (2), 592-595, 1992.
34. "The Effects of Second Phase Additions (SiC, BaZrO₃, BaSnO₃) on the Microstructure and Superconducting Properties of Zone Melt Textured YBa₂Cu₃O_{7-x}", V. Chakrapani, D. Balkin and **P. McGinn**, Appl. Superconductivity **1**, 1/2, 71-80, 1993.
35. "A TEM Study of Grain Boundaries in Zone-Melted YBa₂Cu₃O_x", J.G. Chen, D. Shi, C.M. Wayman, **P.J. McGinn**, W.H. Chen and N. Zhu, Mat. Lett. **14**, 177-181, 1992.
36. "The Chemical Stability of BaSnO₃ in the Melt of YBa₂Cu₃O_{6+x} During Solidification", C. Varanasi, D. Balkin and **P. McGinn**, Mat. Lett. **13**, 363-367, 1992.
37. "The Critical Current of Ag/YBa₂Cu₃O_{7-δ} Random Bulk Composites", J.J. Calabrese, M.A. Dubson and **J.C. Garland**, J. Appl. Phys. **72** (7), 2958-2963, 1992.
38. "Fractional Shapiro Steps in Ladder Josephson Arrays", W. Yu, E.B. Harris, S.E. Hebboul, **J.C. Garland** and **D. Stroud**, Phys. Rev. B **45**, 21, 12624-12627, 1992.
39. "Flux-flow Resistivity in Model High-Temperature Superconductors", K.H. Lee and **D. Stroud**, Phys. Rev. B **46**, 9, 5699, 1992.
40. "Critical Currents of Composite Superconductors: Model Calculations", K.H. Lee and **D. Stroud**, Phys. Rev. B **45**, 5, 2417-2424, 1992.
41. "Critical Current of a Josephson Junction with Spatial Fluctuations of the Order Parameter", V.V. Dorin and M.V. Fistul, Phys. Rev. B **46**, 21, 13951-13955, 1992, (**Giullani Group**).
42. "Metal-Insulator Transitions, Exchange Interactions and Real Space Pairing: An Introduction to the Theory of Strongly Correlated Electron Systems", **J. Spałek** and **J.M. Honig**, Studies of High Temperature Superconductors, **8**, 1-67, 1991.
43. "Electronic Properties of the Metallic Perovskite LaNiO₃: Correlated Behavior of 3d Electrons", K. Sreedhar, **J.M. Honig**, M. Darwin, **M. McElfresh**, P.M. Shand, J. Xu, B.C. Crooker and **J. Spałek**, Phys. Rev. B **46**, 10, 6382-6386, 1992.
44. "Neutron-Diffraction Study of the Antiferromagnetic Form Factor of La₂NiO₄", X. Wang, C. Stassis, D.C. Johnston, T.C. Leung, J. Ye, B.N. Harmon, G.H. Lander, A.J. Schultz, C.-K. Loong and **J.M. Honig**, Phys. Rev. B **45**, 10, 5645-5653, 1992.
45. "Fluorination of La₂NiO₄ and La₂CuO_{4+δ}", V. Bhat, C.N.R. Rao and **J.M. Honig**, Solid State Comm. **81**, 9, 751-756, 1992.
46. "Microscopic Model of Hybrid Pairing: II. Exact Solution for a Single Pair", K. Byczuk, **J. Spałek** and W. Wojcik, Phys. Rev. B **46**, 21, 14134-14141, 1992.
47. "Microscopic Model of the Mott-Hubbard Localization", **J. Spałek** and W. Wójcik, Phys. Rev. B **45**, 7, 3799-3802, 1992.
48. "Superconductivity of La_{2-y}Sr_yCu_{1-x}Ni_xO_{4+δ} (y=0.1, 0.2; 0 ≤ x ≤ 0.5) the Hole-Compensating Effect of Ni", V. Bhat, C.N.R. Rao and **J.M. Honig**, Physica C **191**, 271-276, 1992.
49. "Pinning Potential of Stacking Fault-Related Dislocations in YBa₂Cu₃O₇", **E.P. Kvam**, Physica C **200**, 409-412, 1992.
50. "Correlation of Surface Topography and Flux Pinning in Superconducting YBaCuO Films", **M. McElfresh**, T. G. Miller, D.M. Schaefer, R. Reifengerger, R.E. Muenchausen, M. Hawley, S.R. Foltyn and X.D. Wu, J. Appl. Phys. **71**, 10, 5099-5102, 1992.

51. "Influence of Oxygen Stoichiometry on the Antiferromagnetic Ordering of Single Crystals of $\text{La}_2\text{NiO}_{4+\delta}$ ", P. Gopalan, **M.W. McElfresh**, Z. Kakol, **J. Spalek** and **J.M. Honig**, Phys. Rev. B **45**, 1, 249-255, 1992.
52. "TEM Study of (015) Growth Twins in the Bi-Sr-Ca-Cu-O Superconductors Obtained by Melt Quench Technique ", N. Ohnishi, M. Sankararaman and **H. Sato**, Materials Research Society Symposium Proceedings, **238** "Structure and Properties of Interfaces in Materials", Materials Research Society, p. 841-846, 1992.

(Accepted for Publication)

1. "Vortex-Lattice States of a Two-Dimensional Electron System at Strong Magnetic Fields", H. Akera, **A.H. MacDonald** and M.R. Norman, Excitations in Superlattices and Quantum Wells (accepted).
2. "Landau Quantization and Superconductivity at High Magnetic Fields", M.R. Norman, H. Akera and **A.H. MacDonald**, Physical Phenomena at High Magnetic Fields, Addison Wesley, NY (accepted).
3. "Flux Pinning and Critical Currents in Superconductor-Normal Metal Composites", **D.K. Finnemore**, M. Xu, Q. Li and J.E. Ostenson, Advances in Science (accepted).
4. "Synthesis and Characterization of Ceramic $(\text{Sr}_{1-x}\text{Ca}_x)_2\text{CuO}_3$ ", M. Xu, E.T. Volles, **L.S. Chumbley**, **A.I. Goldman** and **D.K. Finnemore**, J. Mat. Res. (accepted).
5. "Initial Magnetization and Magnetic Relaxation in a Single Crystal of $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_x$ ", M. Xu, A. Umazawa and G.W. Crabtree, Physica C (accepted). (**Goldman**, **Finnemore**, **Chumbley Group**)
6. "Magnetic Relaxation in Generalized Critical State Model", M. Xu, Physica C (accepted). (**Goldman**, **Finnemore**, **Chumbley Group**)
7. "Effective Activation Energy in the Bi-Sr-Ca-Cu-O Systems", S. Sengupta, D. Shi, Z. Wang, M. Smith and **P.J. McGinn** (accepted).
8. "Vortex Motion in Josephson Junction Arrays Near $f=0$ and $f=1/2$ ", W. Yu, K.H. Lee and **D. Stroud**, Phys. Rev. B (accepted).

(Submitted for Publication)

1. "Anhydrous Yttrium Acetylacetonate and the Course of Thermal 'Dehydration' of $Y(acac)_3 \cdot 3H_2O$ ", E.H. Barash, P.S. Coan, E.B. Lobkovsky, W.E. Streib and **K.G. Caulton** (submitted).
2. "I-V Characteristics of High Temperature Superconductors with Columnar Defects", M. Wallin and **S.M. Girvin**, Physical Review Letters (submitted).
3. "Quantum Mechanics and Superconductivity in a Magnetic Field", **A.H. MacDonald**, H. Akera and M.R. Norman, (submitted to the Australian Journal of Physics).
4. "Low Temperature Fluctuations of Vortices in Layered Superconductors", Y.-Q. Song, W.P. Halperin, L. Tonge, T.J. Marks, M. Ledvij, **V.G. Kogan**, and L.N. Bulaevskii, Phys. Rev. B, (submitted).
5. "Role of Vortex Fluctuations in Determining Superconducting Parameters from Magnetization Data for Layered Superconductors", **V. G. Kogan**, M. Ledvij, A. Yu. Simonov, J.H. Cho and D.C. Johnston (submitted).
6. "Magnetic Field of Vortices Crossing the Superconductor Surface", **V.G. Kogan**, A. Yu. Simonov and M. Ledvij (submitted).
7. "Layered High- T_c Superconductors in an a.c. Field", A. Yu. Simonov (submitted).
(Clem/Kogan group)
8. "Fraunhofer Oscillations in a Multilayer System with Josephson Coupling of Layers", L.N. Bulaevskii, **J.R. Clem** and L.I. Glazman, Phys. Rev. B (submitted).
9. "Theory of Microwave Transmission and Reflection in Type-II Superconductors in the Mixed State", M.W. Coffey and **J.R. Clem**, Phys. Rev. B (submitted).
10. "Penetration of Vortices into Magnetic Layered Superconductors", A.Y. Simonov and M.Y. Moiseev (submitted). **(Clem/Kogan group)**
11. "Distorted Vortex in Josephson Coupled Layered Superconductors", L.N. Bulaevskii, M. Ledvij and **V.G.Kogan**, Phys. Rev. B (submitted).
12. "Effects of Flux Flow, Flux Pinning, and Flux Creep Upon the rf Surface Impedance of Type-II Superconductors", **J.R. Clem** and M.W. Coffey (submitted).
13. "Theory of High-Frequency Linear Response of Isotropic Type-II Superconductors in the Mixed State", M.W. Coffey and **J.R. Clem**, Phys. Rev. B (submitted).
14. "Angular Dependences of the Thermodynamic and Electromagnetic Properties of the High- T_c Superconductors in the Mixed State", Z. Hao and **J.R. Clem**, Phys. Rev. Lett. (submitted).
15. "Magnetic Properties of Layered Superconductors Near H_{c2} ", Z. Hao, Phys. Rev. B (submitted). **(Clem/Kogan group)**
16. "Observation of a Novel Vortex Structure Driven by Magnetic Interactions Near a Sawtooth Twin Boundary in $YBa_2Cu_3O_{7-\delta}$ ", P.L. Gammel, C.A. Durán, D.J. Bishop, **V.G. Kogan**, M. Ledvij, A.Y. Simonov, J.P. Rice and D.M. Ginsberg, Phys. Rev. Lett. (submitted).
17. "Comment on 'From Isotropic to Anisotropic Superconductors: A Scaling Approach'", Z. Hao and **J.R. Clem**, Phys. Rev. Lett. (submitted).

18. "Critical Current Enhancement by Neutron Irradiation of Rapidly Textured $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_8$ ", **M.J. Kramer, J.W. Farmer**, S.R. Arrasmith and **R.W. McCallum** (submitted).
19. "Recrystallization of Amorphous and Nanocrystalline $\text{NdBa}_2\text{Cu}_3\text{O}_{7-x}$ and $\text{GdBa}_2\text{Cu}_3\text{O}_{7-x}$ ", T.J. Folkerts, K.W. Dennis, S.I. Yoo, Y. Xu, **M.J. Kramer** and **R.W. McCallum** (submitted).
20. "Containerless Melt Processing of $\text{REBa}_2\text{Cu}_3\text{O}_{7-x}$ (RE=Y, Gd, Nd) High Temperature Superconductors", **R.W. McCallum, M.J. Kramer**, T.J. Folkerts, S.R. Arrasmith, B.D. Merkle, S.I. Yoo, Y. Xu and K.W. Dennis (submitted).
21. "Flux Pinning in $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Single Crystals: Neutron Irradiation and Annealing", B.M. Vlcek, M.C. Frischherz, S. Fleshler, U. Welp, J.Z. Liu, J. Downey, K.G. Vandervoort, G.W. Crabtree, M.A. Kirk, J. Giapintzakis and **J. Farmer** (submitted).
22. "Flux-Flow and Phase-Slip Resistivity in Two Phase Polycrystalline $\text{Bi}_{1.6}\text{Pb}_{0.4}\text{Sr}_{1.7}\text{Ca}_2\text{Cu}_3\text{O}_x$ ", **H.A. Blackstead**, D.B. Pulling and **H. Sato** (submitted).
23. "Anisotropic Resistivity in the Mixed State of $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ ", **H.A. Blackstead**, (submitted).
24. "Current and Angular-Dependent Transport in the Mixed State of $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$ ", **H.A. Blackstead** (submitted).
25. "Electron Spin Resonance in Superconducting Melt-Textured $\text{GdBa}_2\text{Cu}_3\text{O}_{7-\delta}$: Evidence Against Uniform Flux-Entangling", **H.A. Blackstead**, D.B. Pulling and C.A. Clough (submitted).
26. "Giant Flux-Flow and Axially Symmetric Phase-Slip in Superconducting $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Films", **H.A. Blackstead**, D.B. Pulling, J.S. Horwitz and D.B. Chrisey (submitted).
27. "Observation of Giant Flux-Flow in Superconducting $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Films", **H.A. Blackstead**, D.B. Pulling, J.S. Horwitz and D.B. Chrisey (submitted).
28. "Anisotropic Resistivity in the Mixed State of Crystalline $\text{YBa}_2\text{Cu}_3\text{O}_{7+\delta}$ ", **H.A. Blackstead** (submitted).
29. "Phase-Slip Resistivity in Superconducting Crystalline $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$: A Manifestation of Intrinsic Nano-Granularity", **H.A. Blackstead**, (submitted).
30. "Flux-Flow in Multi-Phase Polycrystalline Bi-Sr-Ca-Cu-O", **H.A. Blackstead**, D.B. Pulling, D.G. Keiffer, M. Sankararaman and **H. Sato**, Physics Letters (submitted).
31. "Field Induced Resistivity in Crystalline $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$: Evidence for Granularity", **H.A. Blackstead**, D.G. Keiffer, M.D. Lan and J.Z. Liu (submitted).
32. "Flux Pinning and Phase Transitions in High-Temperature Superconductors with Columnar Defects: Some Model Calculations", K.H. Lee, **D. Stroud** and **S.M. Girvin**, Phys. Rev. B (submitted).
33. "Unique Ba 4d Photoemission from Clean and Degraded Surfaces of (001) Oriented $\text{Er}_1\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$, $\text{Er}_5\text{Ba}_7\text{Cu}_{12}\text{O}_y$ and $\text{Er}_4\text{Ba}_5\text{Cu}_9\text{O}_y$ High-Temperature Superconductor Thin Films", **K.M. Choudhary**, J. Bae, P. Seshadri and M. Marsi, Phys. Rev. B (submitted).
34. "Removal of an Unknown Ba Compound from Degraded Surfaces of $\text{Er}_1\text{Ba}_2\text{Cu}_3\text{O}_{7-\delta}$, $\text{Er}_5\text{Ba}_7\text{Cu}_{12}\text{O}_y$ and $\text{Er}_4\text{Ba}_5\text{Cu}_9\text{O}_y$ High-Temperature Superconductor Thin Films", **K.M. Choudhary**, J. Bae and P. Seshadri, Appl. Phys. Lett. (submitted).

35. "New High-Temperature Superconductor Thin Films in Er-Ba-Cu-O System with Transition Temperature for Zero Resistivity in 93K-95K Range", **K.M. Choudhary**, J. Bae, P. Seshadri and M. Sankararaman, Phys. Rev. Lett. (submitted).
36. "The Effect of $\text{PtO}_2 \cdot \text{H}_2\text{O}$ Additions on the Y_2BaCuO_5 Morphology in Melt Textured $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ ", C. Varanasi and **P.J. McGinn**, Physica C (submitted).
37. "Modified U-j Relationship and Temperature Dependence of j_c in Type II Superconductors", S. Sengupta, D. Shi, Z. Wang, M.E. Smith and **P.J. McGinn**, Phys. Rev. B (submitted).
38. "Flux Pinning in Hot Isostatically Pressed $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_x$ ", D.J. Miller, S. Sengupta, D. Shi, J.D. Hettinger, K.E. Gray, A.S. Nash and K.C. Goretti, Appl. Phys. Letters (submitted). (**McGinn group**)
39. "Effective Flux-Creep Activation Energy and Anisotropy in a $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}$ Single Crystal", M.E. Smith, D. Shi, S. Sengupta and Z. Wang (submitted). (**McGinn group**).
40. "Anomaly in the Irreversibility Line: A Universal Characteristic of the Cuprate Superconductors?", C.C. Almasan, M.C. deAndrade, Y. Dalichaouch, J.J. Neumeier, C.L. Seaman, M.B. Maple, R.P. Guertin, M.V. Kuric and **J.C. Garland**, Phys. Rev. Lett. (submitted).
41. "R.F. Power Dependence of Subharmonic Emission of Two-Dimensional Josephson Junction Arrays", S.E. Hebboul and **J.C. Garland**, Phys. Rev. Lett. (submitted).
42. "Penetration Depth $\lambda(T)$ of $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Films Determined from the Kinetic Inductance", J.-Y. Lee and **T.R. Lemberger** (submitted).
43. "Absence of a Gap in the Infrared Reflectance of Ni-doped $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Films", M.J. Sumner, J.-Y. Kim and **T.R. Lemberger** (submitted).
44. "Crystalline Linkage and Defect Structures in Bulk Zone Melt Textured $\text{YBa}_2\text{Cu}_3\text{O}_7$ ", A. Zanota, **E.P. Kvam**, D. Balkin and **P.J. McGinn**, Appl. Phys. Lett. (submitted).
45. "Structure and Properties of the $\text{LaCuO}_{3-\delta}$ Perovskites ", J.F. Bringley, B.A. Scott, S. J. La Placa, T.R. McGuire, F. Mehran, **M.W. McElfresh** and D.E. Cox (submitted).
46. "Pressure Dependence of the Static Magnetic Susceptibility of the Heavy Fermion Superconductor UBe_{13} ," **M. McElfresh**, M.B. Maple, J.O. Willis, D. Schiferl, J.L. Smith, Z. Fisk, D.L. Cox and **J. Spalek** (submitted).
47. "Irreversibility Line in YBaCuO Thin Films: Correlation of Transport and Magnetic Behavior", J. Deak, **M. McElfresh**, **J.R. Clem**, Z. Hao, M. Konczykowski, R. Muenchausen, S. Foltyn and R. Dye (submitted).
48. "Identifying the Loss of Critical Current Density in YBaCuO Thin Films", J. Deak, **M. McElfresh**, **J.R. Clem**, Z. Hao, M. Konczykowski, R. Muenchausen, S. Foltyn and R. Dye, Phys. Rev. B (Rapid Communication), (submitted).
49. "Elementary Excitations in a Frustrated 2D Heisenberg Antiferromagnet: $\text{La}_{2-x}\text{Sr}_x\text{NiO}_{4+\delta}$ ", M. Darwin, **M. McElfresh**, P. Metcalf, **J. Honig** and B. Crooker, (submitted).
50. "Effect of Flux Creep on the Temperature Dependence of the Current Density in YBaCuO Crystals", J.R. Thompson, Y.R. Sun, L. Civale, A.P. Malozemoff, **M.W. McElfresh**, A.D. Marwick and F. Holtzberg, Phys. Rev. B (submitted).
51. "Enhancement of T_c in $\text{YBa}_2\text{Cu}_3\text{O}_7$ by Chemical Substitution in Bulk and Thin Film Materials: Implications for the Upper Critical Magnetic Field", J.J. Neumeier, **M.W. McElfresh**, L. Hou and A. Lewicki (submitted).

52. "Broad Superconducting Transitions in $\text{Bi}_2\text{Sr}_2\text{Ca}_1\text{Cu}_2\text{O}_x$ Obtained from Amorphous Precursors", M. Sankararaman, N. Ohnishi, Z.P. Zhang, H. Zhang, **H. Sato**, **H.A. Blackstead** and D.B. Pulling (submitted).
53. "Growth Twin in the Bi-Sr-Ca-Cu-O Superconductors Obtained by Melt Quench Technique", N. Ohnishi, M. Sankararaman and **H. Sato** (submitted).

MISCON THESES

January 1992 - December 1992

1. "Characterization of Multilayers of Oxide Thin Films", Iyer R. Venkataraman, M.S. Thesis, School of Materials Engineering Purdue University, 1992. **(Kvam Group)**
2. "Microstructural Features of Directionally Solidified Yttrium Barium Copper Oxide", A. Zanota, M.S. Thesis, School of Materials Engineering, Purdue University, August 1992. **(Kvam Group)**
3. "Universal Conductivity at the Superconductor-Insulator Transition in Thin Films", Min-Chul Cha, Doctor of Philosophy, Department of Physics, Indiana University, September 1992. **(MacDonald Group)**.

APPENDIX I
RESEARCH PROGRAM LISTING
January 1, 1992 - December 31, 1992

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

PI	Univ	Title	Recommended Funding	Affiliations	Students & Professionals	Status
D. V. Baxter K. G. Caulton M. H. Chisholm	IU	Low Temperature Routes to Processing of High-Temperature Superconductors	112,600	Advanced Technology Materials, Inc.	Vincent DiStasi Wen Chung Chiang Dr. Ziling Sr. Sylvain Dutremez	Ph.D. anticipated 1993 Ph.D. anticipated 1994 Professional Professional
R.W. McCallum M.J. Kramer L.S. Chumbley	ISU	Crystallization of REBa ₂ Cu ₃ O _{7-x} High Temperature Superconducting Materials from the Solidified Melt	carry over		Timothy Folkerts Sang Im Yoo	Postdoctoral Associate Postdoctoral Associate
A.I. Goldman D.K. Finnemore L.S. Chumbley	ISU	Crystallization of High Temperature Superconducting Filaments	carry over		Ming Xu	Postdoctoral Associate
P. K. Gallagher	OSU	Improved Synthetic Techniques for High- T_c Superconductors with Deliberate Controlled Additions of a Second Phase	47,115		Siyoungh Choi	Ph.D. anticipated 6-94
P. J. McGinn	ND	Microstructural Dependence of Critical Current Density in Melt Textured YBa ₂ Cu ₃ O _{6+x} Superconductors	120,000		David Balkin Suvankar Sengupta Varanasi Chakripani J. Kirksey Chan Joong Kim	Ph.D. anticipated 5-93 Ph.D. anticipated 5-93 Ph.D. anticipated 5-93 Technician Postdoctoral Associate
K.H. Sandhage P.J. McGinn	OSU ND	Processing of Textured Superconducting Oxide/Noble Metal Microlaminates	115,000	Intermagetics General Corporation Ribbon Technology Corporation	Troy Pyles Dr. Tim Christman Marc Black	B.S. anticipated 6-94 Visiting Scholar Ph.D. anticipated 5-94
K. H. Sandhage	OSU	Anisotropic Grain Growth and Isothermal Grain Alignment of Bulk, Superconducting Oxides	100,390		Yong-Yi Shi David Chmielewski	Ph.D. anticipated 6-94 M.S. anticipated 9-93

Area 1: New and Improved High T_c Superconducting Materials: Phase Relations, Reactions, Synthesis and Processing
CONTINUED

PI	Univ	Title	Recommended Funding	Affiliations	Students & Professionals	Status
G.L. Liedl A.L. Bement, Jr.	PU	Processing and Texture Development of Films from Metallo-Organic Precursors	140,541		C. Venkatraman	Postdoctoral Researcher
K.P. Trumble M.W. McElfresh K.J. Bowman	PU	High Temperature Superconducting Tubes for Magnetic Shielding Applications	160,000	Quantum Magnetism/ Quantum Design	Michael J. Darwin Sih Li Greg Steinlage Darin Aldrich Chad Peterson Amy Trissler Timothy Brent	Ph.D. anticipated 9-94 Ph.D. anticipated 1995 M.S.E. anticipated 5-94 B.S.E. anticipated 5-93 B.S.E. anticipated 5-93 B.S.E. anticipated 12-93 B.S.E. anticipated 5-94
K. M. Choudhary S. T. Ruggiero	ND	Study of Compositional Modulation in High Temperature Superconductor Structures and Its Influence on their Superconducting Properties	108,000		Chungling Zhong P. Seshadri Jewen Bae	Ph.D. anticipated 1995 Ph.D. anticipated 1994 Ph.D. anticipated 1993
J. C. Garland	OSU	High T_c Superconducting Composites/Films	118,605		S.T. Herbert Y.M. Wan C. Ash S.E. Hebboul D.C. Harris	Ph.D. anticipated 1993 Ph.D. anticipated 1995 M.S. anticipated 1993 Professional Postdoctoral Researcher
J. M. Honig J. Spałek	PU	Normal Properties, Magnetism, and Onset of Superconductivity in $La_{1-x}Sr_xNiO_{4+\delta}$ and $La_{2-x}Cu_yNi_{1-y}Sr_xNiO_4$ Systems, and Real Space Pairing in High- T_c Systems	83,366		K. Sreedhar P. Metcal	Visitor Professional
H. Sato	PU	Study of Naturally Modulated High T_c Superconducting Compounds	147,181		H. Zhang M. Sankaraman J.G. Chen Shinichi Kohriyama	Ph.D. anticipated 1993 Postdoctoral Researcher Postdoctoral Researcher Visiting Scientist

Area II: Transport Properties of High-Temperature Superconductors Optimization of Critical Currents, Magnetic Screening, Dynamical Behavior and Other Limiting Factors

PI	Univ	Title	Recommended Funding	Affiliations	Students & Professionals	Status
H. A. Blackstead	ND	Microwave Dissipation in High Temperature Superconductors: Flux-Lattice Dynamics, Crystal Anisotropy and Flux Pinning	84,000		Ann Klunzinger D.B. Pulling	Graduate Student Asst. Professional Specialist
J. R. Clem V. G. Kogan	ISU	Thermally Activated Flux Motion and Anisotropy in High-Temperature Superconductors	75,217	AT&T Bell Laboratories	Maamar Benkraouda Marko Ledvij Andrew Y. Simonov Lev Bulaevskii	Ph.D. anticipated 1994 Postdoctoral Fellow Postdoctoral Fellow Visiting Scientist
G. P. Lafyatis T. R. Lemberger	OSU	Atomic Beam Studies of Vortex Lattices at Superconductor Surfaces	76,000		S. Daport-Schwartz Nathan Woodard	Ph.D. anticipated 1993 Ph.D. anticipated 1994
T. R. Lemberger	OSU	Measurement of the Bernoulli Potential in $Y_1Ba_2Cu_3O_{7-\delta}$ and $Y_1Ba_2Cu_4O_x$ Films	53,379		Ju Young Lee	Ph.D. anticipated 1993
A. H. MacDonald S. M. Girvin	IU	Quantum Effects in Quasi-Two-Dimensional Superconductors	90,000		Min-Chul Cha Yong Wang Kieffer Warman Jun Hu Mats Wallin	Ph.D. completed 1992 Student Student Ph.D. anticipated 1993 Visiting Scientist
W. J. Tomasch J. K. Furdyna	ND	Far-Infrared and Microwave Magneto-Dissipation in High-Temperature Superconductors	121,960	NIST TRW Superconductivity Research	E.K. Moser Mark McClorey	Graduate Student Graduate Student
G. Giulliani	PU	Effects of Magnetic Impurities in High T_c Superconductors	63,000		Mikhail V. Flstul	Postdoctoral Researcher
C. Pennington	OSU	NMR Studies of Vortex Dynamics in High T_c Superconductors	85,000		Joseph Vance	Anticipated Grad. 1995
M. Chandrasekhar	UM-Col	Electrical and Optical Investigations of Pristine and Doped $YBa_2Cu_4O_8$	75,000		Dale Payne	Ph.D. anticipated 1996-97

Area II: Transport Properties of High-Temperature Superconductors Optimization of Critical Currents, Magnetic Screening, Dynamical Behavior and Other Limiting Factors

CONTINUED

PI	Univ	Title	Recommended Funding	Affiliations	Students & Professionals	Status
E. P. Kvam	PU	Structural Defects and Interfaces in YBa ₂ Cu ₃ O ₇	130,836		A. Zanoia V.R. Iyer D.S. Linehan V. Pavate T.J. Brent J.T. Dawley D.L. Perry	M.S. completed 1992 M.S. completed 1992 M.S. anticipated 1994 M.S. anticipated 1994 B.S. anticipated 1994 B.S. anticipated 1994 Professional
M. W. McElfresh R. G. Reifenberger	PU	Intrinsic and Induced Weak Link Behavior in YBa ₂ Cu ₃ O 7-δ Films	94,303	IBM Thomas J. Watson Research Center Public Service Indiana	Tom Miller Lifang Hou James Deak Michael J. Darwin Andrezj Lewicki Patti Metcalf	Ph.D. anticipated 1993 Ph.D. anticipated 1994 Ph.D. anticipated 1994 Ph.D. anticipated 1994 Postdoctoral Researcher Professional
D. G. Stroud	OSU	Dynamical Properties of Josephson-Coupled Systems: Application to High-Temperature Superconductors	60,000		Ki Ho Lee Roman Sasik	Postdoctoral Researcher Student
W. B. Yelon J. W. Farmer	UM-Col	Neutron Diffraction and Defect Studies of High T _c Superconductors	94,000		Zioning Ding H. Xie J. Diederichs D. Bradford S.K. Malik F.K. Ross D.L. Cowan	Ph.D. anticipated 1994 Ph.D. anticipated 1995 Ph.D. anticipated 1993 Ph.D. anticipated 1993 Visitor Professional Co-Investigator

APPENDIX II

Cooperative Laboratory Interactions January 1, 1992 - December 31, 1992

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
SEMINARS AND GUEST SPEAKERS		
Dr. Valerian I. Nikitenko USSR Academy of Sciences, Moscow, USSR	Invited as Seminar Speaker	Purdue University
Dr. David G. Stroud Ohio State University	Invited as Seminar Speaker	Indiana University
Dr. Mark Parish CPS Superconductor Corporation	Guest Speaker at Group Meetings	Ohio State University
Dr. Thomas Worthington IBM Thomas J. Watson Research Center	Guest Speaker at Group Meetings	Ohio State University
Dr. D. L. Cox Ohio State University	Invited as Seminar Speaker	Purdue University
Dr. Steven M. Girvin Indiana University	Invited as Seminar Speaker	University of Notre Dame
Dr. R. E. Muerchausen Los Alamos National Laboratory	Invited as Seminar Speaker	Purdue University
Dr. M. Daeumling IBM T.J. Watson Center	Invited as Seminar Speaker	Purdue University
Dr. J. R. Thompson Oak Ridge National Lab	Invited as Seminar Speaker	Purdue University
Dr. Michael McElfresh Purdue University	Invited as Seminar Speaker	University of Notre Dame

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Dr. Ron Saeger Quantum Design	Invited as Seminar Speaker	Purdue University
Dr. Mark Coffey Iowa State University	Invited as Seminar Speaker	University of Notre Dame
Dr. James C. Garland Ohio State University	Invited as Seminar Speaker	Iowa State University
Dr. Alan Goldman Iowa State University	Invited as Seminar Speaker	Indiana University
Dr. James Schirber Sandia National Laboratories	Invited as Seminar Speaker	Purdue University
Dr. J. M. Hong Purdue University	Invited as Seminar Speaker	University of Notre Dame
Courant Institute of Mathematical Sciences New York University	Invited as Seminar Speaker	Mark Coffey Iowa State University
IUPUI Indianapolis, IN	Invited as Seminar Speaker	Dr. Michael McElfresh Purdue University
Ecole Polytechnique Palaiseau, France	Invited as Seminar Speaker	Dr. Michael McElfresh Purdue University
Pradeep Haldar Intermagetics General Corporation	Guest Speaker at Group Meetings	Iowa State University
David J. Bishop AT&T Bell Labs	Guest Speaker at Group Meetings	Iowa State University
Dr. Youwen Xu Ames Laboratory	Invited as Seminar Speaker	Purdue University
Jacques Schneck Center National d' études des Télécommunications Bagneux, France	Invited as Seminar Speaker	Purdue University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Dr. David V. Baxter Indiana University	Invited as Seminar Speaker	Purdue University
Dr. Stuart Berman IBM T.J. Watson Research Center	Invited as Seminar Speaker	Purdue University
Dr. Alan Kleinsasser IBM T.J. Watson Research Center	Invited as Seminar Speaker	Purdue University
Dr. Dan Goldschmidt Crown Center for Superconductivity Haifa, Israel	Invited as Seminar Speaker	Purdue University
PROGRAMMATIC EXCHANGE PROGRAM		
Dr. Mark Coffey National Institute of Standards and Technology Boulder, CO	Visit & Discussions	J. Clem Group Iowa State University
Dr. Mark Coffey National Institute of Standards and Technology Boulder, CO	Visit & Discussions	W. Tomasch Lab Univ. Notre Dame
Michael Darwin and James Deak McElfresh Group Purdue University	Study of Specialized Lithography Techniques	J. C. Garland Lab Ohio State University
Steve Herbert and Yue-Min Wan Garland Group Ohio State University	Use of the Scanning Tunneling Microscope	M. W. McElfresh Lab Purdue University
CO-OP EFFORTS/COLLABORATIONS		
Mike Norman Argonne National Laboratory Argonne, IL	Discussions	A. H. MacDonald and S. M. Girvin Indiana University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
A. Peter Young University of California at Santa Cruz Santa Cruz, CA	Discussions	A. H. MacDonald and S. M. Girvin Indiana University
David Stroud Ohio State University Columbus, OH	Discussions	A. H. MacDonald and S. M. Girvin Indiana University
Matthew Fisher IBM T.J. Watson Labs Yorktown Heights, NY	Discussions	A. H. MacDonald and S. M. Girvin Indiana University
J. Schilling Washington University	Collaboration on neutron and high pressure techniques	W. Yelon and J. Farmer University of Missouri-Col
Prof. K. Riedel, Prof. R. Klein Courant Institute of Mathematical Sciences New York University	Visit & Discussions	M. Coffey Iowa State University
W. J. Tomasch University of Notre Dame Notre Dame, IN	Discussions on rf response	J. R. Clem and V. Kogan Iowa State University
M. McElfresh Purdue University W. Lafayette, IN	Discussions on irreversibility line	J. R. Clem and V. Kogan Iowa State University
D. Bishop and P. Gammel AT&T Bell Labs	Discussions on vortex interactions with grain boundaries	J. R. Clem and V. Kogan Iowa State University
J. M. Honig Purdue University W. Lafayette, IN	Discussions	J. R. Clem and V. Kogan Iowa State University
Prof. B. Bukiet, Prof. D. Stuckler New Jersey Institute of Technology	Visit & Discussions	M. Coffey Iowa State University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Dr. H. Blackstead University of Notre Dame Notre Dame, IN	Discussions	K. M. Choudhary and S. T. Ruggiero University of Notre Dame
Dr. H. Sato Purdue University W. Lafayette, IN	Discussions	K. M. Choudhary and S. T. Ruggiero University of Notre Dame
Dr. W. Tomasch University of Notre Dame Notre Dame, IN	Discussions	K. M. Choudhary and S. T. Ruggiero University of Notre Dame
Dr. M. Chandrasekhar University of Missouri-Columbia Columbia, MO	Discussions	K. M. Choudhary and S. T. Ruggiero University of Notre Dame
Dr. Xiao Ping Jiang Morris Research, Inc. Berkeley, CA	Joint Project	P. M. McGinn University of Notre Dame
National Institute of Standards and Technology Boulder, Colorado	Visit & Discussions	W. J. Tomasch and Eric Moser University of Notre Dame
TRW Los Angeles, CA	Visit & Discussions	W. J. Tomasch and Eric Moser University of Notre Dame
Jet Propulsion Laboratory Pasadena, CA	Visit & Discussions	W. J. Tomasch and Eric Moser University of Notre Dame
M. B. Maple University of California San Diego, CA	Collaboration on writing a paper	J. C. Garland Ohio State University
M. W. McElfresh Group Purdue University	Interactions as far as understanding various transport properties	G. F. Giuliani Purdue University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Jim Thompson Oak Ridge National Lab	Visit & Discussions	M.W. McElfresh Purdue University
Dr. Michael McHenry Carnegie Mellon University	Visit & Discussions	M.W. McElfresh Purdue University
Michael Brady IBM T.J. Watson Research Center Yorktown Heights, NY	Discussions	M. W. McElfresh and R. Reifenberger Purdue University
Jim Ekstein Varian Research Laboratories Palo Alto, CA	Discussions	M. W. McElfresh and R. Reifenberger Purdue University
Ross Muenchausen DuPont Central Research Los Alamos, NM	Discussions	M. W. McElfresh and R. Reifenberger Purdue University
Dr. H. A. Blackstead University of Notre Dame Notre Dame, IN	Discussions	H. Sato Purdue University
Dr. K. M. Choudhary University of Notre Dame Notre Dame, IN	Discussions	H. Sato Purdue University
Stuart Bermon IBM T.J. Watson Research Center Yorktown Heights, NY	Discussions	Trumble, Bowman and McElfresh Purdue University
Nicholas Coppa Los Alamos National Laboratory Los Alamos, NM	Discussions	Trumble, Bowman and McElfresh Purdue University
Dean Peterson Los Alamos National Laboratory Los Alamos, NM	Discussions	Trumble, Bowman and McElfresh Purdue University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
SAMPLE EXCHANGE/COLLABORATIONS		
Argonne National Laboratory Argonne, IL	Collaboration on the decomposition of (Bi-Pb) ₂ Sr ₂ Ca ₂ Cu ₃ O _{7-δ}	A. I. Goldman, D. K. Finnemore and L. S. Chumby Iowa State University
W. J. Tomasch University of Notre Dame Notre Dame, IN	Samples	J. C. Garland Ohio State University
National Nanofabrication Facility Cornell University Ithaca, NY	Sample Fabrication	J. C. Garland Ohio State University
Prof. Brian Maple University of California, San Diego San Diego, CA	Samples	C. Pennington Ohio State University
Prof. James Garland Ohio State University Columbus, OH	Crystals	C. Pennington Ohio State University
Brian Maple University of California, San Diego San Diego, CA	Collaboration on modeling transport and magnetic properties of polycrystalline electron-doped high-temperature superconductors	D. Stroud Ohio State University
H. A. Blackstead University of Notre Dame Notre Dame, IN	Collaboration in the study of surface impedance measurements of La _{2-x} Sr _x NiO ₄ in the 10-20 GHz range	J. M. Honig Purdue University
Dr. Dean Face and Dr. M. Subramanian DuPont Central Research Wilmington, DE	Samples	M. W. McElfresh Purdue University
Superconductivity Research Laboratory International Superconductivity Technology Center Dr. Hisao Yamaguchi	Collaboration on the Sol-Gel method of synthesizing superconductors	H. Sato Purdue University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
INDUSTRIAL CONTACTS		
Dr. B. Lindgren Quantum Design	Discussions	G. L. Liedl, M. McElfresh Purdue University
Dr. E. Michael Gyorgy AT&T Bell Laboratories	Discussions	P. K. Gallagher Ohio State University
Superconductor Technologies, Inc. Dr. A. H. Cardona & Dr. L. C. Bourne Santa Barbara, CA	Visit & Discussions	S. T. Ruggiero University of Notre Dame
Dr. R. Ramesh Bell Communications Research Laboratories	Industrial Affiliate Discussions	E. Kvam Purdue University
INDUSTRIAL AFFILIATES		
Advanced Technology Materials, Inc. John Steinbeck Danbury, CT	Written Agreement	K. G. Caulton Indiana University
AT&T Bell Labs Dr. David J. Bishop Murray Hill, NJ	Written Agreement	J.R. Clem, V.G. Kogan Iowa State University
Intermagetics General Corporation Dr. Pradeep Haldar Guilderland, NY	Equipment Access	K. Sandhage, P. McGinn Ohio State University University of Notre Dame
Ribbon Technology Corporation Dr. Tom Gaspar	Equipment Access	K. Sandhage, P. McGinn Ohio State University University of Notre Dame
National Institute of Standards and Technology Dr. Robert A. Kamper and Dr. M. W. Coffey	Written Agreement	W. J. Tomaszch University of Notre Dame

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
TRW Superconductivity Research Stephen M. Schwarzbek Redondo Beach, CA	Written Agreement	W. J. Tomasz University of Notre Dame
IBM Thomas J. Watson Research Center Dr. Stuart Berman Yorktown Heights, NY	Written Agreement	M. W. McElfresh Purdue University
Public Service Indiana Dr. Dave Odor Plainfield, IN	Written Agreement	M. W. McElfresh Purdue University
Quantum Magnetics Dr. Ronald E. Sager and Dr. Barry Lindgren San Diego, CA	Written Agreement	M. W. McElfresh Purdue University
GIFTS FROM INDUSTRY		
IBM T.J. Watson Yorktown Heights, NY	Microtech Table, Mask Aligner, and Hall Sensor	M. W. McElfresh Purdue University
FOREIGN INTERACTIONS		
Hiroshi Akera Hokkaido University	Discussions	A. H. MacDonald and S. M. Girvin Indiana University
Dr. Satoshi Shimura Superconductivity Research Laboratory ISTEC, Japan	Visit and Discussions	P. J. McGinn University of Notre Dame
Dr. Marcin Konczykowski Ecole Polytechnique Palaiseau, France	Joint Projects	M. W. McElfresh Purdue University

COMPANY/CONTACT	ACTIVITY	MISCON PI/LOCATION
Dr. Eli Zeldov Weizmann Institute Rehorot, Israel	Joint Projects	M. W. McElfresh Purdue University
Dr. Yosi Yeshurun Bar-Ilan University Ramat-Gan, Israel	Joint Projects	M. W. McElfresh Purdue University
Dr. John Neumeier Munich University Munich, Germany	Samples	M. W. McElfresh Purdue University

APPENDIX III

ORGANIZATION

January 1, 1992 - December 31, 1993

<u>Name</u>	<u>Location</u>	<u>Telephone Number</u>
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C. COMMITTEES		
Steering Committee:		
Robert Greenkorn Chair Vice President for Research	Purdue University	317-494-6840
Joseph A. Franklin Director Government Policy and Federal Relations	Indiana university	812-855-6394
Stuart Hadley Assistant Director Office of Science Policy and Research	Iowa State University	515-294-0523
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