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SCIENTIFIC PRESENTATIONS ON HIGH TEMPERATURE SUPERCONDUCTIVITY AND CRYOGENIC POWER RESEARCH FROM 2005 to 2013

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Thermal and Mechanical Systems Branch
Power and Controls Division

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14. ABSTRACT
This program addresses basic scientific and engineering issues related to the development of advanced high temperature superconductor (HTS) materials and wire conductors. Specific research topics are addressed to support Air Force applications. The goals and expected impact of this work are to reduce the weight, heat loss and volume of AF systems, and also to improve performance or enable new capabilities. As the development of HTS applications progress with time, these goals are being reached very significantly. Specific subtopics and approaches to be emphasized in this work include:

- **Novel Superconductor Materials.** Study and develop novel classes of high temperature superconductors with improved properties, especially higher transition temperature (T_c) and lower anisotropy, but also better intrinsic flux pinning, lower toxicity, and will lead to an ease of manufacturing in long length and useful wire shapes.
- **Basic Issues of YBCO Conductors.** Develop properties of the Y-Ba-Cu-O (YBCO) superconductor for optimal performance, especially by flux pinning mechanisms but also thicker films. Development will have an emphasis on those issues that can also be useful to new superconductors developed in the first subtopic area.
- **AC Loss and Stability.** Determine and minimize ac losses experienced by advanced wires conductor and devices in a high power generator with consideration of stability issues, and develop ac-tolerant architecture and composite materials. This is an equally theoretical and experimental effort that is relevant to any newly discovered superconductor or the YBCO superconductor.
- **Fundamental Research Topics of Superconductors.** Study of fundamental research issues, such as heat dissipation mechanisms in complex grain boundaries, the effects of edge barrier pinning on multifilament or multilayer conductors, ac loss mechanisms especially in fine filament wires and at high frequencies from 200 to 1200 hz, methods to minimize flux creep and increase pinning in low-field and in high-field fluid flow regimes, and understanding the effects of strain on $J_c(H,T,\theta)$.

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FOREWORD

This report summarizes the in-house research efforts for high temperature superconductors and cryogenic power research of the AFRL/RQQM team, covering both 6.1 and 6.2 research efforts for a 8-year period of 11-Aug-2005 to 11-Aug-2013. The research output of this team was significant with 330 scientific presentations and over 110 scientific publications. It is not reasonable to comprehensively cover such a large amount of material in a single report, so a synopsis and summary is provided instead. An introduction is given to the major research topics covered, and the lists of presentation and publications is provided to summarize the research output that was made publically available.

PREFACE

The authors would like to especially thank Dr. Harold Weinstock and The Air Force Office of Scientic Research (AFOSR) and the Power and Controls Division of the Aerospace Systems Directorate (AFRL/RQQ), for their generous and consistent support of this work from 2005 to 2013.

Superconductivity is the only known phenomena that allows energy and current to be transmitted and controlled with absolute zero resistance and zero heat loss, as determined with any known measurement technique. As an example, a superconducting magnet in an magnetic resonance imaging (MRI) machine has currents circulating in 60 to 80 km length superconductor wires, connected at the ends with a full-superconducting joint. The current in an MRI magnet is well known to circulate for even up to 10 years with the B-field of the magnet not even dropping 1 part in 1,000,000! So even for that time interval, the state of absolute zero resistance for power flow is achieved to the limits of experimental measurement.

As a consequence of zero resistance, it is possible for current to flow in superconductor wires with extremely high current densities (J_c) > 10^6 A/cm^2 in self-field in fully engineered superconducting wires with Cu or Al metal quench protection, and incredibly $J_c > 10^8$ A/cm^2 in the superconductor film itself! This achieves supposedly the highest energy density of any known earthly material besides nuclear energy. Energy stored in currents stored in magnetic coils is also known as superconducting magnetic energy storage (SMES). And it is well known that energy stored in SMES devices can an be discharged inductively without any known theoretical limit to shortness of time, and, therefore, SMES units provide the highest power levels of any known power generation source, including batteries, supercapacitors, flywheels, rotational generators and motors, and other.

How the phenomena of superconductivity will find roles to play for the U.S. Air Force is still not known, and we believe is just beginning to be studied and realized. Initial work indicates superconducting/cryogenic power systems can reduce the weight of a 40 to 50 megawatt (MW) class electric propulsion systems by 15 to 20 times, and increase the drivetrain efficiency up to 98 to 99 percent, compared to conventional Cu-wire drivetrains with efficiencies of 85 to 88 percent, and thermodynamic limited Brayton cycle combustion engines with efficiencies of 35-37 percent. Also, a cryogenic electric drivetrain that can achieve a 45-MW power level is more than 5 times lighter than turbine combustion engines, and has orders of magnitude lower cost for maintenance upkeep.

1 SUMMARY

Executive Summary of Progress and Milestones/Lessons Learned

During the fiscal years (FY) of FY06 to FY13, varying methods of adding nanosize defects were studied to enhance flux pinning in Y-Ba-Cu-O (YBCO) superconductor films, as a mechanism to increase the engineering current density (J_e) in applied magnetic fields YBCO films would be exposed to in different applications. Many types of second-phase material defects were tested, including nonreactive compounds such as Y_2BaCuO_5 (Y211) or Y_2O_3 that form nanoparticle defects, > 5% lattice mismatch materials such as $BaZrO_3$ (BZO) and $BaSnO_3$ (BSO) form nanorods, minute dopants < 2% including CeO_2, Tb, and layering of defects in $(M_x/YBCO_y)_L$ superlattice or repeating type structures, with M = Y211, BZO, BSO and other. It was generally observed that each defect addition was not optimal for all conditions, and varying defect additions and microstructures greatly changed the J_e values as a function of operation temperature (T), magnetic field strength (H), magnetic field orientation (ϴ), different applied stresses (ξ) that YBCO conductors would experience. It is recently generally understood that nanoparticle defects are good strong pinning centers for all temperatures, and nanorods are stronger pinning when the H field is oriented parallel to the nanorod direction.

In the FY09 to FY12 time frame, nanorod additions were studied, by testing different experimental conditions including vicinal angle, volume %, and processing temperature. It was found that an optimal splay of ~ 10 percent could be achieved, with optimized parameters. This has markedly improved the $J_e(H)$ and also anisotropy necessary for many applications. Work on increasing flux pinning at T < 50K and H > 3T with $(BaZrO_3/YBCO)_N$ multilayer structures was continued, with record enhancements. Grain boundary (GB) studies showed strong 2 to 3 times increase of critical current for technologically important misorientation angles of 4 to 6°. In the FY10 to FY11 period, this was demonstrated with $BaZrO_3$ nanorods, in addition to Y_2O_3 nanoparticle additions observed previously in FY09. In the FY10 to 11 period, work on GBs was done in collaboration with the University of Kansas, to begin studying the low levels of dissipation noise that occur at GBs.

The flux pinning and GB enhancement methods developed so far importantly are compatible with long length wire manufacturing processes, and also simultaneously enhance intragranular flux pinning and high-field J_c. In the FY10 to FY12 period, theoretical and experimental studies on the effect of edge barrier pinning were made, which show the strong effect of filament size < 10 μm on critical current density.

Studies of quench propagation were achieved, using a different set of boundary conditions which required difficult mathematical modeling and simulation. Efforts in FY10 to FY13 period finished to develop the spin-around-magnet (SAM) machine, a novel high-rotating-speed alternating current (AC) loss test rig weighing 2 tons and with world-record sweep rates ~ 250 T/s, and further refining a calometric heat loss device for AC loss measurements. Five different iterations of a cryovessel were needed, to achieve a vessel that did not crack under vacuum pressure on the outside and liquid N_2 on the inside, and also maintained it's shape and tolerance in the stator slot.

The impact of superconducting technology on applications was beginning to be investigated for power transmission cables, SMES energy devices, and also re-learning lessons already accomplished for mega-watt (MW) class generator development. Development of cryogenic power transmission cables continued by interacting closely with Phase II STTR contractors, and also working with one company Advanced Conductor LLC developing a conductor-on-round-core (CORC) cable made of YBCO tapes. A DC co-axial power transmission cable was built and successfully tested, that weighed only 0.97 lbs per meter and carried in excess of 7,561 A (2.1 MW @ 270V). In the FY10 to FY11 time frame, work began on the basic physics of a high power switch a Dayton-area electromagnetic modeling company BerrieHill Research Inc., with a $50K exploratory fund from the RQ Chief Scientist. This was complemented by an experimental study of magnetic switching of YBCO films at the National High Magnetic Field Laboratory (NHFML). For new superconductors, there was continuing work in FY11 to FY13 on creating novel RE-C-Ti-O compounds.

2 INTRODUCTION

2.1 Background – Task Narrative and Research Effort

The general reasoning to consider cryogenic technologies and superconductors for Air Force power systems is illustrated in Figure 1 and 2, which shows how reduced resistance (or zero resistance for superconductors) at cryogenic temperatures lowers the overall heat loss and mass of power systems and components sometimes dramatically, even including cryogenic refrigeration or cooling liquids required. From Ohm's law, the waste heat loss for any resistive component is $P = R*I^2$, where R = resistance (Ohms) and I = current (A), and $R = \rho*L/A$ where ρ is resistivity (Ohm-m) and L = device length, and A = wire cross-section area. Since R = 0 for superconductor wires of almost unlimited length and ultrahigh current levels, the heat lost is primarily due to refrigeration if used for cooling instead of liquid cryogens. The total heat loss and mass is a function of the operation temperature, and system design optimizations can determine the optimal conditions for any power electronic system. Since superconductor wires are up to 10,000 to 50,000 times lighter and smaller (at 5 to 20 K) than Cu-wires, both the mass and heat loss are dominated by the cryo-system as shown in Figure 2. The impact of superconductors was presented in publications by the RQQM from 2005 to 2013 for different applications, demonstrating the significant benefits of reducing system heat loss, weight and volume, and improving performance and enabling new capabilities.

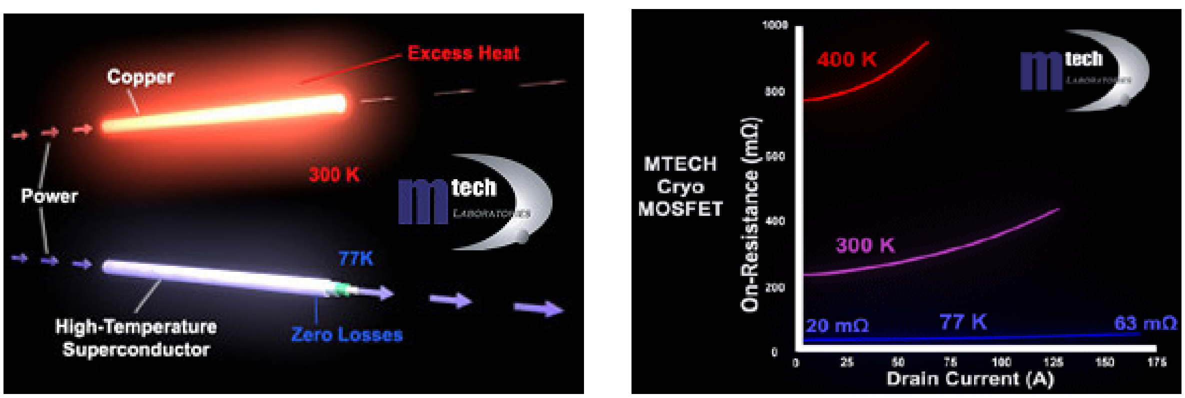


Figure 1. General Properties of Power Devices At Cryogenic Temperatures Compared to Room Temperature (*from http://www.cryocircuits.com/why-cryo*).

Left: General properties of power electronic devices that operate at cryogenic temperatures. Right: Resistance of a metal-oxide-semiconductor-field-effect-transistor (MOSFET) dropping > 15 to 70 times or more at 77 K compared to 300 to 400 K.

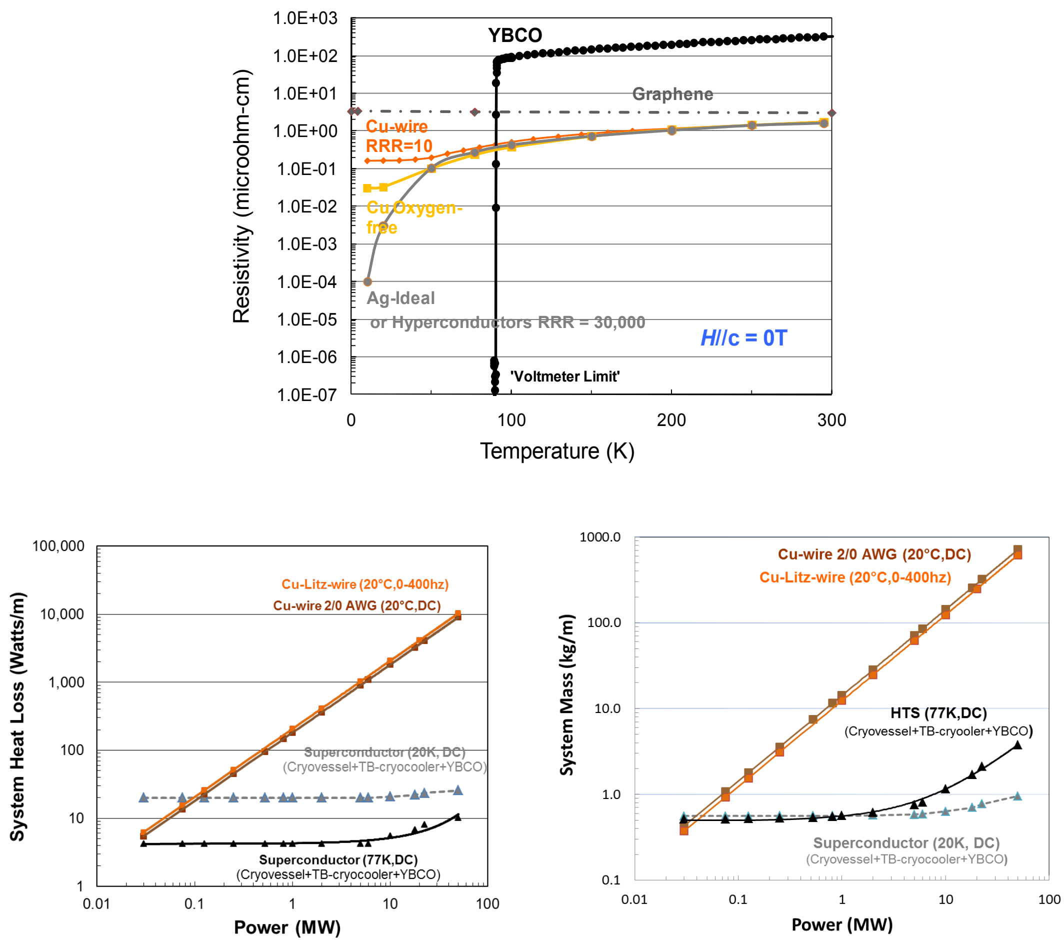


Figure 2. Impact of Conductor Resistivities on MW-class Power Transmission Cables

*(top) Resistivity as a function of temperature for metal conductors including ultra-pure hyperconductors, compared to Y-Ba-Cu-O (YBCO) superconductor and graphene. The residual-resistivity-ratio (RRR) is the ratio of resistivity at room temperature compared to reduced temperature [Pierce et al., IEEE Trans. Appl. Supercond., **23(3)**, 700205 (2013); RQQM paper]. (bottom) Heat loss and mass of Cu-wire or (cryo-vessel vacuum tubing + superconductor + cryocooler), assuming a Nexan's cryoflex tubing with heat loss of 0.5 W/m [Haugan et al., SAE Int. J. Aerosp., **1(1)**, 1088 (2008), updated]. This only shows one example, as other insulating cryoflex tubing is available with only mW/m of heat loss [Nexans, products brochure, 2012].*

While there are different research topics that can be studied in the field of superconductivity, we have chosen to focus on a few general topic areas which are described in detail following. The scientific background, objectives, current state of research, and future goals are included in the detailed descriptions.

2.2 Search for Advanced Superconductor Materials and Conductors

Since the discovery of superconductivity in 1911 by K. Onnes in 1911, many hundreds of superconductors have been discovered, and been classified into subcategories such as organics, metallics, oxides, and other. Figure 3 gives an overview of materials and classes of superconductors discovered, including the high temperature superconductor (HTS) families of Cu-oxides and Fe-based materials. The Fe-based superconductors including RE-Fe-M-(O,F) (RE = rare-earth, M = As,Se, other) were discovered in 2008 in Japan and China, with superconducting transitions now reaching 56 K maximum, as shown in Figure 4. This was the first non-Cu oxide with a superconducting transition (T_c) temperature higher than about 20 K, and this family of superconductors is still generating intense excitement and interest worldwide. New publications on Fe-based superconductors are posted at the http://arxiv.org/ website at a rate of ~ 900 per year. However, many Fe-based compounds contain toxic and flammable elements, and generally require safeguards and precautions to process and handle. It's still a challenge to determine if these materials can be manufactured inexpensively in 0.5-40 km piece lengths needed for power applications.

While many superconductors have been discovered, only six have been fully developed into long length wires necessary for power applications, as shown in Figure 5. As Figure 5 indicates, the engineering critical current density (J_e) varies considerably depending on the wire type, and other properties such as mechanical, T_c, and filament size also vary. Each superconductor therefore has unique properties for different applications, and the wires can be further modified for specific applications by optimizing the composite structures.

The discovery of materials with desired properties is followed by development of long length wires, which is already starting to occur for new materials discovered in the last 5 years: **i)** electron-doped KFe_2As_2 with $T_c \sim 38$ K is remarkably malleable and easy to draw into fine wires possibly < 10 micron diameter, and is not sensitive to sheath material or reaction temperature [Weiss et al., *Nat. Mater*. DOI: 10.1038/NMAT3333 (2012)], **ii)** K_3C_{60} filaments with $T_c = 18$ K were grown with very high $J_e(H<5T)$, which could be the lightest wire yet achieved [Takano, National Institute of Materials Science (NIMS) Japan, Applied Superconductivity Conference (ASC) 2012], and **iii)** FeSe coated conductors with $T_c \sim 22$ K and with flux pinning achieve high $J_c(H<30T, 4.2K)$, and have potential low cost compared to YBCO coated conductors [Wi et al., *Nat. Comms*, DOI: 10.1038/nomms2337 (2013)].

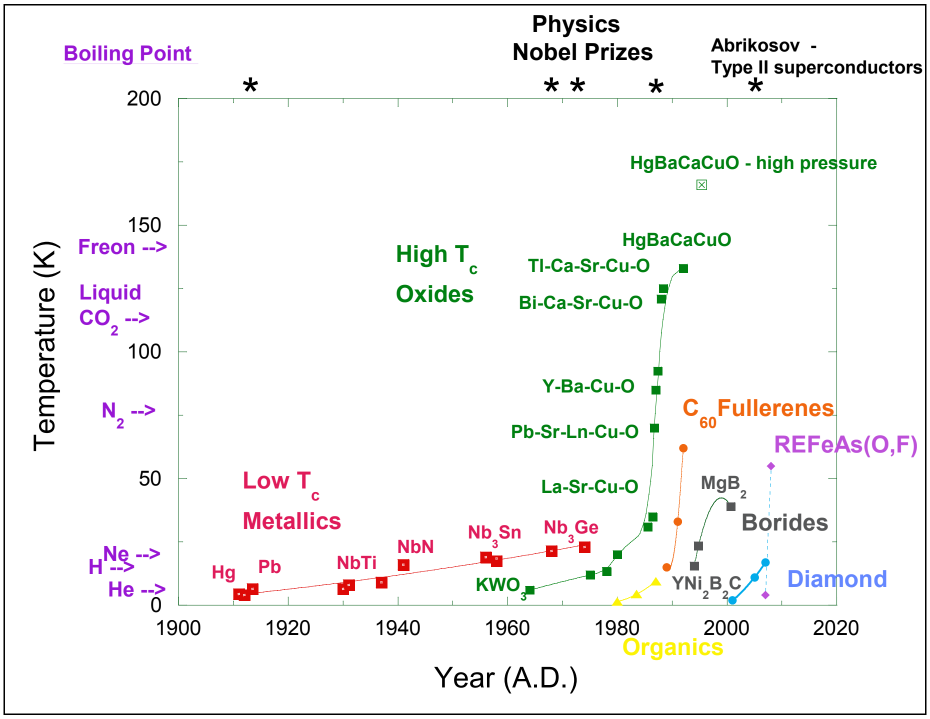


Figure 3.   Discovery of Compounds and Classes of Superconductors

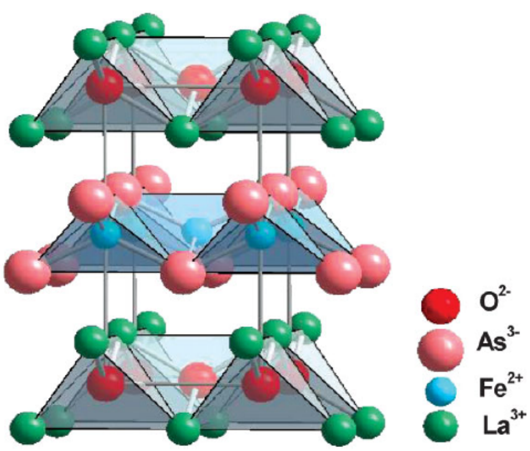


Figure 1. The atomic structure of LaFeAsO. It has a typical layered structure with $-(LaO)_2-(FeAS)_2-(LaO)_2-(FeAs)_2-$ alternative stacking along the *c*-axis. The Fe ions construct a square lattice with a near-neighbor distance of about 2.853 Å, but a diagonal distance of about 3.97 Å.

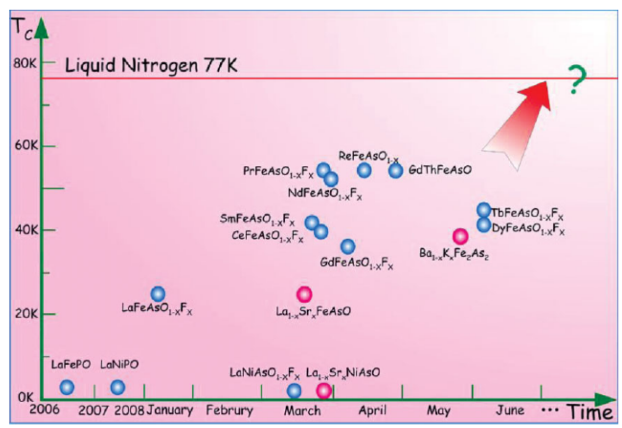
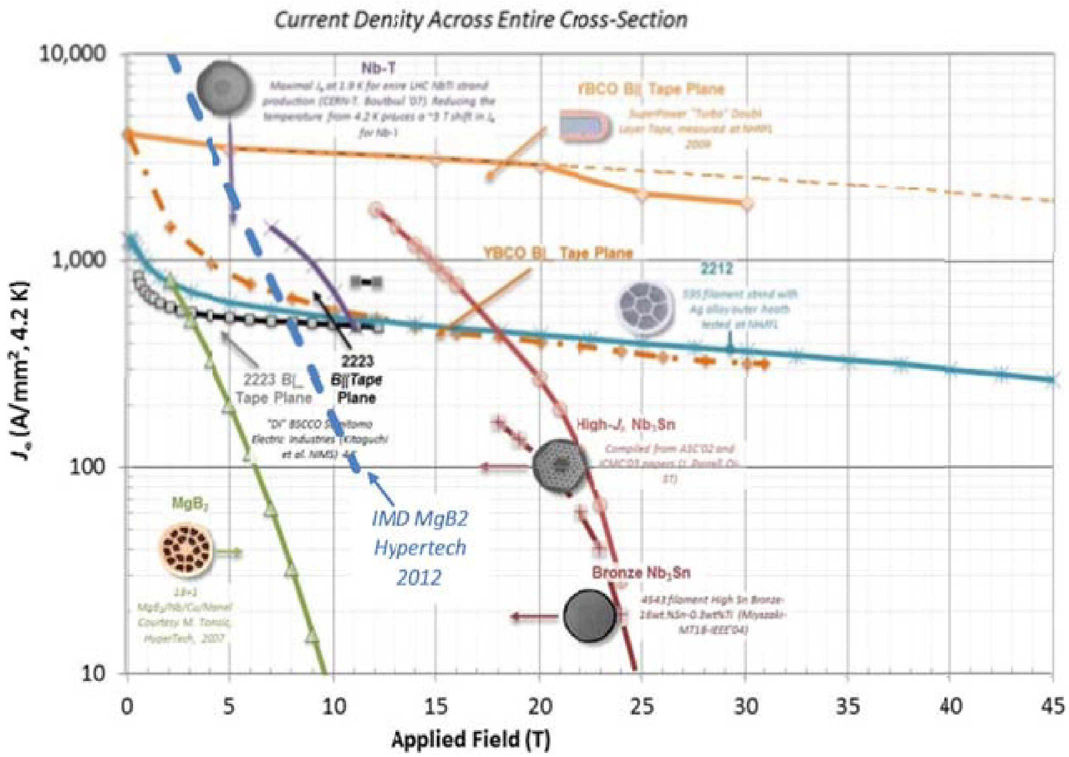
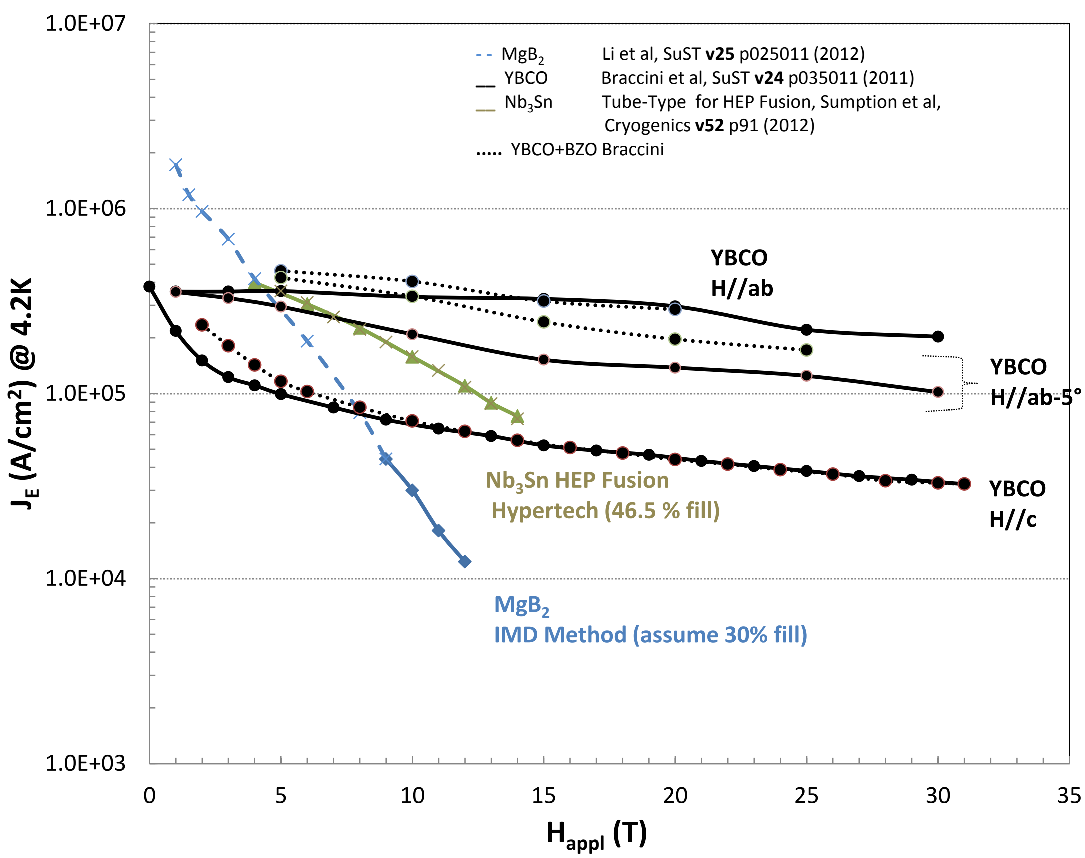


Figure 2. The superconducting transition temperatures of the iron-based superconductors versus the time of discovery. The blue dots represent the electron-doped samples, either by F-doping or by using oxygen vacancies. The red dots show the samples with hole doping. Superconductors with a higher T_c are expected. (This picture was composed by Lei Fang and Hai-Hu Wen on 6 June 2008.)

Figure 4. Discovery of new RE-Fe-As-O class of high temperature superconductors; (top) crystal structure, and (bottom) increase of T_c for compounds discovered in 2008.


Current Density Across Entire Cross-Section
10,000
1,000
100
10
Je (A/mm², 4.2 K)
0
5
10
15
20
25
30
35
40
45
Applied Field (T)
Nb-T
YBCO B|| Tape Plane
YBCO B⊥ Tape Plane
2212
2223 B⊥ Tape Plane
2223 B||Tape Plane
High-Jc Nb3Sn
Bronze Nb3Sn
MgB2
IMD MgB2
Hypertech
2012


1.0E+07
1.0E+06
1.0E+05
1.0E+04
1.0E+03
JE (A/cm²) @ 4.2K
0
5
10
15
20
25
30
35
Happl (T)
- - MgB2 Li et al, SuST v25 p025011 (2012)
__ YBCO Braccini et al, SuST v24 p035011 (2011)
__ Nb3Sn Tube-Type for HEP Fusion, Sumption et al, Cryogenics v52 p91 (2012)
..... YBCO+BZO Braccini
YBCO
H//ab
YBCO
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Nb3Sn HEP Fusion
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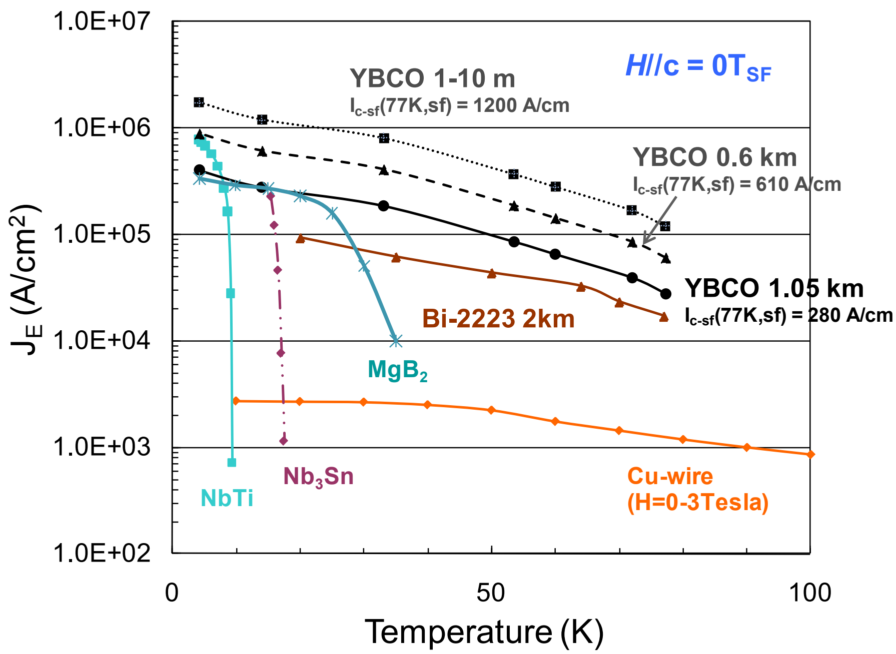
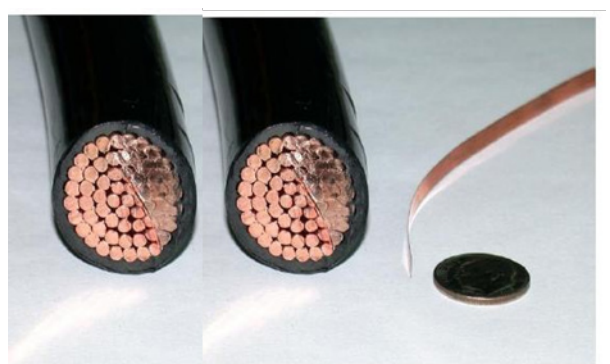
MgB2
IMD Method (assume 30% fill)





Equivalent ~ 800A conductors:
two MCM 750 gauge Cu-wire cables, and YBCO tape @ 55K.

Figure 5. Engineering current density of commercially available km-length superconductor wires

(top) from [*http://fs.magnet.fsu.edu/~lee/plot/plot.htm*](http://fs.magnet.fsu.edu/~lee/plot/plot.htm)*; updates for* MgB_2*, YBCO and Bi-2212 needed, (middle)* $J_e(H=0T)$ *at 4.2 K and as a function of temperature [Haugan et al, IEEE Trans. Appl. Supercond.* ***19****, 3270 (2009), updated]. (bottom) Equivalent 800A conductors, compared in size to a dime.*

2.3 Desired and Required Properties of Superconductors

While presently known superconductors including first-generation Bi-Sr-Ca-Cu-O (BSCCO) with transition temperature (T_c) ~ 110 K and second-generation Y-Ba-Cu-O (YBCO) with T_c ~ 92 K have been developed for power applications, there is always need to improve the superconductor materials further, to enhance performance or to provide new capabilities. YBCO is an important material for specialized applications, but it is not able to address all needs and it is not being produced yet with fine filaments needed to reduce ac loss. A summary of desirable and needed properties of new superconductors is given following, and Table I shows wire properties needed for specific AF applications.

- Higher transition temperature (T_c) to reduce cooling requirements as much as possible, and generally enhancing $J_c(H,T)$.
- Lower anisotropy to increase J_c for the complete range of H field orientations a wire can experience in applications; H angles $0^o \leq \Theta \leq 90^o$, and also to increase intrinsic flux pinning.
- Multi-filament cable with 1- to 10-micron-size filaments also with $T_c > 20$ K, which is needed for many applications with ac frequency = 60 to 400 hz important for the AF.
- Ultrastrong conductors are needed, and even the highest attainable > 5 GPa to increase the mass-specific energy density of superconducting magnetic energy storage (SMES) devices, which is directly proportional to wire strength.
- Manufacturing in useful wire shapes including round or hexagonal to allow uniform or ultra-tight winding density in magnets or generators.
- Fine bending radius < 5 cm for tight winding in generators or small coils.
- Multi-filament cable and designed for increased quench protection and stability.
- Lightest possible weight to enable specific applications such as energy dense SMES.
- Highest possible flux pinning, to increase $J_e(H)$ properties.
- Highest possible J_e properties.
- Low toxicity to allow widespread use.
- Manufacturing in useful wire shapes including round or hexagonal to allow uniform or ultratight winding density in magnets or generators.
- Manufacturing compatible with desired support structures including ultralight and low ac-loss such as titanium, and ultra-strength such as graphene.
- Ease of manufacturing in 1 to 80 km wire lengths with high reliability and yield, and low cost.

Table 1. Air Force Applications and Desired Properties of Superconductor Wires to Increase Performance

Applications	Properties	Current State-of-Art	Desired Goals
Generators/Motors (all supercond)	Filament size	30 microns	1-10 (required)
	Operating temperature	20 K (MgB_2)	> 50 K
	Strength	100 MPa	300 MPa
	Bending radius	50 cm	5 cm (based on current designs)
SMES	J_e	10^5 A/cm^2 at ≥ 10T	> 10^6 A/cm^2 at ≥ 10T
	Strength	0.7 GPa	> 5 GPa
	Mass Density	9 g/cm^3	1-2 g/cm^3
	Conductor Length	0.5-4 km	40-80 km
	Cost	\$6-40/m (MgB_2, YBCO	\$1-5/m (MgB_2, YBCO)
Transmission Lines	J_e	10^4 – 10^5 A/cm^2 at (H=0.5T,20-65K)	> 10^6 A/cm^2 at (H=0.5-2T,20-65K)
Gyrotrons	J_e	2x10^5 A/cm^2 at 3.4T	2x10^5 A/cm^2 at 3.4T
	Operating temp.	5 K (NbTi)	50-77 K (YBCO)

2.4 Theory of Superconductor Materials

The theory of unconventional high temperature superconductors (HTS) that include the Cu-oxides is not fully understood yet after 25+ years of study, so the search for new superconductors is generally done by semi-empirical and serendipitous methods. The term unconventional is used to generally classify any superconductor that can't be understood by Bardeen-Cooper-Schrieffer (BCS) theory. The understanding of superconductivity is improving recently with physics-based models, however new theories and models still cannot predict new materials especially with high T_cs accurately yet. Some general guidance in understanding of physics mechanisms for superconductivity is given in Table II, for the major classes of superconductors. Possible concepts to explore were also developed in the AFOSR-sponsored workshop "Road to Room Temperature Superconductors (RTS)," held June 2007 in Norway (www.road2rts.com). It should be remembered that firm rules used in the search for superconductors from the 1960s to 1970s were completely overturned, with the major discovery since the 1980s of oxides and Fe-based magnetic dopant families.

Table 2. Major Classes of Unconventional Superconductors Discovered, and Interaction and Mechanism Thought to Control Superconductivity

Material Class	T_c	Interaction	Guidance
Bismuthates (i.e. doped $BaBiO_3$)	30K	Charge + Lattice	Doped Negative Potential Energy (U) Insulator
$(Cs_2Rb)C_{60}$	28K	Lattice + Correlation (charge)	Electron-Phonon (El-Ph) Covalent Bonds
MgB_2	38K	Lattice	El-Ph Covalent Bonds Prediction
Fe-based	57K	Spin	Antiferromagnetism Multiple Orbitals
Cuprates	135K	Spin	Doped Antiferromagnetism Positive U Mott Insulator
Trace High T_c Anomolies	297 K ?	?	Shouldn't ignore

* Electron spin important to consider [Ref. M. Beasley, ASC 2012 presentation, courtesy].

2.5 Basic Issues of YBCO Conductors

Progress continues world-wide on improving the performance and lowering the manufacturing cost of YBCO HTS coated conductor wires, as well developing applications that particularly benefit from this new superconducting wire. The approach of continually improving the YBCO wire and simultaneously developing applications was also used by the RQQM research team. Increasing the critical current (I_c) of YBCO wires is important to enable performance and capabilities, and also to reduce wire manufacturing cost. The in-house program focused mostly on increasing I_c by increasing critical current density (J_c) via flux pinning, which is a cost-savings method desired by manufacturers.

Effort continues to develop YBCO wire for AF applications, as YBCO km-length wire operating at 55 to 77 K has about 300 to 100 times (respectively) higher power and weight density than the best room temperature wire conductors (Cu or Al) available commercially, as shown in Figure 4. Figure 4 also compares ~ 380 A wire made of Cu operating at room temperature (293K) to YBCO wire operating at 55K. Until a clearly superior alternative to YBCO wire is demonstrated, near-future efforts on long length wire development for applications operating > 55 K will remain mostly on YBCO.

Flux pinning is a critical factor of wire development, particularly for the AF directed energy (DE) application of the gyrotron magnet which uses higher fields of 3.6T, and the 7T magnets used for the Mach 10 speed test track based MagLev trains at Holloman Air Force Base (AFB). For applications of approximately 3T or lower YBCO km-length wire produced presently by commercial manufacturers has achieved engineering current density (J_e) high enough to allow operation of at 60 to 65K, which is highly desired to reduce refrigeration weight and size. For such applications, any significant increase of J_e is desired to improve operation and performance. Figure 6 shows that addition of $BaZrO_3$ nanorods has tremendous potential to increase J_e enough to enable the gyrotron system operation temperature to be raised up to 65K, and this type of pinning addition has recently been implemented into YBCO coated conductors made by MOCVD at Superpower Inc.

Flux pinning is important both to enable performance, and also to make the coated conductor cost effective enough for industrial manufacturing. Wire manufacturing cost is almost directly proportional to critical current, and critical current must be optimized for AF applications for different operation temperature, applied magnetic field, angle of magnetic field incidence, stress applied, and other parameters.

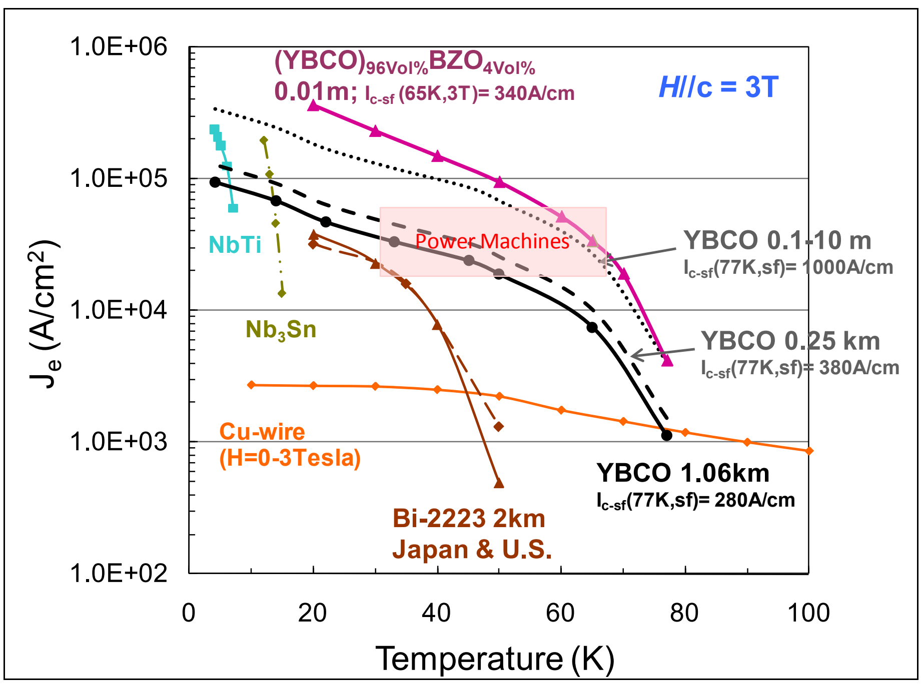


Figure 6. Engineering Current Density (J_e) of Industrial-manufactured Wire Conductors at Cryogenic Temperatures;

(for high field applications with H ~ 3T such as generators or magnets. Properties of YBCO are shown for different piece lengths, and also with flux pinning additions for H = 3T. Properties of Cu wire assumes the resistivity of 2/0 wire, and the J_e of Cu wire at room temperature (293K) is approximately 200 A/cm^2.)

2.6 Flux Pinning - Improving In-field Properties of Superconductors

Experimental or Edisonian methods are being used world-wide to improve in-field properties of the YBCO coated conductor by flux pinning enhancements. The microscopic understanding and theory of flux pinning is only partially understood and explained, therefore lab efforts almost everywhere primarily use "Edisonian" or "Black-Art" experimental methods to add pinning defects and incrementally study and improve J_c. However, modeling and simulation continuing in Japan and recently in the U.S. shows new theoretical understanding of effective pinning mechanisms, and suggests that unexepected approaches for adding defects can provide even stronger benefits. Some examples are that random defect distributions pin stronger than perfectly-ordered defects, and planar type defects might provide the stronger pinning strength than isolated defects. Also combining pinning types is now understood to be critical, to minimize different flux melting mechanisms.

The RQQM in-house program focused primarily on experimental methods to study flux pinning, both to determine values of critical current that can be reached by optimization, as well as to increase understanding of the basic science and principles that are effective to increase flux pinning. Edisonian methods of introducing defects being studied to increase flux pinning include: nanoparticle additions via nanolayer or random methods, rare-earth chemical substitutions, and minute doping additions at levels < 1%, and recently mixing both nanoparticle and nanorod defects. In other collaborations primarily with Univ. of Kansas, other methods are being researched including surface engineering, and/or three-dimensional (3-D) nanoscale engineering combined with nanoparticle additions. AFRL results provide important benchmark standards and are being considered as goals for industry to meet with their specific processing methods. The RQQM in-house program also provided strong understanding to the HTS community of specifically how defect additions affect flux pinning, both with positive and negative results.

Recent results optimized $BaZrO_3$ nanoparticle-layer additions particularly for H > 4 T and at lower temperatures ≤ 50K, and further improved pinning with $BaSnO_3$ nanorod additions by optimizing volume concentrations. Work completed in FY9-FY11 focused on studying addition of varying amounts of deleterious elements Nb and Tb, as seen in Figure 7. Additional work in FY10 was on studying the effect of splay in YBCO+$BaZrO_3$ films, as shown in Figure 8. In Figure 8, it was possible to vary the splay and nanorod size strongly, by varying parameters including $BaZrO_3$ vol %, processing temperature, and vicinal angle. These microstructure variations also strongly changed the J_c(77K,H) performance.

Future in-house research efforts will study the effect of nanoparticle size and volume percentage addition, comparing different dopants including Y211 by single-target methods, Y_2O_3, and BZO nanorods and nanolayers. New studies will test different ways of combining both $BaSnO_3$ and Y211 additions, which might be more effective than either method separately. The progress made on improving I_c(T,H) by flux pinning with AFRL studies is charted in Figure 9, or similarly J_c(T,H) by assuming a film thickness of 1 micron. Steady progress has been made by using nanoparticle pinning, however by testing a new method of nanorod pinning, a more significant increase was achieved in a shorter time span. However, I_c(H) is still improving with nanoparticle additions. One area that will be explored in the coming year is to study if increasing the nanoparticle size provides a significant increase. Several theories suggest this would occur; however, it is necessary to find methods to study and verify this which to our knowledge has not been emphasized recently, because of the present popularity of study different types of nanorod additions rather than nanoparticles.

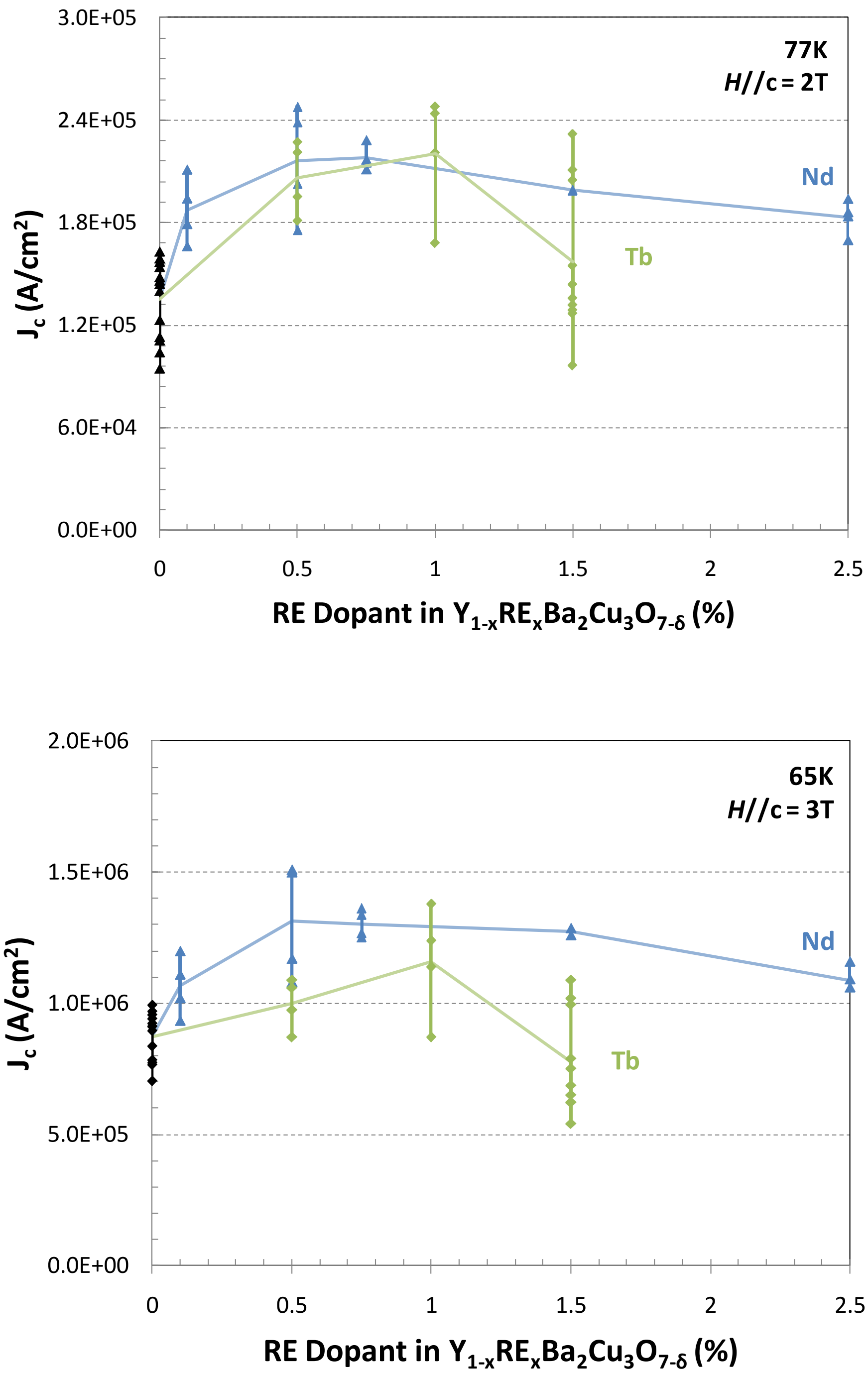
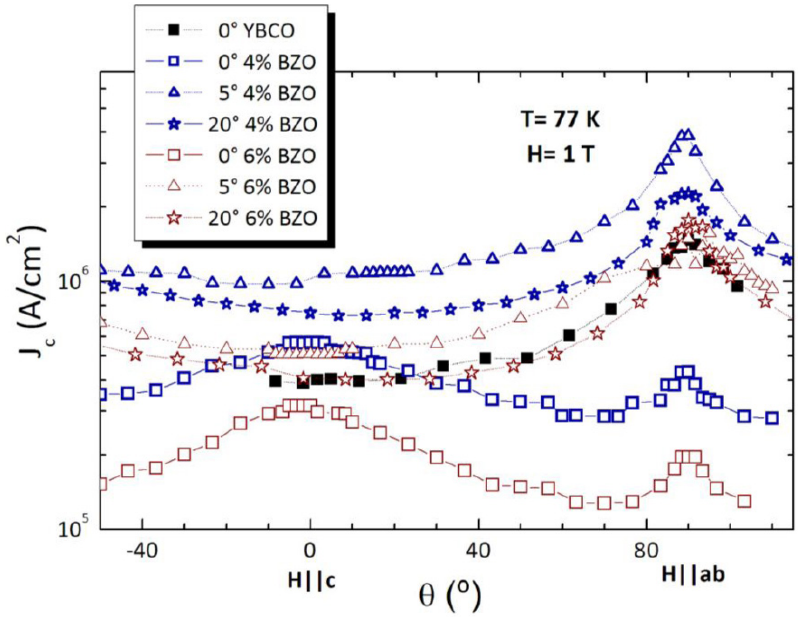
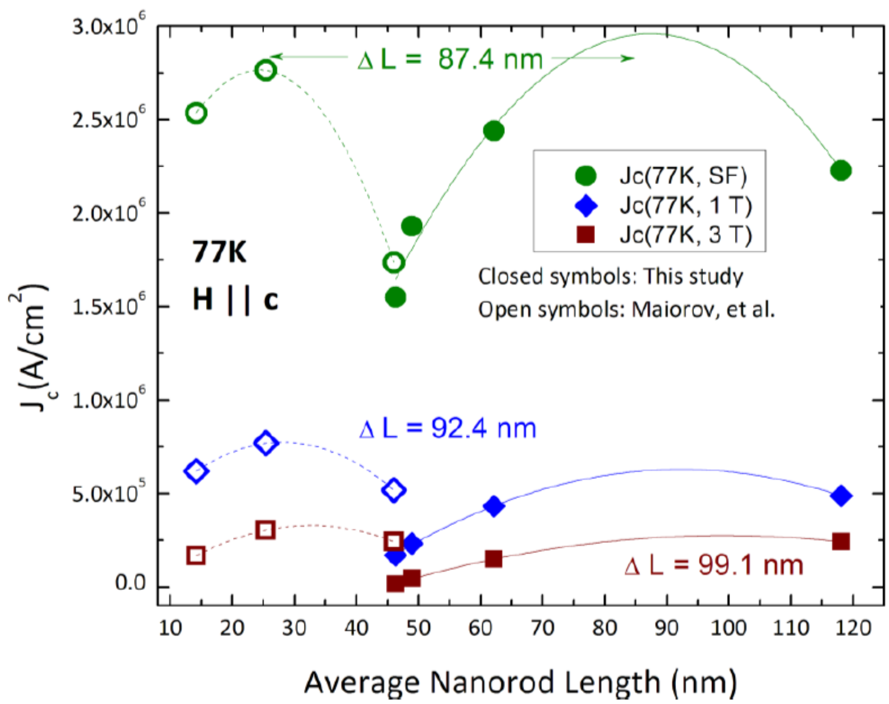


Figure 7. Studies to optimize J_c of $(Y_{1-x}RE_x)$BCO films at 65K and 77K, by minute doping with RE = deleterious Nd and Tb elements. J_c was measured by magnetic methods (J_{cm}).

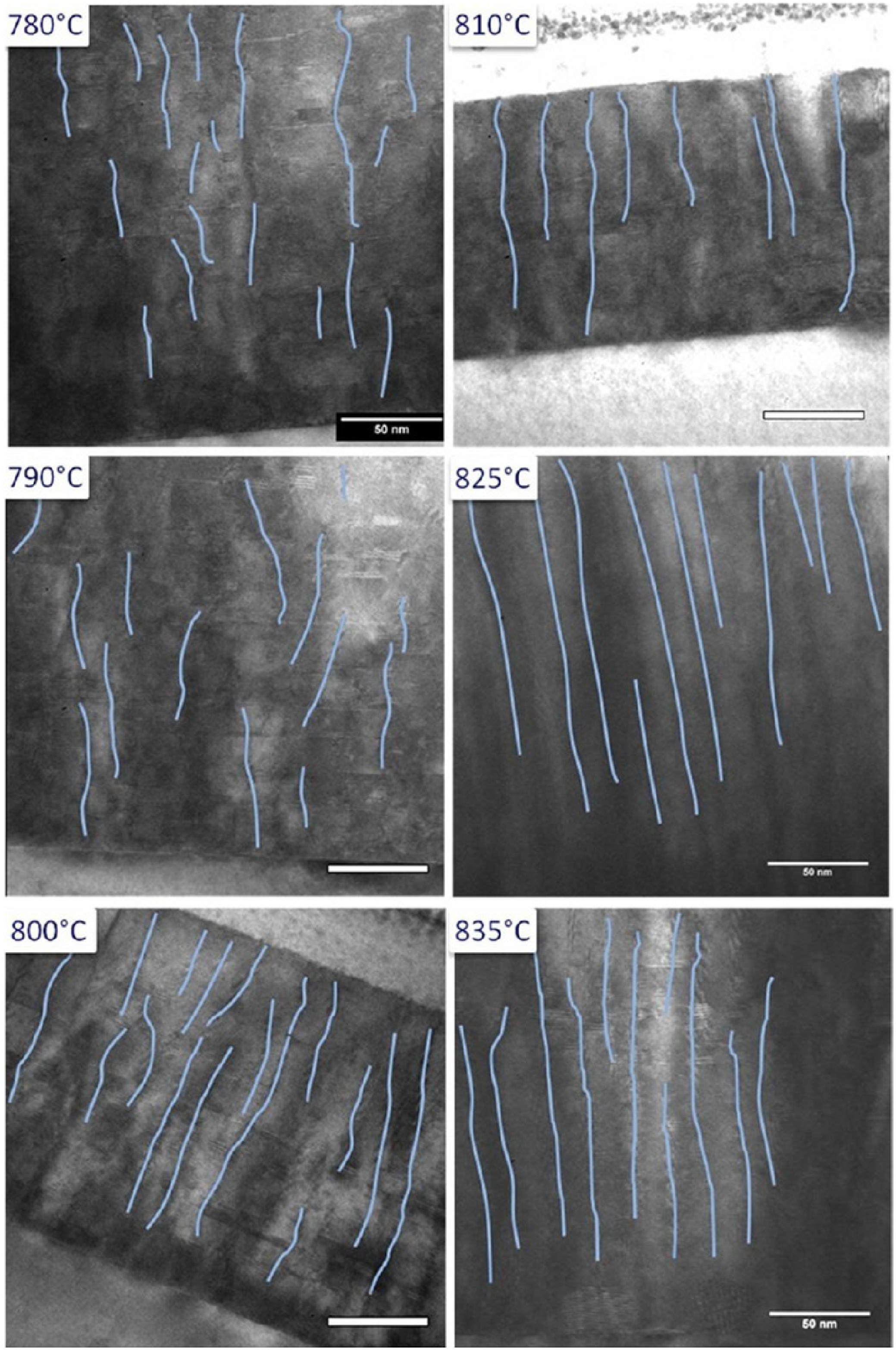
a)


0° YBCO
0° 4% BZO
5° 4% BZO
20° 4% BZO
0° 6% BZO
5° 6% BZO
20° 6% BZO
T= 77 K
H= 1 T
J_c (A/cm^2)
10^6
10^5
-40
0
40
80
H||c
H||ab
θ (°)

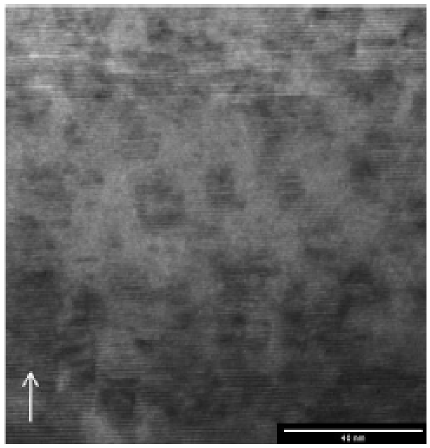
b)


ΔL = 87.4 nm
Jc(77K, SF)
Jc(77K, 1 T)
Jc(77K, 3 T)
Closed symbols: This study
Open symbols: Maiorov, et al.
77K
H || c
ΔL = 92.4 nm
ΔL = 99.1 nm
J_c (A/cm^2)
3.0x10^6
2.5x10^6
2.0x10^6
1.5x10^6
1.0x10^6
5.0x10^5
0.0
10
20
30
40
50
60
70
80
90
100
110
120
Average Nanorod Length (nm)

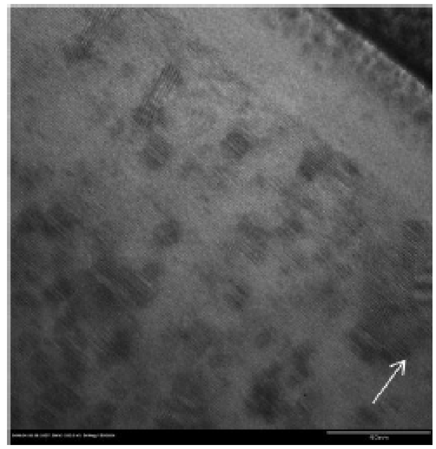
c)



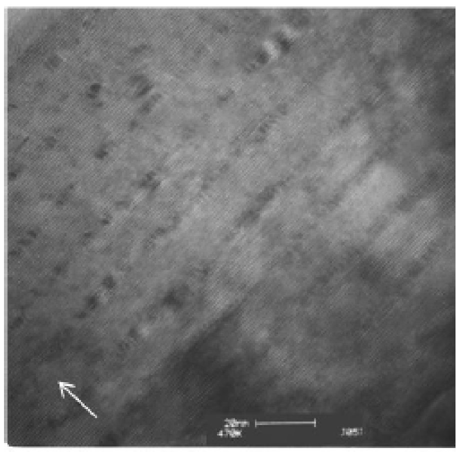
d)



$(Y_2O_{3\,0.4nm}/YBCO_{6.2nm})_{35}$



$(Y211_{0.6nm}/YBCO_{6.7nm})_{35}$



$(BaZrO_{3\,0.7nm}/YBCO_{16.2nm})_{19}$

$(YBCO)_{96\,Vol\%}(BZO)_{4\,Vol\%}$

e)

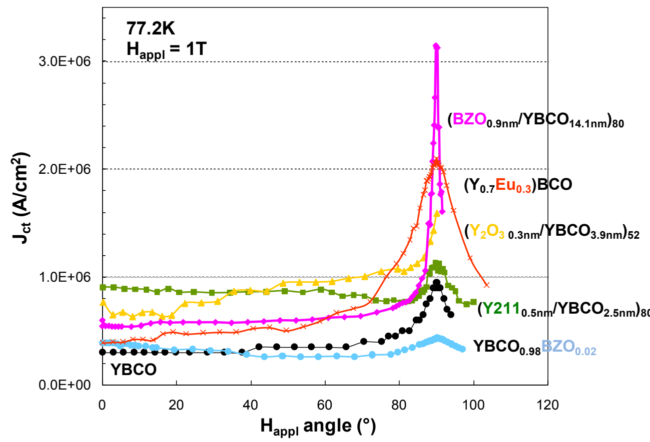


Figure 8. Flux pinning of YBCO with varying nanoparticle additions, and resulting microstructures observed with scanning electron microscopy (SEM) and transmission electron microscopy (TEM):

a) transport J_c at 77K, b) average nanorod length, compared to other study with 5% Y_2O_3 addition, c) TEM micrographs for 2Vol% $BaZrO_3$ addition and different deposition temperatures, d) TEM micrographs of Y_2O_3 and Y_2BaCuO_5 (Y211) nanoparticles, $BaZrO_3$ nanoparticle-layers, and $BaZrO_3$ nanorods, and e) transport J_c as a function of orientation angle: Ref. F.J. Baca, K.U. Ph.D. Thesis Nov 2009 and Haugan et al, IEEE Trans. Appl. Supercond. ***19****, 3270 (2009). The J_c vs angle studies are important to study for generator applications, where the conductor experiences magnetic fields varying in angle.*

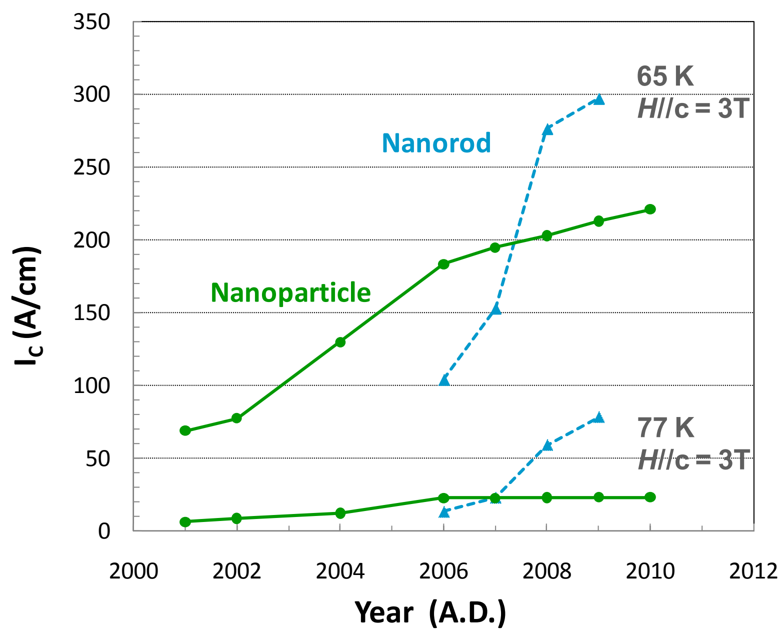


Figure 9. Yearly progress of the RQQM in-house program for increasing I_c(T,H) of YBCO coated conductors from flux pinning enhancement

(top) increase of I_c for all levels of $I_c(H,T)$ shown for different years, (bottom) yearly summary for H = 3T at 65K and 77K. In this plot, $I_c(T,H)$ was calculated from $J_{cm}(T,H)$ measured on single-crystal substrates and assuming that a 1 micron thickness could be deposited by manufacturers with the same J_c, which are reasonable assumptions since both manufacturers achieve maximum levels of $J_c(77K,sf)$ and film thickness.

2.7 AC Loss and Stability

Whether incorporating a newly discovered high temperature superconductor or the existing YBCO conductor, AC loss issues are an important area of study, because if the AC loss is not minimized and controlled the machine and cryocooler heat losses can be unacceptably high which can prevent or de-stabilize device operation. AC loss and the associated heat generated from this loss occur predominantly from hysteric and coupling components, however in recent years a new and significant loss term was discovered "dynamic resistance" that is approximately equal to hysteretic loss. The discovery of "dynamic resistance" occurred from an AFOSR SBIR funded program studying ac loss of coils. Dynamic resistance was observed when the self-field of the coil was discovered to have an additional deleterious effect. The AC losses of single filaments can be written by combining hysteretic and coupling losses as $Q = a(Bf) + b(Bf)^2$ where B is the magnetic field and f is the AC frequency. To increase power output of an electrical generator, both B and f should be increased which increases the losses strongly especially at high f. The Air Force is interested in developing applications generally from AC frequencies of 100 to 1000 hz and transient ripples up to 10 khz, while other agencies such as the Navy and Department of Energy (DOE) are concerned with AC frequencies < 100 hz. Therefore the Air Force must address specific needs especially for f > 100 hz, by both in-house research and external programs or collaborations. Problems of AC loss also have to be considered simultaneously with stability and quench issues, as solutions for AC loss might worsen quench and stability issues, and vice-versa. It is also realized now that AC loss must be studied for specific Air Force machine designs, where losses are expected to be 3 to 5 times higher than for controlled test beds, because of transient and interacting effects of alternating high magnetic fields and currents. Therefore additional work is required both in-house and externally to develop the wire technology specifically for these requirements. The AC loss of short lengths is understood for several types of samples and has reached levels almost acceptable for some Air Force applications in short lengths, however for specific use the conductor filament size must be reduced even further to ~ 5-15 micron diameter and be produced in km-lengths.

Another important topic in ac loss is the potential difference between ac frequencies expected at low-magnetic fields (low-field) and high-magnetic-fields (high-field). The author Carr provided a theoretical assessment [Supercond. Sci Technol. **20,** 168 (2007)] that the strong-field AC losses are different from the weak-field ac losses currently measured. He argued that a more complete understanding of the general AC loss problem is necessary due to the existence of a surface charge that must be added to the standard theory. A recalculation was done on the hysteresis and coupling current loss for a striated coated conductor in a strong perpendicular AC magnetic field using the new theory. The total loss was given as:

$$\frac{\bar{P}}{L} = N w^2 d J_c B_0 f + \frac{\pi^2}{6}\frac{(WL)^2}{N R_g L}(B_0 f)^2 + \frac{\pi^2}{6}\frac{d_{sub} W^3}{\rho_{sub}}(B_0 f)^2$$

Figure 10 given below shows the result compared to recent measurements in the weak-field regime. Efforts by the RQQM team proposed to verify this conjecture with a new AC loss system that operates at both higher fields and frequencies than currently in existence (discussed later), and improve the general AC loss theory in the strong-field regime.

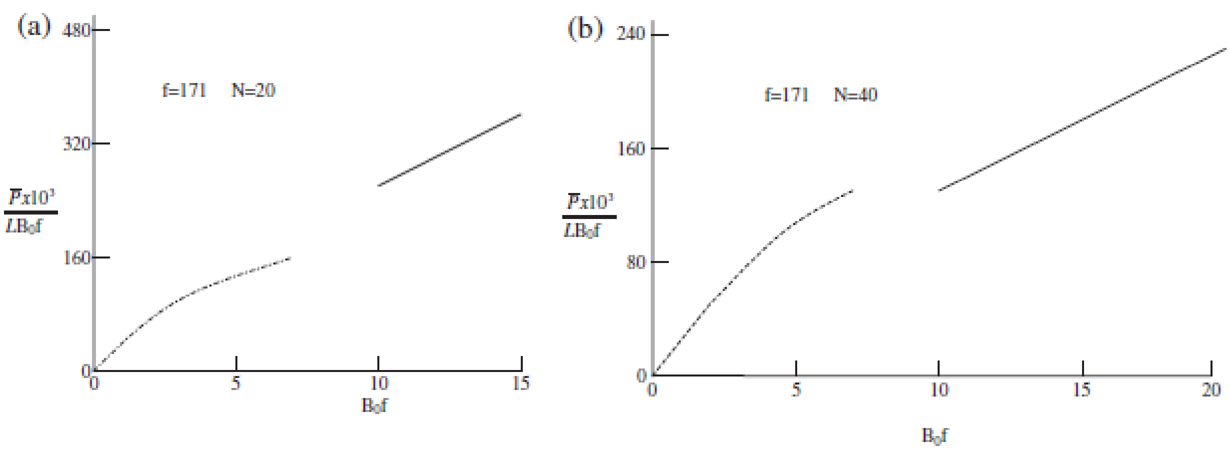


Figure 10. Reduced loss expression plotted against reduced magnetic field for frequency of 171 Hz for (a) 20-filament sample and (b) 40-filament sample

(Dashed lines are approximate copies of weak field measurements published by Levin et al, and solid lines calculated from strong field results given here. From Carr et al., Supercond. Sci Technol. ***20,*** *168 (2007).)*

Stability and quench protection must also be considered, as superconductor quench is potentially a serious problem for reliability in Air Force applications. The new high-temperature superconductors such as YBCO are dramatically different compared to the low-temperature metallic superconductors; and this also is expected be true of any new superconductor discovered with different crystal structures and higher transition temperatures. It is extremely difficult to quench the YBCO superconductors, however in the case of a quench it can be more catastrophic because the heat conductance is very low to conduct heat generated from a quench away from a localized area. Therefore efforts are needed to improve the YBCO wire architecture to reduce these problems, and also new device designs can be considered as different solutions. In-house work on quench and stability was a large effort from FY07-FY12, and was studied by a very strong modeling and simulation effort both in-house and from FY07 to FY11 by RQ-minority grant to Florida A&M University and North Carolina State University.

To study AC loss, several test devices were fabricated, including a heat calorimetry device shown in Figure 11 based on evaporation of N_2 gas, and a new AC loss test rig developed as shown in Figure 12. All measurements made previously for ac losses have been in the weak—magnetic-field regime. However, in rotating machinery applications, the environment is in the strong-field regime. Since the losses generated in the weak-field regime do not necessarily scale to the strong-field regime, it will be necessary to create a device capable of making measurements in the strong-field regime. The new AC loss test rig (also referred to as the spin-around-magnet (SAM) machine) is an eight-pole rotating magnet machine that achieves an alternating peak magnetic field of H = 0.6 T near the poles at the sample space, and a rotation rate up to 6,000 rpm and AC frequencies up to 400 hz. This test rig is capable to achieve sweep rates = H*f = 240 T/s, which is about 10 times higher than typically achieved of 15 to 25 T/s that to our knowledge is a world-record high. The AC loss test rig has been fully built and succefully tested yet; and it has been balanced up to 3,000 rpm so far. This system comes very close to simulating the environment of a real motor or generator, which to our knowledge might be unique-only in the world.

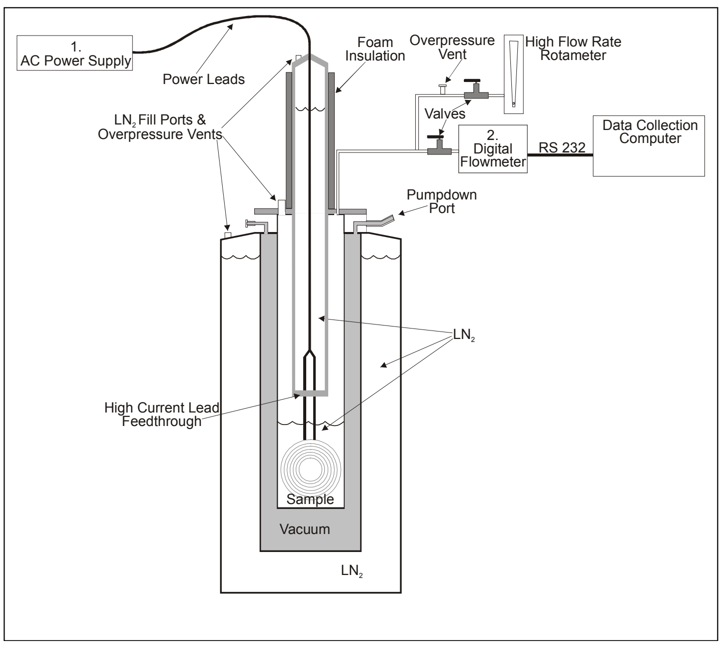
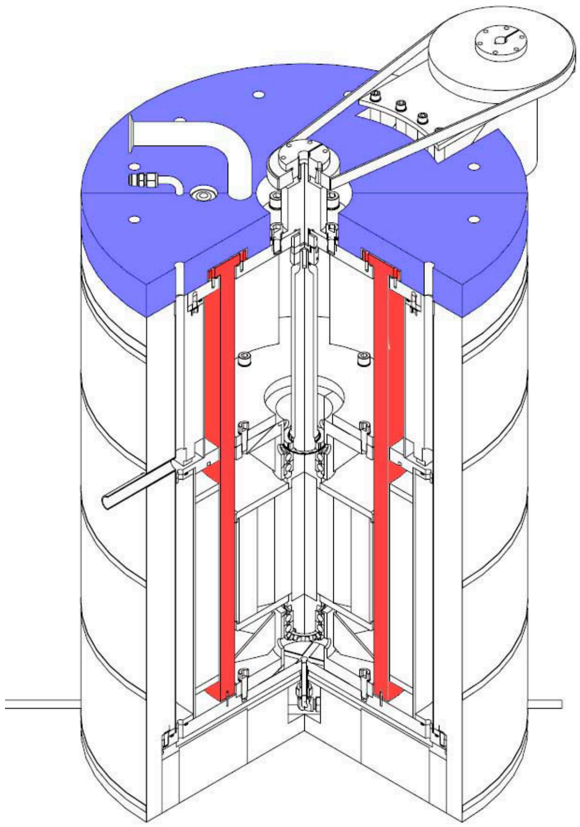
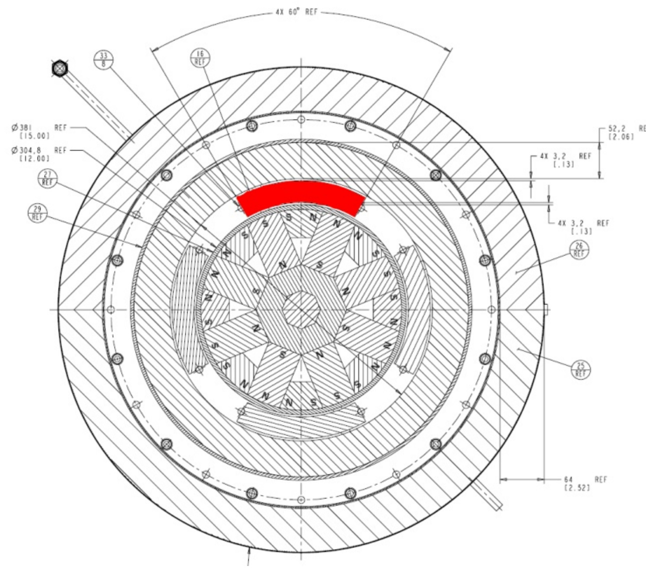
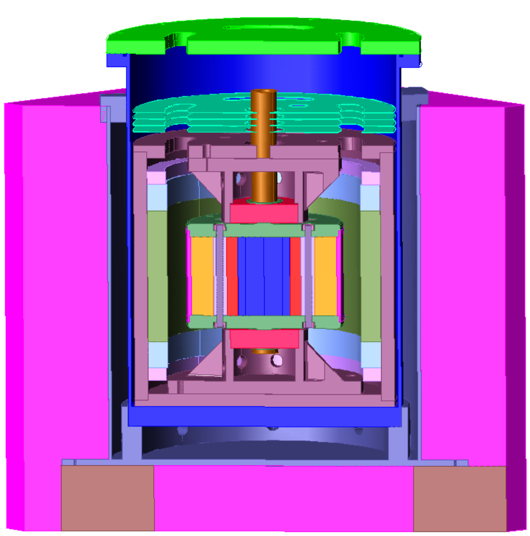
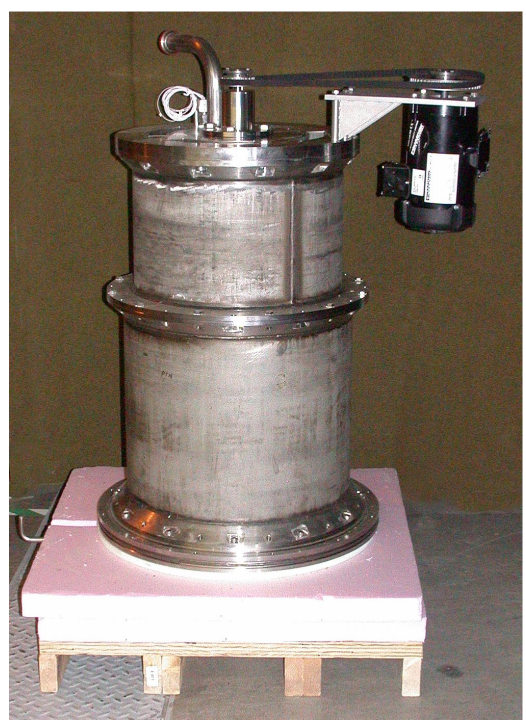


Figure 11. AC loss heat calorimetry device: (top) apparatus, and bottom) schematic diagram of operation.









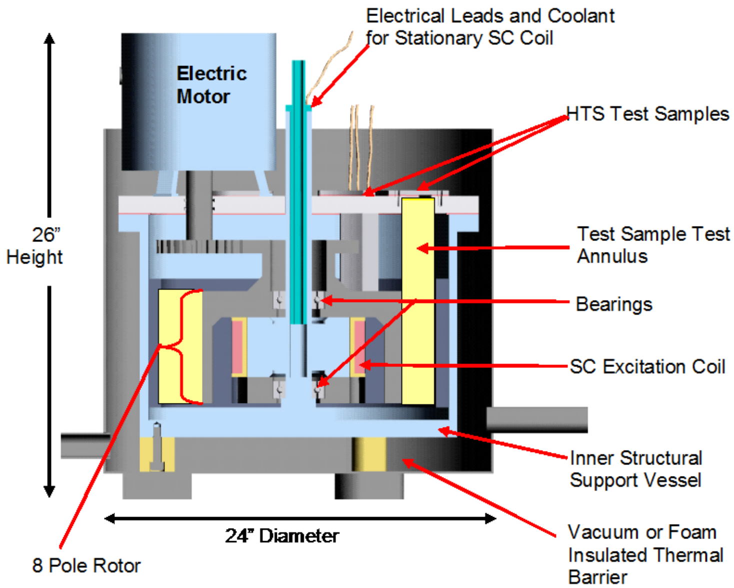


Figure 12. New AC loss test rig developed, also called the spin-around-magnet (SAM) machine. This is an 8-pole machine, capable of achieving peak fields of 0.6 T in the sample space (red in top-right diagram), and designed to spin up to 6000 rpm to achieve AC frequencies up to 400 hz.

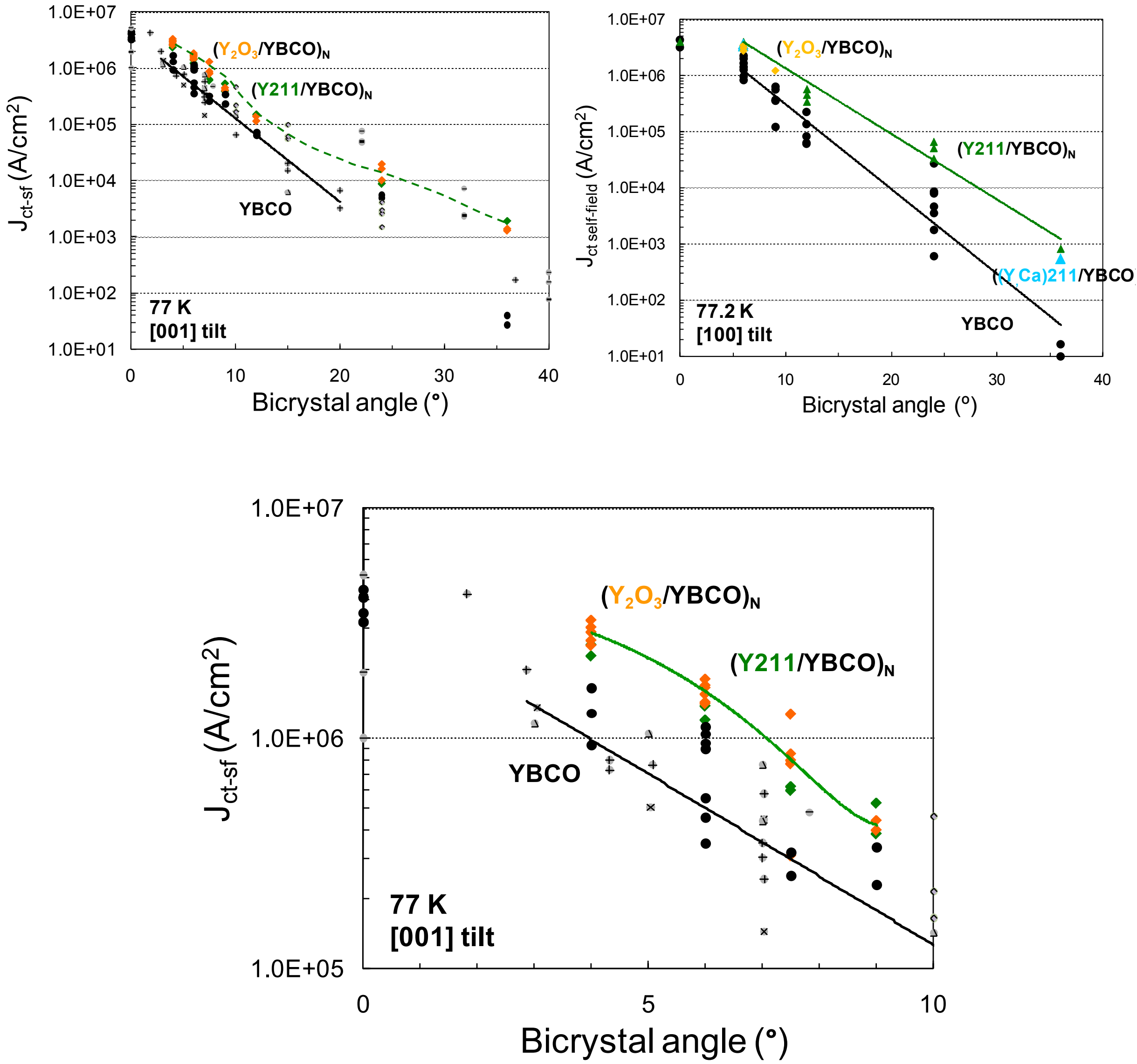
2.8 Fundamental Research Topics of Superconductors

While basic research is needed for materials and wire development, there are additional topics that are important to address, which can be considered fundamental science issues for superconductivity that are not limited to one material or wire processing method. Topics that we propose to work on are listed and described following.

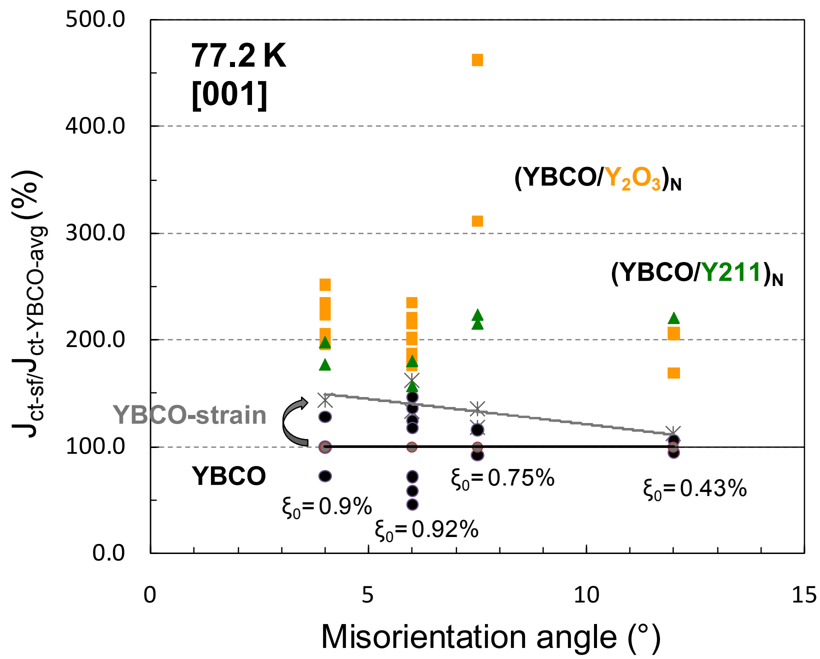
2.8.1 Grain Boundary Enhancements and Heat Dissipation Mechanisms

Grain boundaries can be important limiting factors for long length wires, and especially are a critical aspect for YBCO coated conductor wires. Long length manufactured YBCO wires have low-angle grain boundary misorientations up to 7°, which cause a sharp decrease of J_c; e.g., even a 4° [001] orientation GB's will cause the critical current to decrease almost 300%.

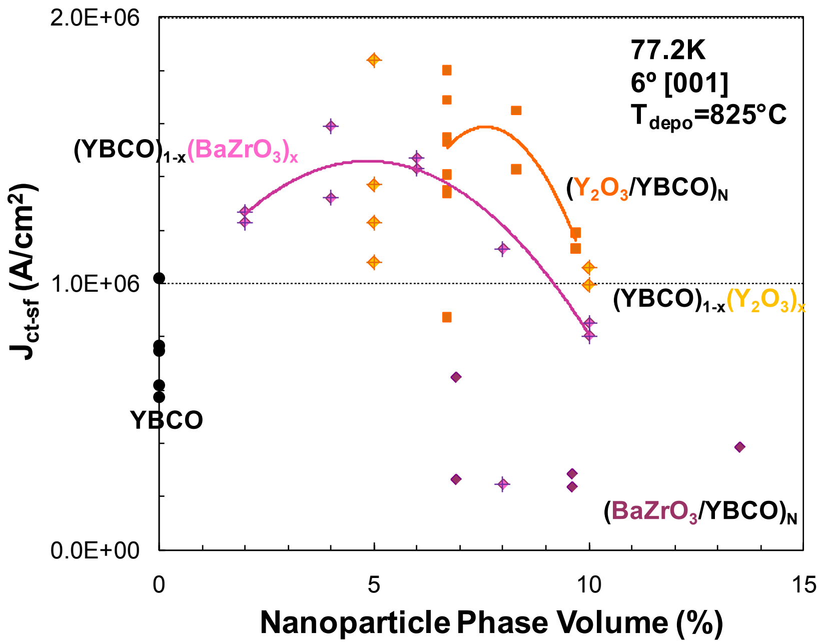
We have previously obtained strong enhancements of J_c across a large variety of grain boundaries, with different nanoparticle additions as shown in Fig. 13. These studies could be continued for different variations of nanoadditions and processing conditions, and the science of how the grain boundaries behave and dissipate heat as a function of time and applied electric fields as also of interest. Studies of heat dissipation were done by evanescent microwave imaging in collaboration with the Univ. of Kansas.



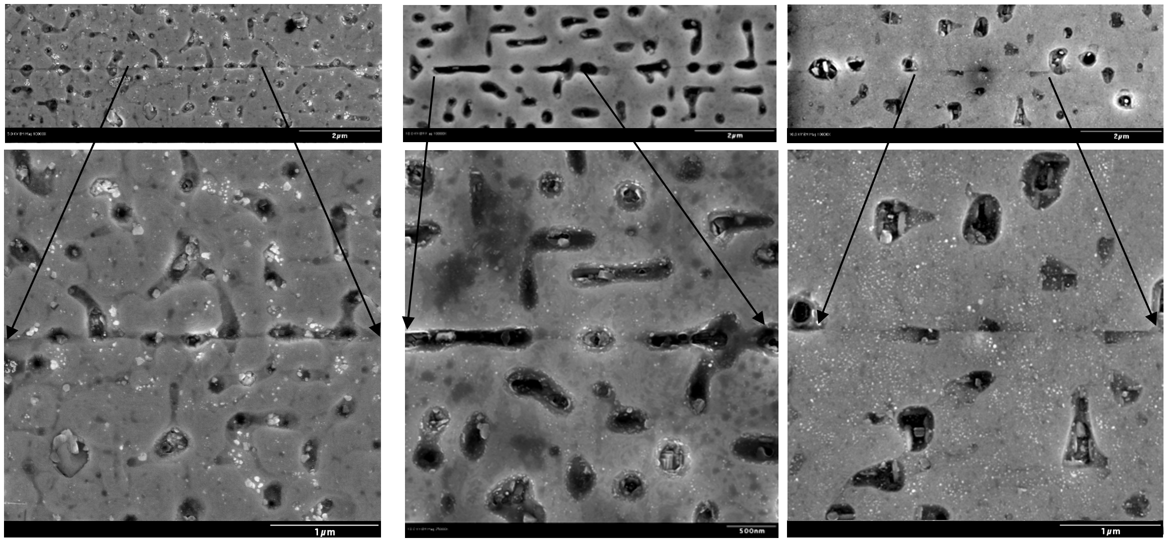
(Y2O3/YBCO)N
(Y211/YBCO)N
YBCO
77 K
[001] tilt
Jct-sf (A/cm2)
Bicrystal angle (°)
(Y Ca)211/YBCO
77.2 K
[100] tilt
Jct self-field (A/cm2)



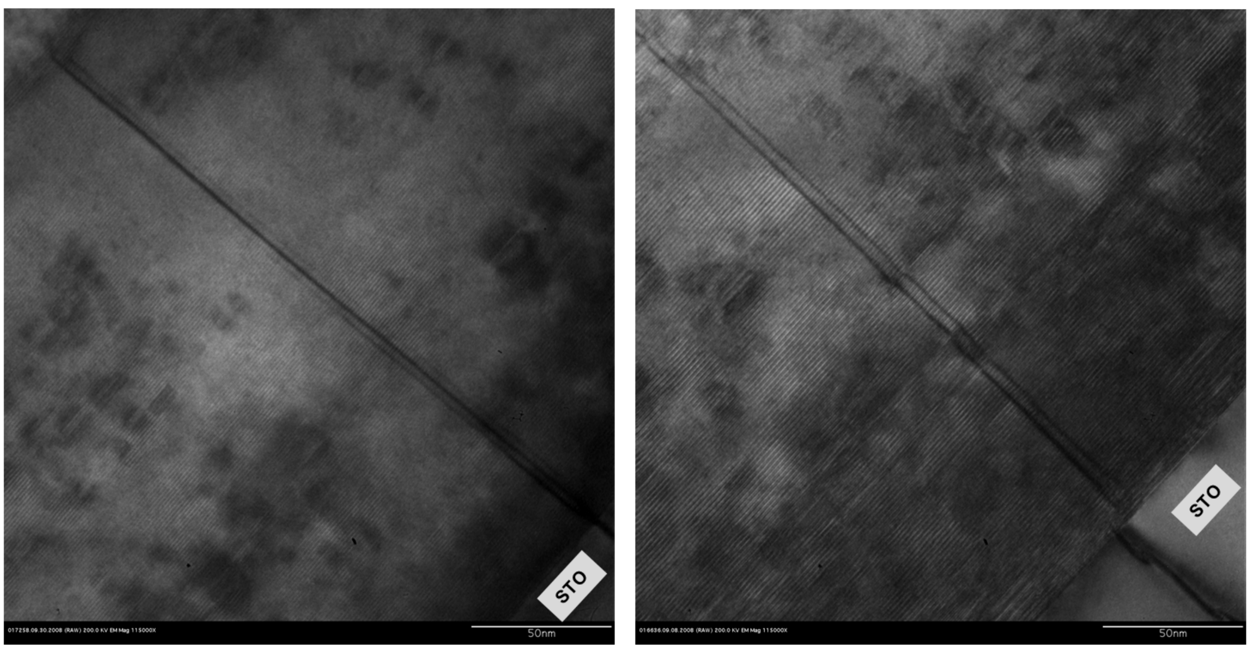
77.2 K
[001]
(YBCO/Y2O3)N
(YBCO/Y211)N
YBCO-strain
YBCO
ξ0= 0.9%
ξ0= 0.92%
ξ0= 0.75%
ξ0= 0.43%
Jct-sf/Jct-YBCO-avg (%)
Misorientation angle (°)



77.2K
6º [001]
Tdepo=825°C
(YBCO)1-x(BaZrO3)x
(Y2O3/YBCO)N
(YBCO)1-x(Y2O3)x
YBCO
(BaZrO3/YBCO)N
Jct-sf (A/cm2)
Nanoparticle Phase Volume (%)



YBCO 775°C | $(Y_2O_3/YBCO)_N$ 800°C | $(Y_2O_3/YBCO)_N$ 825°C



YBCO | **YBCO+Nanoparticle**

Figure 13. Effect of Nanoparticle Additions on YBCO Grain Boundaries

(top) Improvement of bicrystal grain boundary critical current densities @ 77K at self-field with varying nanoparticle additions and increasing deposition temperature, and (bottom) SEM and TEM micrographs of 6° [001] tilt grain boundaries for YBCO and YBCO+nanoparticle additions.

2.8.2 Edge Barrier Pinning Effect

The RQQM research team noticed in the literature that the highest critical current densities (J_cs) were being reported in papers where J_c was measured for ultra-narrow bridges < 5 microns in width. By looking in the literature we found that edge-barrier pinning might be a mechanism that could cause J_c to increase. Subsequent preliminary work by others indicated that this edge-barrier effect does not impact bridges of micron size or larger. However, the RQQM team provided a detailed theoretical assessment along with more substantive supporting experimental data that suggested edge-barrier pinning can significantly enhance J_c for bridges of a few microns or even tens of microns in width. Initial work was accomplished where two experimental approaches were taken to indicate the presence and relative effect of the edge barrier pinning in bridged samples based on the theoretical model. A third approach to testing the theory using magnetic field reductions could also be performed to further expand and verify the theory. This study suggest that J_c comparisons amongst institutions are skewed when using differently sized narrow bridges. If so, then when reporting flux pinning and superconductor processing improvements, the bridge width of the sample has to be taken into consideration as is currently done for the film thickness for proper comparison of J_c.

2.8.3 AC loss mechanisms Studied by Imaging

The effects of different multifilamentary geometries on the dynamic current and field distributions in YBCO thin films was explored with finite-element model simulations, and compared to the calculated magnetic flux and current profiles experimentally measured by time-resolved magneto-optical imaging. This was done for YBCO-only films, however could be extended to YBCO+nanoparticle films since the addition of nanoparticles is expected to significantly change the flux dynamics and ac loss mechanisms, This has not been attempted yet to our knowledge. First work in this area was done in collaboration with The College of William and Mary, using single and multifilament thin film samples provided by the RQQM research team.

2.8.4 Enhancing Flux pinning in the Vortex Liquid Regime

There is some initial indication that the $BaSnO_3$ (BSO) pinning performed in our lab is actually providing pinning in the vortex liquid regime of the superconductors. Typically, in the liquid regime, the fluxons flow and no supercurrent is carried. However, it has been thought that if a significant amount of pinning structure is "crammed" into the superconductor, pinning can occur raising the irreversibility field. In the BSO nanocolumnar pinning, BSO material amounts of up to over 20 wt% (well over the typical low single digit percentages) provide large amounts of pinning at high fields pushing the irreversibility field higher, even though low-field pinning is suppressed. Since this type of vortex pinning is frequency dependant when magnetic values for J_c are obtained, it provides a means to make a determination of actual pinning in the liquid regime. This could be a significant discovery in moving closer to the depairing current density in YBCO.

2.8.5 Effects of Strain on Superconductor Grains and Grain Boundaries

The role of grains and grain boundaries in producing reversible strain effects on the transport J_c of YBCO conductors was investigated in collaboration with a team at NIST-Boulder. This topic was was studied for YBCO-only films and also compared to YBCO+nanoadditions films, and achieved significant differences. It was discovered that the bicrystal grain boundaries have strains 5-10 times higher than the aperiodic, meandered, nonplanar grain boundaries that develop in ex situ grown MOD-YBCO in the coated conductor of this study. This work could be extended by studying grain boundaries doped with optimized flux pinning nanoparticle additions. This work is important for many applications of interest to the AF, such as high-speed generators operating in high stress environments and variable and high magnetic fields. Initial work in this area was done in collaboration with NIST-Boulder, with optimized and well-characterized thin film samples provide by the RQQM research team.

3 RESULTS – SCIENTIFIC PRESENTATIONS

3.1 Summary of Presentations for Different Research Topic Categories for 11-Aug-2005 to 11-Aug-2013

The total number of presentations by the RQQM team for the eight-year period are summarized below.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	Totals
Search for New Superconductors							4	5	3	**12**
Basic Issues of YBCO Conductors	6	22	12	16	6	10	17	6	7	**102**
Flux Pinning	16	27	17	17	10	9	5	4	4	**109**
AC Loss and Stability	7	8	5	10	4	2	2	4	2	**44**
Fundamental Research Topics	3	9	13	16	8	8	4	1	1	**63**
Totals	**32**	**66**	**47**	**59**	**28**	**29**	**32**	**20**	**17**	**330**

3.2 Listing of Scientific Presentations for 11-Aug-2005 to 11-Aug-2013

The lists of presentations are given following, grouped into calendar years.

3.2.1 Listings for 2005

Meeting	Authors	Title	Presentation Date (exact)	Session Paper #	Invited ?
US-JAPAN 12	G. A. Levin, P. N. Barnes	Application-Specific Requirements for Multifilament Coated Conductors	9-Oct-05		
US-JAPAN 12	T.J. Haugan, P.N. Barnes, T.A. Campbell, N. Pearce, M. F. Locke, I. Maartense	Flux Pinning of YBCO with nanoparticle additions and RE substitution	9-Oct-05		

US-JAPAN 12	P.N. Barnes, J.W. Kell, T. A. Campbell, S. Sathiraju, T.J. Haugan, M. F. Locke, B.C. Harrison	Minute Additions to YBa2Cu3O7-x to Improve the Transport Current Property	9-Oct-05
US JAPAN 12	J. Z. Wu, R.L.S. Emergo, X. Wang, T. J. Haugan, P. N. Barnes, D. Chriten, T. Aytug, M. Varela	Interplays between nanopores and nanoparticles in YBCO films	9-Oct-05
Wire Development Workshop sponsored by the US Department of Energy's Superconductivity for Electrical Systems	P.N. Barnes, T. Haugan	High-Temperature Superconductors: AFRL Programs and In-house Research	Aug-05
CCA '05	T.J. Haugan, P.N. Barnes, T.A. Campbell, N. Pearce, N. Pierce, J. W. Kell, M. F. Locke, S. Sathiraju, I. Maartense	Flux pinning of YBCO with nanoparticle additions, Ca-doping, and minute-quantity chemical substitutions	Dec-2005
CCA '05	P.N. Barnes, J.W. Kell, B.C. Harrison, C. Varanasi, T. Haugan, I. Maartense, N. Pearce, E. Stinzianni, K. Dunn, M. Rane, F. Ramos	Nanoparticulate Flux Pinning Centers for YBa2Cu3O7-x Films	Dec-2005
CCA '05	B. Majorov, H. Wang, T. G. Holesinger, Q. X. Jia, P. Arendt, S. R. Foltyn, L. Civale, J.L.	Comparison of different routes for improving vortex pinning in YBa2Cu3O7 thin films and coated conductors	Dec-2005

	Macmanus-Driscoll, T. Haugan, P. N. Barnes			
CCA '05	J. Z. Wu, R.L.S. Emergo, X. Wang, T. J. Haugan, P. N. Barnes, A. Polyanskii, D. Chriten, T. Aytug, M. Varela	Effect of nanopores and nanoparticles on the electrical transport properties of YBCO films	Dec-2005	
CCA '05	P. N. Barnes, G. A. Levin, T. J. Haugan, A. Lucarelli, G. Lupke, M. D. Sumption	Time Resolved magneto-optical imaging of ac currents and filamentary current sharing in YBCO ac conductor	Dec-2005	
PACRIM 6	P.N. Barnes, J.W. Kell, T.J. Haugan, C.V. Varanasi, and M.F. Locke	Minute doping (x<0.01) of Y1-xRExBa2Cu3O7-y films with Ce and Tb for magnetic flux pinning	Sep-05	invited
PACRIM 6	T. Haugan, P. N. Barnes, T. A. Campbell, M. F. Locke, N. Pierce, I. Maartense	Nanoparticle Additions to Increase Jc(B,T,theta) Performance of YBCO Films	Sep-05	invited
PACRIM 6	T. Haugan, P. N. Barnes, T. A. Campbell, M. F. Locke, N. Pierce, S. Sathiraju, I. Maartense, F. Meisenkothen, R. Wheeler, H.E.Smith, T. Aytug, M. Paranthaman, K. J. Leonard, H. Y. Zhai, M.S. Bhuiyan, E.A. Payzant, A. Goyal, S. Sathyamurthy, D.B. Beach, P.M. Martin,	Interfacial Reactions of YBCO Coated Conductor Composites and Effects on Flux Pinning and Device Properties	Sep-05	invited

	D.K. Christen, X. Li, T. Kodanthanh, U. Schoop, M.W.Rupich			
ICMC '05	C. V. Varanasi, C. Leon, A. D. Chaney, N. A. Yust, P. N. Barnes	Tensile Strength Testing of Copper Alloy Substrates for Use in Coated Conductors (Poster)	29-Aug-05	
ICMC '05	C. V. Varanasi, P. N. Barnes, J. Burke, T. Haugan	Particulate pinning centers in YBa2Cu3O7-x films introduced during pulsed laser deposition	29-Aug-05	
ICMC '05	G. A. Levin and P. N. Barnes	The Integration of YBCO Coated Conductors into Magnets and Rotating Machinery	29-Aug-05	
ICMC '05	C. Varanasi, P.N. Barnes, Jack Burke, Lyle Brunke, Harry Efstathiadis	Copper alloy substrates for coated conductors to be used in AC and DC applications	29-Aug-05	
ICMC '05	B. Craig Harrison, H. Fang, J. Carpenter, Patrick Klenk, P. N. Barnes, C. V. Varanasi	Sm and Nd Substitutions in YBCO Films Produced Through Metal Organic Deposition	29-Aug-05	
ICMC '05	J.M. Evans, B.C. Harrison, K.W. Schmaeman, M.F. Locke, T.J. Haugan, P.N. Barnes	Properties of (Y1-x,REx)1+yBa2-yCu3O7-z Bulk Superconductors for Flux Pinning	29-Aug-05	
ICMC '05	N. Amemiya, K. Yoda, Z. Jiang, G.A. Levin, P.N. Barnes, C.E. Oberly	Structure of Multifilamentary YBCO Coated Conductors and their Magnetization Loss Characteristics	29-Aug-05	

ICMC '05	P.N. Barnes, J.W. Kell, T.J. Haugan, M.F. Locke, and C.V. Varanasi	Rare earth doping of YBCO films at minute levels for magnetic flux pinning	29-Aug-05	
ICMC '05	P.N. Barnes, G.A. Levin, M.D. Sumption, and M. Polak	Striated YBCO coated conductor with filamentary current sharing	29-Aug-05	
ICMC '05	T.J. Haugan, P.N. Barnes, T.A. Campbell, M.F. Locke, N. Pierce, I. Maartense, M.D. Sumption	Addition of Nanoparticle Disperions to Enhance Jc(B,T,θ) Properties of YBCO Films	29-Aug-05	
ICMC '05	T.J. Haugan, T.A. Campbell, P.N. Barnes, J.W. Kell, I. Maartense, K.W. Schmaeman	Flux Pinning Properties of (Y1-xREx)Ba2Cu3O7-d Thin Films: RE = Er,Eu	29-Aug-05	
ICMC '05	S. Srinivas, A. Chaney, P.N. Barnes, C.V. Varanasi	Metallic buffers for coated conductor applications	29-Aug-05	
Korea Superconductor Society KSS2005	C. V. Varanasi, P.N. Barnes, T. Haugan	Particulate pinning centers in YBa2Cu3O7-x films during pulsed laser deposition and Biaxially Textured Copper Alloy Substrates	18-Aug-05	invited
DOE Peer Review 2005	Prepared by Paul Barnes; Presented by Pani Varanasi; Other coauthors AFRL,ANT,WSU	Fundamental studies of magnetic flux pinning mechanisms; Development of striated filaments of YBCO conductor	3-Aug-05	
EUCAS '05	M. Polak, L. Krempasky, E. Usak, L. Jansak, E. Demencik, G. Levin, P. Barnes, D. Wehler. B.	Coupling losses and transverse resistivity of filamentary YBCO coated conductors	Sep-05	

	Moenter				
EUCAS '05	M. Majoros, B. A. Glowackia, A. M. Campbell, G. A. Levin, P. N. Barnes	Transport AC losses in striated YBCO coated conductors	Sep-05		
MT-19 International Conference on Magnet Technology	M. Polak, E. Demencik, L. Jansak, P. Barnes, G. Levin, C. Thieme	Properties of a YBCO pancake coil operating with AC current at frequencies up to 1000 Hz	20-Sep-2005	TUA01P 005	
ISS 2005	N. Amemiya, Z. Jiang, K. Yoda, G.A. Levin and P.N. Barnes	The Effects of filament width on magnetization loss of multifilamentary YBCO coated conductors	Nov-05		
KL College of Engineering, Vijayawada, A.P. India	C. V. Varanasi	Introduction to Emerging Technologies	23-Dec-2005		invited

3.2.2 Listings for 2006

Meeting	Authors	Title	Presentation Date (exact)	Session Paper #	Invited ?
MRS '06	B.A. Maiorov, H. Wang, J.L. MacManus-Driscoll, T. Haugan, T.G. Holesinger, Q.X. Jia, P.N. Arendt, S.R. Foltyn, P.N. Barnes, L. Civale	Identification and Engineering of Defects for Vortex Pinning Enhancement in $YBa_2Cu_3O_7$ Films and Coated Conductors	Apr-06	HH3.5	invited
MRS '06	S. Sathiraju, P.N. Barnes, G.V. Narasimharao	Studies on Nb Substitution at Cu site in YBa2Cu3O7-x thin films	Apr-06	GG4.4	
MRS '06	C. Kwon, J.L. Young, G. You, G.A. Levin, T.J. Haugan, P.N. Barnes	Study of Striated Coated Conductors using Scanning Laser Microscopy	Apr-06	HH10.7	
MRS '06	A. Lucarelli, G. Luepke, T.J. Haugan, G.A. Levin, P.N.	Time Resolved Magneto-optical	Apr-06	HH10.9	

	Barnes	Imaging of AC Currents in $YBa_2Cu_3O_{7-d}$ Conductor		
MRS '06	T. Haugan, P. Barnes, T. Campbell, N. Pierce, S. Sathiraju, C. Varanasi, M. Sumption	Artificial Flux Pinning of YBCO and Correlation With Pinning Mechanism Studies	Apr-06	HH3.2
MRS '06	C. Varanasi, J. Burke, P.N. Barnes, M. Sumption, I. Maartense, T. Haugan	Flux Pining Enhancement in Pulsed Laser Deposited YBa2Cu3O7-x Coated Conductors with BaSnO3 Nano Particle Additions	Apr-06	HH3.7
MRS '06	C. Varanasi, J. Burke, P. Barnes, H. Efstathiadis, P. Haldar, A. Chaney	Study of Biaxial Texture Development in Copper Rich, Cu–Ni Alloy (Cu 55 wt%, Ni 45 wt%) Substrates for Coated Conductor Applications	Apr-06	HH5.14
MRS '06	T. Haugan, T. Campbell, P. Barnes, N. Pierce, I. Maartense, W. Wong-Ng, L. Cook	Superconducting and Microstructural Properties of $(Y_{1+y-x}Eu_x)Ba_{2-y}Cu_3O_{7-z}$ Thin Films: x = 0 to 1 and y = 0 to 0.1	Apr-06	HH8.12
MRS '06	N.M. Sbrockey, E.M. Dons, L.G. Provost, G.S. Tompa, B.C. Harrison, N.A. Pierce, T. Haugan, P.N. Barnes	Design and Implementation of a High-Rate, Reel-to-Reel MOCVD System for Continuous Production of $YBa_2Cu_3O_x$ Coated Conductors	Apr-06	HH8.5
MRS '06	B. C. Harrison, J.W. Kell, T.J. Haugan, M.F. Locke, C.V. Varanasi, P.N. Barnes	Flux Pinning Enhancement of YBCO Films by Rare Earth Doping at Minute Concentrations	Apr-06	HH9.9
MRS '06	B. C. Harrison, H. Fang, J. Carpenter, I.	Sm and Nd Doped YBCO Films	Apr-06	HH8.11

	Maartense, C. V. Varanasi, P. N. Barnes	Produced Through Metal Organic Deposition		
ASC '06	P.N. Barnes, J.W. Kell, B.C. Harrison, T.J. Haugan, C.V. Varanasi, M. Rane, F. Ramos	Minute doping of YBCO thin films with Tb, Pr, Ce, Nd, and La	29-Aug-06	2MY01
ASC '06	P.N. Barnes, G.A. Levin, J.P. Murphy, C.V. Varanasi	Design and Construction of a Calorimeter for Determining AC Losses in High Temperature Superconducting Coils	29-Aug-06	2MH11
ASC '06	G.A. Levin, P.N. Barnes, N. Amemiya,	Low ac Loss Multifilament Coated Conductors	28-Aug-06	1MX06
ASC '06	G.A. Levin, P.N. Barnes,M. Majoros, B.A. Glowacki, A.M. Campbell, A. Polyanskii,	Optimization of Interfilament Current Sharing in Multifilamentary Coated Conductors for Power Applications	29-Aug-06	2LI06
ASC '06	E. Demencik, P. Usak, M. Polak, Bratislava, Slovakia; G.A. Levin, P.N. Barnes	Hall probe based system for study of AC transport current distribution in YBCO coated conductors at frequencies up to 500 Hz	29-Aug-06	2MH09
ASC '06	B.C. Harrison, J. Carpenter, J.W. Kell, P.N. Barnes,C. V. Varanasi	Flux Pinning Enhancement of YBCO Films by Rare Earth Doping at Minute Concentrations Produced by TFA-MOD	28-Aug-06	2ML05
ASC '06	N Pierce, T Haugan, B C Harrison, P Barnes, I Maartense	Growth of YBCO and Y211-addition superconducting thin films by metal organic chemical vapor deposition	31-Aug-06	4MI03
ASC '06	B.C. Harrison, P.N Barnes, J.W. Kell, I. Maartense, T.L. Peterson, T.J.	Correlation of YBCO Film Quality to Magnetic Susceptibility	1-Sep-06	5MG07

	Haugan	Measurements—A More Accurate Empirical Consideration		
ASC '06	T.J. Haugan, T. A. Campbell, N.A. Pierce, P.N. Barnes, I. Maartense	Superconducting and Microstructural Properties of (Y1-xEux)1+yBa2-yCu3O7-z Thin Films: x = 0 to 1 and y = 0 to 0.1	29-Aug-06	2MI08
ASC '06	T.J. Haugan, P.N. Barnes, T.A. Campbell, N.A. Pierce, The Air Force Research Laboratory; I. Maartense	Use of nanoscale (211-M/123)xN multilayer film architectures to enhance current transport across grain boundaries of YBCO bicrystals at 77K	30-Aug-06	3MX02
ASC '06	T.J. Haugan, P.N. Barnes, T.A. Campbell, N.A. Pierce, P. Varanasi,M.D. Sumption	Flux pinning strengths and mechanisms of YBCO with nanoparticle additions	28-Aug-06	2MY03
ASC '06	J.L. Young, R.G. James, C. Kwon, G.A. Levin, T.J. Haugan, P.N. Barnes	Local Current Transport and Current Sharing Between Filaments in Striated Coated Conductors with Artificial Defects	30-Aug-06	3MC05
ASC '06	R.G. James, J.L. Young, C. Kwon,G.A. Levin, T.J. Haugan, P.N. Barnes	Effects of Bend Strain to Local Current Transport in Striated Coated Conductors	1-Sep-06	5ME07
ASC '06	B. Maiorov, Q.X. Jia, S.R. Foltyn, L. Civale, J.L. MacManus-Driscoll, H. Wang, T. Haugan, P.N. Barnes	Novel phenomena in flux pinning and flux cutting in YBa2Cu3O7 thin films	29-Aug-06	2MI06
ASC '06	R. A. Kleismit, T. J. Haugan, R. R. Biggers, T. L. Peterson, P. N. Barnes, T. A. Campbell, I. Maartense, G.	Cryogenic Characterization of Superconducting YBCO Films on Strontium Titanate Bicrystals using Evanescent	1-Sep-06	5MG06

	Kozlowski	Microwave Microscopy			
ASC '06	M. Polak, J. Kvitkovic, P. Mozola, P.N. Barnes, G.A. Levin	Characterization of individual filaments in a multifilamentary YBCO coated conductor	29-Aug-06	2MH03	
ASC '06	M.D. Sumption, T.J. Haugan, P.N. Barnes, P. Varanasi, S. Sathiraju	Pinning Strength, Mechanisms, and Dimensionality in YBCO PLD with Various Types of Artificial Pinning Structure-Based Enhancements	29-Aug-06	2MJ04	
ASC '06	C. Varanasi, V. Nalladega, S. Shamachary, T. Haugan, P. Barnes	Ultrasound Force Microscopy to Image the Nano-particulate Flux Pinning Centers in YBa2Cu3O7-x Films	29-Aug-06	2MJ06	
ASC '06	C. Varanasi, L. Brunke, I. Maartense, C. Leon, J. Burke, A.D. Chaney, P.N. Barnes, P. Nagaiah, H. Efstathiadis, P. Haldar	Biaxial Texture Development in Constantan Alloy Substrates for YBa2Cu3O7-x Coated Conductor Applications	28-Aug-06	4MF06	
ASC '06	C Varanasi, I. Maartense, J Burke, P.N. Barnes, T. Haugan, M. Sumption, E. Stinzianni, H Efstathiadis, P. Haldar	BaSnO3 Nanoparticle Introduction into Pulsed Laser Deposited YBa2Cu3O7-x Coated Conductors for Flux Pinning Enhancement	29-Aug-06	2MB09	
ASC '06	J.Z. Wu, R. Emergo, X. Wang, T. Haugan, P. Barnes	Significantly enhanced Jc in porous YBCO films	29-Aug-06	2MY05	
Wright-State Univ. Dept. of Physics	P.N. Barnes	Hight Temperature Superconducting Wire - From Basic Research to Why the Air Force Cares	2006		invited
APS '06	A. Lucarelli, G. Luepke, T. Haugan, G. Levin, and P. Barnes	Time resolved magneto‑optical imaging of ac currents in YBCO	1-Mar-2006		

		conductor		
ST-WISC '06	J. Young, C. Kwon, G.A. Levin, T.J. Haugan, P.N. Barnes	Enhancing the scanning laser microscope	24-Apr-06	
ST-WISC '06	C. Kwon, J.L. Young, G. You, G.A. Levin, T.J. Haugan, P.N. Barnes	Local Current Transport and Dissipation in Striated Coated Conductors	24-Apr-06	
ST-WISC '06	C.V. Varanasi, J. Burke, P. Barnes, H. Efstathiadis, P. Haldar, A. Chaney, P.N. Barnes	Study of bi-axial texture development in constantan (Cu54-Ni45-Mn1) alloy substrates and magnetic and tensile strength property characterization	24-Apr-06	
ST-WISC '06	A.D. Chaney, C.V. Varanasi, C. Leon, L. Brunke, J. Burke, P.N. Barnes	A new simplified method to determine the tensile strengths of bi-axially textured substrates (Ni, Ni-W, Constantan) used in YBCO coated conductors	24-Apr-06	
ST-WISC '06	T.J. Haugan, P.N. Barnes, T.A. Campbell, N.A. Pierce, M.A. Locke, L. Swanson, A. Chaney, B.C. Harrison, I. Maartense, T. Peterson, R. Wheeler, and M. Rane	Enhanced transport properties of YBCO grain boundaries with novel methods	24-Apr-06	
ST-WISC '06	X. Wang, R.L. Emergo, J. Wu, T.J. Haugan, P.N. Barnes, D. Christen, T. Aytug, M. Varela	Effect of magnetic coupling on the J_c of $YBa_2Cu_3O_{7-x}/CeO_2/YBa_2Cu_3O_{7-x}$ trilayers	24-Apr-06	
ST-WISC '06	T.J. Haugan, T.A. Campbell, N. Pearce, C.V. Varanasi, M.D. Sumption, P.N. Barnes	Flux Pinning of YBCO with Nanoparticle Additions and RE Substitution	24-Apr-06	
ST-WISC '06	B.C. Harrison, J. Carpenter, N. Pearce, C.V. Varanasi, T.J. Haugan, P.N. Barnes	Effect of Rare Earth Doping on the Performance of YBCO Films Prepared by TFA-	24-Apr-06	

		MOD and MOCVD YBCO Films		
ST-WISC '06	P.N. Barnes, J.W. Kell, B.C. Harrison, C.V. Varanasi, T.J. Haugan, I. Maartense, N. Pearce, M. Rane, F. Ramos	Minute additions of deleterious rare earths into high quality YBCO films for significant pinning enhancements	24-Apr-06	
ST-WISC '06	M. Sumption, T.J. Haugan, P.N. Barnes, T.A. Campbell, N. Pearce, C. Varanasi, J. Kell	Pinning in YBCO PLD samples	24-Apr-06	
ST-WISC '06	C. Varanasi , Jack Burke , Lyle Brunke, I. Maartense, M. Sumption, T.J. Haugan, E. Stinzianni, H. Efstathiadis, P. Haldar, Vijay Nalladega, Sathish Shamachary, P.N. Barnes	Nanoparticel (e.g. Y211, $BaSnO_3$) incorporation into YBCO films using a dual sector PLD target and use of ultrasonic force microscopy (UFM) technique to image these sub-surface nm particles	24-Apr-06	
ST-WISC '06	J. Wu, R. Emergo, T.J. Haugan, P.N. Barnes	Transport Properties of YBCO films with nanopores and nanoparticles	24-Apr-06	
ST-WISC '06	M.D. Sumption, Kawabata, J. Parker, J. Carr, L. Long, P.N. Barnes, G. Levin, E.W. Collings, and V. Selvamanickam	AC Losses in YBCO coated conductors	24-Apr-06	
ST-WISC '06	G. A. Levin, N. Amemiya, M. Sumption, M.Majoros, A, Polyanskii, M. Polak, C. Kwon, P.N. Barnes, T. Haugan, C. V. Varanasi	Losses, Reliability, and Integration into Applications of AC Tolerant Coated Conductors	24-Apr-06	
ST-WISC '06	P.N. Barnes, G.A. Levin, J. Murphy, C. Varanasi, M.Polak, E. Demencik, L. Jansak, P. Mozola, A. Lucarelli, G. Luepke, C. Thieme, and M. Sumption	Calorimetric measurements for determining AC losses in YBCO tapes and coils	24-Apr-06	
DOE	T.J. Haugan, P.N.	(Y,RE)123 Flux	Jan-06	

WORKSHOP '06	Barnes	Pinning and Ca-doping in YBCO			
DOE WORKSHOP '06	P.N. Barnes	YBCO Coated Conductors: DOD Requirements	Jan-06		
DOE WORKSHOP '06	D. Larbalestier, Z. Chen, S. Kim, M. Feldmann, A. Gurevich, X. Li, W. Zhang, T. Kodenkandath, M. Rupich, C-B. Eom, T. Haugan, P.Barnes, and T. Holesinger	The Thickness Dependence of J_c in MOD Coated Conductors	Jan-06		
Basic Energy Sciences Superconductivity Workshop	P.N. Barnes	Methodologies for incorporating pinning centers in high temperature superconductors	Jul-06		invited
19th ISS 2006 - Nagoya, Japan	P.N. Barnes, C..V. Varanasi, J.W. Kell, G. A. Levin, B. C. Harrison, T. J. Haugan, J. L. Burke	A comparison of YBCO pinning by minute dopants and nanoparticulates and coated conductor ac loss reduction	1-Nov-06	wt-25-inv	invited
19th ISS 2006 - Nagoya, Japan	T. J. Haugan, P. N. Barnes, N. A. Pierce, F. J. Baca, I. Maartense, T. L. Peterson, E. A. Stinzianni, M. V. Rane, K. A. Dunn, P. Haldar, H. Wang	Flux Pinning and Grain Boundary Enhancements of YBCO with Nanoparticle Additions	30-Oct-06	WTP-1	
19th ISS 2006 - Nagoya, Japan	C. V. Varanasi, P. N. Barnes, J. Burke, L. Brunke, I. Maartense, T. J. Haugan, E. A. Stinzianni, K. A. Dunn	BaSnO3 Nanoparticle Incorporation Into YBCO Films to Improve Flux Pinning Properties	30-Oct-06	WTP-2	
19th ISS 2006 - Nagoya, Japan	**Chakrapani Varanasi**	Flux Pinning Enhancement in Pulsed Laser Deposited YBCO Films with BaSnOe Nanoparticles Introduced Using a Dual Phase Sector Target	31-Oct-06		
19th ISS 2006 - Nagoya, Japan	J.Z. Wu, R.L.S. Emergo, X. Wang. T. Haugan, P. Barnes,	Superconductor "Sponges" Carry High Jc	1-Nov-06	wt-28-inv	invited

	D. Christen, M. Varela				
ICPAC 2006	Kenneth Busby, Campbell Carter, Kevin Kirkendall, and Paul Barnes	Performance of Pulsed Scramjet Ignitions	19-Sep-06		
University of Dayton	C. V. Varanasi	Pulsed Laser Deposition of Advanced Materials to Process Electrical Conductors	10-Feb-06		
University of Kansas, Dept. of Physics Colloquium	Timothy J. Haugan	Superconductivity: Basic Science to Novel Technology	13-Nov-06		invited
MS&T 2006 - Cincinnati, Ohio	Timothy J. Haugan, Paul Barnes, Timothy Campbell, Neal Pierce, Chakrapani Varanasi, R. Kleismit, timothy Peterson, AFRL	Flux Pinning and Grain Boundary Transport Enhancements of YBCO with Nanoparticle Additions	16-Oct-06	9:20 AM	invited
MS&T 2006 - Cincinnati, Ohio	Paul N. Barnes, Joseph Kell, Brandon Harrison, Chakrapani Varanasi, timothy Haugan, AFRL, UDRI	YBCO Flux Pinning Enhancement Using =1% of Y Doping with Deleterious Rare Earths	16-Oct-06	11:20 AM	invited
MS&T 2006 - Cincinnati, Ohio	Chakrapani Varanasi, J. Burke, L. Brunke, P. N. Barnes, M. Sumption, I. Maartense, T. Haugan, H. Efstathiadis, P. Haldar	Flux Pinning Enhancement in YBa2Cu3O7-x Coated Conductors with BaSnOe and YwBaCuO5 Nano Particle Additions Introduced Using a Dual Phase PLD Target Method	18-Oct-06	10:00 AM	
MS&T 2006 - Cincinnati, Ohio	Vijay Nalladega, Shamachary Sthish, Amarjit Brar, Chakrapani V. Varanasi, Paul N. Barnes	Sub-Surface Imaging of Materials Using Atomic Force Mircroscope and Ultrasonic Force Microscope (AFM/UFM)	15-Oct-06	6-9 PM	
CCA '06	P. Barnes, J. Kell, J. Burke, C. Varanasi, B. C. Harrison, T. J. Haugan	Flux Pinning of YBCO Films	Jul-06		invited

3.2.3 Listings for 2007

Meeting	Authors	Title	Presentation Date (exact)	Session Paper #	Invited?
13th US-JAPAN Workshop on Adv Supercond	T.J. Haugan, P.N. Barnes, N.A. Pierce, F.J. Baca, M. Mullins, T.A. Campbell, M.F. Locke, I. Maartense, C. Kwon, M. Yamamoto, R. James, J. Young	Novel Method of Enhancing Current Transport Across Grain Boundaries of YBCO	10-Nov-07	sess 2 1A2-1	invited
13th US-JAPAN Workshop on Adv Supercond	T. Haugan, P. Barnes, N. Pierce, F. Baca, M. Mullins, T. Campbell, M. Locke, V. Varanasi, B. Harrison, A. Chaney, I. Maartense, H. Wang, M. Sumption	Flux Pinning Enhancements of YBCO with (M/123)xN Magnetic Multilayer Films	7-Nov-07		invited
AFOSR REVIEW '07	T.J. Haugan, P.N. Barnes, N.A. Pierce, T.A. Campbell, F.J. Baca, M. Mullins, M.F. Locke, B.C. Harrison, A.D. Chaney, C. Varanasi, P. Klenk, D. Blubaugh, R. Morgan, I. Maartense, H. Wang	Flux Pinning and Grain Boundary Enhancements of YBCO	Apr-07		
AFOSR REVIEW '07	J. Kell, B.C. Harrison, T. Haugan, P. Barnes	Flux Pinning of YBCO with Minute Doping Additions	Apr-07		
AFOSR REVIEW '07	J. Wu, R. Emergo, T.J. Haugan, P.N. Barnes	Basic Research of YBCO	Apr-07		
AFOSR REVIEW '07	C.V. Varanasi, J. Burke, P. Barnes, T. Haugan,	Flux Pinning of YBCO with Nanorod Additions	Apr-07		
AFOSR REVIEW '07	D.C. Larbalestier, A. Gurevich, T. Haugan, P. Barnes	Doping of YBCO with Nanoparticle Defects	Apr-07		
AFOSR REVIEW '07	H. Wang, T. Haugan, P. Barnes, C.V. Varanasi	Thin Film Deposition of YBCO and Nanoadditions	Apr-07		
AFOSR REVIEW '07	M.D. Sumption, P.N. Barnes, T.J. Haugan,	Flux Pinning Properties of YBCO	Apr-07		

	C.V. Varanasi	with Nanoparticle Dispersions		
AFOSR REVIEW '07	P. Barnes, J. Kell, T. Haugan, C.V. Varanasi	YBCO Pinning by Nanoparticulate Dispersions	Apr-07	
APS '07	A. Lucarelli, R. Yang, G. Luepke, F. Grilli, T. Haugan, G. Levin, and P. Barnes	AC Current driven vortex dynamics in YBCO thin films and coated conductors	5-Mar-2007	B9-4
APS '07	B. Maiorov, L. Civale, Q.X. Jia, H. Zhou, S.R. Foltyn, T.G. Holesinger, H. Wang, J.L. MacManus-Driscoll, T.J. Haugan, P.N. Barnes	Influence of disorder on the vortex pinning and cutting of $YBa_2Cu_3O_{7-x}$ films	5-Mar-2007	B9-5
ICMC 2007	G.A. Levin, P.N. Barnes	Superconductor-Stabilizer Interfacial Resistance and Normal Zone Propagation in Coated Conductors	18-Jul-07	M2-M-04 2:30 PM
ICMC 2007	T.J. Haugan, P.N. Barnes, N.A. Pierce, F.J. Baca, T.A. Capmpbell, M.F. Locke, I. Maartennse, T.L. Peterson, C. Kwon, M. Yamamoto, R.G. James, J.L. Young	Enhanced Current Transport Across Grain Boundaries of YBCO by Novel Methods	19-Jul-07	M3-P-01 3:45 PM
ICMC 2007	C.V. Varanasi, J. Burke, I. Maartense, T.J. Haugan, P.N. Barnes	YBa2Cu3O7-x Films With BaSnO3 Nanoparticles Prepared by Pulsed Laser Ablation Mehtod Using Different Processing Approaches	19-Jul-07	M3-P-03 4:15 PM
ICMC 2007	T.J. Haugan, P.N. Barnes, N.A. Pierce, F.J. Baca, M.F. Locke, T.A. Campbell, C.V. Varanasi, B.C. Harrison, A.D. Chaney, M. Sumption, H. Wang	Optimization of (M/YBa2Cu3O7-delta)xN Multilayer Films by Control of Layer Parameters	18-Jul-07	M2-H-02 10:45 AM
ICMC 2007	C.V. Varanasi, P.N. Barnes, J. Burke, I. Maartense, R. Lu, J.	Pulsed Laser Deposition LaMnO3 Cap Layers and	18-Jul-07	M2-O-04 3:30 PM

	Wu	YBa2Cu3O7-x Coatings on IBAD - MgO Buffered Flexible YSZ Ceramic (Ceraflex) Substrates			
ICMC 2007	P.N. Barnes, C.V. Varanasi, L.L. Burke, B.C. Harrison, J.W. Kell, T.J. Haugan	Pinning Mechanisms in YBCO films with Nanoparticulates	18-Jul-07	M2-H-03 11:00 AM	
ICMC 2007	B. C. Harrison, J.W. Kell, P.N. Barnes, T.J. Haugan, H. Wang, M. Rane, F. Ramos	Flux Pinning Enhancement of YBCO Films by Elemental Doping at Minute Concentrations	18-Jul-07	M2-H-04 11:15 AM	
ICMC 2007 ?	M. Polak, J. Kvitkovic, P.N. Barnes, G. Levin	Properties of an Experimental Coil Wound with YBCO Coated Conductor Carrying AC Current with Frequencies up to 432 Hz			
ISS 2007 Tsukuba, Japan	T. J. Haugan, P. N. Barnes, N. A. Pierce, F.J. Baca, M. Mullins, T.A. Campbell, M.F. Locke, A.D. Chaney, I. Maartense, H. Wang, M.D. Sumption	Flux Pinning and Grain Boundary Enhancements of YBCO with Ca-Doping and Nanoparticle Addition	7-Nov-07	WT-19-INV	invited
MRS '07	**BC Harrison, J Kell, P Barnes**, H Wang, **T Haugan, C V Varanasi**, M Rane, F Ramos	Flux Pinning Enhancement of YBCO Films by Y and Ba Site Doping at Minute Concentrations	7-Apr-07	M13.3	
MRS '07	D Blubaugh, P Barnes, J Murphy, T Haugan, G Levin, C V Varanasi	Calorimetric Determination of AC Losses in High Temperature Superconducting Coils	10-Apr-07	M10.10	
MRS '07	B C Harrison, P N Barnes, M D Sumption, J Kell, I Maartense, T Peterson, T Haugan	Correlation of Film Quality to Magnetic Susceptibility Measurements	10-Apr-07	M10.4	
MRS '07	C V Varanasi, J Burke, P Barnes, I Maartense, R T Lu, J	$YBa_2Cu_3O_{7-x}$ Coating on flexible YSZ Ceramnic	10-Apr-07	M5.5	

	Wu	(Ceraflex) Substrates with IBAD-MgO and PLD-$LaMnO_3$ Cap Layers			
MRS '07	T Haugan, P Barnes, N Pierce, F J Baca, T Campbell, I Maartense, T Peterson, E Stinzianni, M Rane, K Dunn, P Haldar, H Wang	Flux pinning and grain boundary enhancements of YBCO with Nanoparticle Additions	10-Apr-07	M1.4	
MRS '07	M Sumption, T Haugan, P Barnes, C V Varanasi, T Campbell	Pinning strength, mechanisms, and dimensionality in YBCO PLD with various types of artificial pinning structure-based enhancements	10-Apr-07	M5.10	
MRS '07	R L Emergo, J Wu, F J Baca, T Haugan, P Barnes	Combination of nanopores and nanorods increases overall Jc(B,θ) in YBa2Cu3O7-δ	11-Apr-07	M7.4	
MRS '07	C V Varanasi, P N Barnes, J Burke, I Maartense, K Dunn	Unique pinning and enhanced irreversibility field for YBa2Cu3O7-x films with BaSn)3 nanoparticles	11-Apr-07	M8.1	invited
MRS '07	F Kametani, S Il Kim, D Larbalestier, T Haugan, P Barnes	Weak thickness dependence of Jc and responsible features of microstructure in a strong pinning YBCO film	11-Apr-07	M8.3	
MRS '07	T Haugan, N Pierce, F J Baca, T Campbell, D Blubaugh, B C Harrison, I Maartense, P Barnes	Superconducting and Microstructural Properties of (Y1+y-xEux)Ba2-yCu3O7-z Thin Films: x = 0 to 1 and y = 0 to 0.1	11-Apr-07	M8.4	
MRS '07	B A Maiorov, H Zhou, S Baily, H Wang, J L MacManus-Driscoll, T G Holesinger, T Haugan, P Barnes, Q X Jia, S R Foltyn, L	Influence of random and correlated disorder on the critical current of YBa2Cu3O7 coated conductors in	11-Apr-07	M9.4	

	Civale	variable Lorentz force configuration			
MRS '07	P N Barnes, C V Varanasi, J Burke, B C Harrison, J Kell, T Haugan	A consideration of pinning mechanisms in nanoparticulate films	11-Apr-07	M9.5	
MRS '07	J Wu, R L Emergo, X Wang, T Haugan, P Barnes	Nanotube pores in YBa2Cu3O7-x thick films: improved single vortex pinning and correlated pinning	11-Apr-07	M9.6	
MRS '07	R G James, J L Young, M Yamamoto, C Kwon, G A Levin, T J Haugan, P N Barnes	New operating modes of scanning laser microscopy	11-Apr-07	M10.5	
MRS '07	P Barnes, B C Harrison, J Kell, T Haugan, M Sumption	An empirical consideration of the critical current density as a function of temperature	11-Apr-07	M10.17	
MRS '07	A Lucarelli, R Yang, G Lupke, G Levin, T Haugan, P Barnes, F Grilli	AC current driven vortex dynamics in YBCO thin films and coated conductors	12-Apr-07	M11.2	
MRS '07	G Levin, P Barnes, M Sumption	Copper stabilized multifilament coated conductors	12-Apr-07	M11.5	
MRS '07	C Kwon, M Yamamoto, R James, J Young, T Haugan, P Barnes	Sub-gap structures and local inhomogeneity in YBCO films on bicrystal substrates	12-Apr-07	M12.3	
MRS '07	W Wong-Ng, L Cook, Z Yang, I Levin, M Otani, P Schenck, J Ritter, M Vaudin, R Feenstra, T Holesinger, A Goyal, T Haugan, P Barnes	Phase Equilibria for the Ba-R-Cu-O (R+Y and Lanthanides) Coated-Conductor Research	12-Apr-07	M13.1	invited
MS&T 2007	F. Javier Baca, N. A. Pierce, M. J. Mullins, M.F. Locke, A. D. Chaney, C. Varanasi, T. Haugan, P. N. Barnes, J. Wu, R. Emergo, H. Wang	Transmission Electron Microscopy of YBCO with Flux Pinning Additions	19-Sep-07	9:40 AM	
MS&T 2007	J. Wu, R. emergo, X. Wang, J. Baca, T. Haugan, P. Barnes	Optimal Vortex Pins at Different Magnetic Fields	18-Sep-07	9:20 AM	invited

MS&T 2007	W. Wong-Ng, G. Liu, Z. Yang, L.P. Cook, T. Haugan, P. N. Barnes, T. Holesinger	Phase Releationships of the Ba-Sm-Y-Cu-O Coated Conductor	16-Sep-07	6 - 9 PM	
MS&T 2007	T. Haugan, N. A. Pierce, F.J. Baca, M. J. Mullins, T,A. Campbell, M. F. Locke, I. Maartense, A. D. Chaney, P. N. Barnes, H. Wang, C. Kwon, M. D. Sumption	Flux Pinning and Grain Boundary Enhancements of YBCO with Nanoscale Multilayer Films	17-Sep-07	4:10 PM	invited
MS&T 2007	N. A. Pierce, T. Haugan, F. J. Baca. M. J. Mullins, M. F. Locke, I. Maartense, A. D. Chaney, P. N. Barnes, H. Wang, M. D. Sumption	Flux Pinning Enhancement of YBCO with (M/123)xN Multilayer Films	19-Sep-07	11:20 AM	
MS&T 2007	C. Varanasi, J. Burke, L. Brunke, P. N. Barnes, M. Sumption, H. Wang	Flux Pinning Mechanisms in YBCO + BaSnO3 Films and Properties of YBa2Cu3O7-x Coated Conductors Processed with BaSnO3 and Y2BaCuO5 Nanoparticles Using Dual Phase Sector PLD Target Method	17-Sep-07	4:50 PM	invited
MS&T 2007	H. Wang, J. Yoon, R. Araujo, S.R. Foltyn,Q.X. Jia, B. Maiorov, H. Zhou, L. Civale, J.L. MacManus-Driscoll, Z. Zhang, T. Haugan, P. Barnes	Probing the Interfacial Defects in YBa2Cu3O7-x Thin Films	18-Sep-07	2:10 PM	invited
13th US-JAPAN Workshop on Adv Supercond	T.J. Haugan, P.N. Barnes, N.A. Pierce, F.J. Baca, M. Mullins, T.A. Campbell, M.F. Locke, I. Maartense, C. Kwon, M. Yamamoto, R. James, J. Young	Novel Method of Enhancing Current Transport Across Grain Boundaries of YBCO	10-Nov-07	sess 2 1A2-1	invited
13th US-JAPAN Workshop on	T. Haugan, P. Barnes, N. Pierce, F.	Flux Pinning Enhancements of	7-Nov-07		invited

Adv Supercond	Baca, M. Mullins, T. Campbell, M. Locke, V. Varanasi, B. Harrison, A. Chaney, I. Maartense, H. Wang, M. Sumption	YBCO with (M/123)xN Magnetic Multilayer Films			
AFOSR REVIEW '07	T.J. Haugan, P.N. Barnes, N.A. Pierce, T.A. Campbell, F.J. Baca, M. Mullins, M.F. Locke, B.C. Harrison, A.D. Chaney, C. Varanasi, P. Klenk, D. Blubaugh, R. Morgan, I. Maartense, H. Wang	Flux Pinning and Grain Boundary Enhancements of YBCO	Apr-07		

3.2.4 Listings for 2008

Meeting	Authors	Title	Presentation Date (exact)	Session Paper #	Invited?
AFOSR REVIEW '08	T. Haugan, P. Barnes, et al	Improving YBCO performance by magnetic flux pinning and grain boundary enhancments	Apr-08		
AFOSR REVIEW '08	C. Varanasi, P. Barnes, T. Haugan, et al	Flux Pinning of YBCO with $BaSnO_3$ Nanorod Additions	Apr-08		
AFOSR REVIEW '08	G. Levin, P. Barnes, et al	Novel methods to improve quench and stability of YBCO coated conductors	Apr-08		
AFOSR REVIEW '08	J. Wu, P. Barnes, T. Haugan, et al	Microstructure Variation of YBCO to Enhance Properties	Apr-08		
AFOSR REVIEW '08	C. Kwon, P. Barnes, T. Haugan, et al	Laser Scanning Microscopy Study of YBCO Bicrystals	Apr-08		
AFOSR REVIEW '08	H. Wang, P. Barnes, T. Haugan, C. Varanasi, et al	TEM Investigation of YBCO microstructure and flux pinning additions	Apr-08		
AFOSR REVIEW '08	T. Haugan	Improving YBCO performance by magnetic flux pinning and grain	Apr-08		

		boundary enhancments		
AFOSR REVIEW '08	P. Varanasi	Flux Pinning of YBCO with $BaSnO_3$ Nanorod Additions	Apr-08	
AFOSR REVIEW '08	G. Levin	Novel methods to improve quench and stability of YBCO coated conductors	Apr-08	
AFRL Nanotechnology&Science Workshop	T. Haugan, P. Barnes, C. Varanasi, G. Garcia, L. Hampton, A. Chaney, N. Pierce, F. Baca, T. Campbell, M. Mullins, M. Locke, J. Burke, J. Kell	Nanoparticle Additions to Enhance Performance of High Temperature Superconductor Wires for Power Applications	Feb-08.	
APS '08	E. Cimpoiasu, J.D. Feldmann, C.V. Varanasi, T.J. Haugan, P.N. Barnes, G.A. Levin	Strong Reduction of Tc Suppressoin by Magnetic Field in YBa2Cu3O7-x Films with Dispersed Nanoparticles	Dec-08	
APS '08	Chuhee Kwon, Megumi Yamamoto, Samuel Pottish, Timothy Haugan, Paul Barnes	Characteristics vs. Spatial Dissipation Maps in YBCO Grain Boundary on Bicrystal Substrates	11-Mar-2008	H10-12
APS '08	Ran Yang, Andrea Lucarelli, Gunter Luepke, Timothy Haugan, Paul Barnes	AC Losses in multifilamentary YBCO Thin Films	11-Mar-2008	L10-6
APS '08	Chakrapani Varanasi, Jack Burke, Lyle Brunke, Haiyan Wang, Paul Barnes,	Critical Current density variation with increasing Thickness in YBaxCu3O7 + BaSnO3 (BSO) films	12-Mar-2008	S10-12
APS '08	George Levin, Paul Barnes, Jose Rodriguez	Emergence of Dissipative structures in current-carrying stabilized Superconducting Wires	14-Mar-2008	X11-14
APS '08	M.D. Sumption, T.J Haugan, P.	Magnetization, Creep, and Flux Pinning In	11-Mar-2008	K1-17

	N. Barnes	YBa2CuO7-x Thin Films with Nanoscale Pinning		
APS '08	Jie Wang, J. H. Kwon, J. Yoon, H. Wang, T.J. Haugan, F	Deposition Temperature dependence of YBCO Transport Properties	11-Mar-2008	K1-19
ASC '08	T. Haugan, N.A. Pierce, J. Reichart, M. Mullins, F. J. Baca, I. Maartense, P. Barnes	Flux Pinning Enhancement of YBCOwith Nanosize Magnetic Additions	18-Aug-08	1MPG01
ASC '08	C.V. Varanasi, J. Burke, L. Brunke, H.Wang, M. Sumption , P.N. Barnes	Angular Dependence of Transport Critical Current Density in YBCO+BaSno3 (BSO) Films Formed with Different Number Density of BSO Nanocolumns	18-Aug-08	1MPG08
ASC '08	C.V. Varanasi, J. Burke, L. Brunke, H.Wang, , P.N. Barnes	High Critical Current Density in Thick YBCO+ BaSnO3 (BSO) films	21-Aug-08	1MX04
ASC '08	A. Lucarelli, R. Yang, G. Luepke, T. Haugan, P. Barnes	AC losses in mulitfilamentary YBCO thin films	19-Aug-08	2MPM09
ASC '08	G.A. LEVIN, P.N. BARNES, J.P. RODRIQUEZ, J.S. BULMER, J.A. CONNORS	Stability and normal zone propagation speed in YBCO-coated conductors	22-Aug-08	5MC07
ASC '08	T. Haugan, F. J. Baca, N.A. Pierce, M. Mullins, E. Brewster, P. Barnes, H.Wang, M. Sumption	Temperature, Angel and Field Dependence of YBCO with Strong Flux Pinning naoparticle Aditions	21-Aug-08	4MA03
ASC '08	P.N. Barnes,M. Polak, P. Mazola, G.A. Levin,	Critical current in YBCO-coated conductors in the presence of macroscopic defects	21-Aug-08	4MC06
ASC '08	S.H. Wee, A. Goyal, Y.L. Zuev, W.	Fabrication of (Y0.667Sm0.333+x)Ba2-xCu3O7-delta films with x	21-Aug-08	4MPA03

	Wong-Ng, T.J. Haugan	varied from 0 to 0.15 on IBAD-MgO templates via pulsed laser deposition		
ASC '08	F. Javier Baca, T.J. Haugan, M.J. Mullins, P.N. Barnes, R.L. Emergo, X. Wang, J.Z. Wu, J. Burke, L. Brunke, and C. Varanasi	Microstructural characterization by Transmission Electron Microscopy of YBa2Cu3O7-x films with BaZrO3 nanorods grown on vicinal substrates	21-Aug-08	4MZ04
ASC '08	G.A. Levin, P.N. Barnes, J.P. Rodriguez, J.S. Bulmer, J.A. Connors	Stability and normal zone propagation speed in YBCO-coated conductors	22-Aug-08	5MC07
ASC '08	R. Emergo, J. Baca, J. Wu, T. Haugan, P. Barnes	Combination of Nanopores and Nanorods increases overall Jc(B, theta) in YBa2Cu3O7-x	22-Aug-08	5MX01
ASC '08	R. Goswami, R.L Holtz, T. Haugan, P. Barnes, G. Spanos	Effect of Europium Additions on Microstructure and Superoconducting properties of YBa2Cu3O7-theta	22-Aug-08	5MXO2
ASC '08	T. Haugan, P. Barnes, N.A. Pierce, M. Mullins, E. Brewster, F. J. Baca, T. A Campbell, I. Maartense, J.S. Bulmer, C. Kwon, M. Yamamoto, J.L. Young	Enhanced Current Transport at Grain Boundaries of YBCO with Nanoparticle Additions	22-Aug-08	5MXO3
ASC '08	H. Wang, J. Wang, J. Yoon, S.R. Foltyn, Q.X. Jia, H. Zhou, B. Maiorov, L. Civale, J. L. MacManus-Driscoll, T. Haugan, F. J. Baca, C. V. Varanasi, P.N.	Microstructural characteristics of nanostructed YBa2Cu3Or-theta	22-Aug-08	5MXO4

	Barnes				
ASC '08	D.C. van der Laan, J.W. Ekin, T. Haugan, P. Barnes	Reversible Effect of Strain on the Critical Current of YBa2Cu3O7-d Films on Coated Conductors and SrTiO3 Substrates	22-Aug-08	5MZ03	
CCA '08	F. J. Baca ,T. J. Haugan, J. N. Reichart, P. N. Barnes, R. L. Emergo and J. Z. Wu	BaZrO3 Nanorod Realignment in YBa2Cu3O7-x Thin Films by Surface Modulation Using Vicinal SrTiO3 Substrates	5-Dec-08	2E-07	invited
CCA '08	P. Barnes, T. Haugan, et al	Study of YBCO Bridge Width Variation			
CCA '08	F. J. Baca ,T. J. Haugan, J. N. Reichart, P. N. Barnes, R. L. Emergo and J. Z. Wu	BaZrO3 Nanorod Realignment in YBa2Cu3O7-x Thin Films by Surface Modulation Using Vicinal SrTiO3 Substrates	5-Dec-08	2.00E-07	invited
CHATS	P. Barnes, R. Dunning, J. connors, G. Levin, T. Haugan, C. Varanasi, J. Rodriguez, J. Clem	Edge-Barrier Pinning and Stability Issues in YBCO Conductors	30-Oct-08		
COMSOL	F. Grilli, A. Lucarelli, G. Lupke, T. Haugan, P. Barnes	Dynamic Study of Field and Current Distribution in Multifilamentary YBCO Thin Films	9-Oct-08		
General Use	P. Barnes, G. Levin, R. duning, J. Connors, M. Mullins	Superconducting Machines	4-Nov-08		
ICEC22-ICMC2008	C. Kwon, M. Yamamoto, J. Young, T. Haugan, P. Barnes	Local Inhomogeneity at YBCO grain boundary with Ca-doping and Second-Phase Nanoparticle Additions	21-Jul-08		
6th Panel Discussion on Technology Development and Prospect of Superconductin	P. Barnes, G. Levin, E. Durkin	Superconducting Machines Related Measurement Methods	29-Oct-08		

g Electric-Power Devices					
ISS 2008 Tsukuba, Japan	P. Barnes, G. Levin, E. Durkin	Superconducting Machines-Improving the YBCO Coated Conductor	29-Oct-08		
ASC '08	P.N. Barnes,M. Polak, P. Mazola, G.A. Levin,	Critical current in YBCO-coated conductors in the presence of macroscopic defects	21-Aug-08	4MC06	
MRS '08	Ran Yang, Andrea Lucarelli, Guneter Luepke, Timothy Haugan and Paul Barnes	AC Losses in Multifilamentary YBCO Thin Films	27-Mar-08	II2.3	
MRS '08	T. J. Haugan, N.A. Pierce, M. J. Mullins, F.J. Baca, J.S. Bulmer, P. N. Barnes, I. Maartense, H. Wang, M.D. Sumption	Flux Pinning Enhancements of YBCO with Nanosize Magnetic Additions	27-Mar-08	I4.6/I15.6	invited
MRS '08	Jie Wang, Jiheon Kwon, Jongsik Yoon, Haiyan Wang, Timothy J Haugan, F. J. Baca, N.A Pierce and Paul N. Barnes	Deposition Temperture Dependence of YBCO Transport Properties	27-Mar-08	II4.14	
MRS '08	Chakrapani V. Varanasi, J. Burke, L. Brunke, H. Wang and Paul N. Barnes	Critical Current Density Variations with Thickness (300nm to 3 microns) in YBCO+ BaSnO3 (BSO) Films Deposited by using a Dual Phase Sector Pulsed Laser Ablation Target Method	27-Mar-08	II4.15	
MRS '08	George Levin, Pual N Barnes, Jose Prodriguesz, Jon S Bulmer and Jake A Connors	Effects of Increased Interface Resistivity on Stability and Quench in Coated Conductors	27-Mar-08	II7.8	
MRS '08	Xiang Wang,	The Mechanism	27-Mar-	II7.9	

	Judy Wu, Javier Baca, Timothy Haugan, and Paul Barnes	Responsible and the Ultimate Solution for the Thickness Dependence of Critical Current Density in HTS Coated Conductor	08	
MRS '08	Haiyan Wang, Jongsik Yoon, Joyce Wang, Steve R. Foltyn, Quanxi Jia, Honghui Zhou, Boris Maiorov, Leonardo Civale, Judith L. MacManus-Driscoll, Timothy J Haugan, F.J. Baca, C.V. Varanasi, and Paul N. Barnes	Exploring the Interfacial Defects in Nanostructured Yba2Cu3O7-delta Thin Films	27-Mar-08	II8.2
MRS '08	Chakrapani Varanasi, J. Burke, L. Brunke, H. Wang, M Sumption, J. Rodriquez and P. N Barnes	Flux Pinning Enhancement and Structure-Property Relationships in YBCO+BaSnO3 (BSO) Films Processed with Varying Amounts of BSO NanoParticles/Nanocolumns	27-Mar-08	II8.6
MRS '08	Timothy Haugan, Paul Barnes, Neal Pierce, Matthew Mullins, F. Javier Baca, Timothy Campbell and Chuhee Kwon	Grain Boundary Enhancements of YBCO with Ca-Doping and Nanoparticle Additions	27-Mar-08	II8.8
MRS '08	Jose P. Rodriguez, Pual N. Barnes, Chakrapani V. Varanasi	In-Field Critical Current by Strain Field due to Dislocations and Nanorods Threading Films of PLD-YBCO	27-Mar-08	II8.11
MRS '08	Danko Van Der Laan, J. Ekin, T. Haugan, and P. Barnes	Will the Electr-Mechanical Properties of YBa2Cu3O7-delta Coated Conductors Help Reveal the Mechanism Behind	25-Mar-08	II2.1

		High-temperature Superconductivity			
MS&T 2008	T. Haugan, M. J. Mullins, E. Brewster, J. Reichart, J. F. Baca, J. Bulmer, P. Barnes, H. Wang, M. Sumption	Enhancing Critical Currents of YBCO Superconductors with Nanoparticle Additions	9-Oct-08	3:40 PM	
MS&T 2008	H. Wang, J. Wang, S.R. Foltyn, Q. Jia, H. Zhou, B. Maiorov, L. Civale, J. MacManus-Driscoll, T.J. Haugan, F. J. Baca, C. V. Varanasi, P. N. Barnes	Exploring the interfacial defects in nanostructured YBa2Cu3O7-delta thin films	9-Oct-08	4:00 PM	
IEEE Power and Energy Society General Meeting 2008	P. Barnes, G. Levin, E. Durkin	Superconducting Generators for Airborne Applications and YBCO Coated Conductors	20-Jul-08		invited
SAE CONFERENCE '08	Timothy J. Haugan, L. A. Hampton, J. D. Long, P.N. Barnes	Development of Compact, Lightweight Power Transmission Devices for Specialized High Power Applications	Oct-08		
U.S.-Taiwan (5th) Nanoscience Workshop	P Barnes, C. Varanasi, Z. Turgut, J. Horwath, T. Haugan	Nanoscience for Power in Magnetic Materials, Carbon Nanotubes, and Superconductivity	Feb-08.		invited
Wright-State Univ. Center For Nanoscale Materials	T. Haugan	Overview of Nanoscale Materials Research at Propulsion Directorate RZPG	31-Oct-08		invited
AFOSR REVIEW '08	T. Haugan, P. Barnes, et al	Improving YBCO performance by magnetic flux pinning and grain boundary enhancments	Apr-08		
AFOSR REVIEW '08	C. Varanasi, P. Barnes, T. Haugan, et al	Flux Pinning of YBCO with $BaSnO_3$ Nanorod Additions	Apr-08		

3.2.5 Listings for 2009

Meeting	Authors	Title	Presentation Date (exact)	Session Paper #	Invited?
AFOSR Superconductivity Review 2009	P. Barnes	The Development of High Temperature Superconductors	1-May-09		
APS Mar '09	E. Cimpoiasu, J.D. Feldmann, C.V. Varanasi, T.J. Haugan, P.N. Barnes, G.A. Levin	Strong Reduction of Tc Suppressoin by Magnetic Field in YBa2Cu3O7-x Films with Dispersed Nanoparticles	17-Mar-09	H34.2	
CCA '09	T. J. Haugan, P. N. Barnes	New Applications of Superconductors in Aircraft Systems: Design of Compact, Lightweight Power Transmission Cable for Specialized High Power Applications	24-Nov-09	E.12.05	invited
CCA '09	J.R. Dizon, J.Z. Wu, T. Haugan, P. Barnes	Characterization of dissipation evolution at YBa2Cu3O7-x grai boundaries using low-temperature near-field scanning microwave microscopy	24-Nov-09	D3.11:30	
CEC-ICMC '09	T.J. Haugan, P.N. Barnes	Design of Compact, lightweight Power Transmission Cable for Specialized High Power Applications	28-Jun-09	C1-O-01	
CEC-ICMC '09	M. Polak, P. Mozola, P. Barnes, G. Levin	The Effect of a Filament Interruption on Current-Voltage curves and Critical Currents of Filamentary YBCO Tapes with Superconducting Bridges	28-Jun-09	M1-I-01	
CEC-ICMC '09	J. Burke, C. Varanasi, L. Brunke, H. Wang, P. Barnes	Microstructural and Critical Current Density of YBa2Cu3O7-x + BaSnO3 Thick Films Grown with Pre-Mixed Pulsed Laser Ablation Target	28-Jun-09	M1-I-02	
CEC-ICMC '09	G.A. Levin, K. Novak, J.S.	Stability and AC losses in coated conductors with	30-Jun-09	M2-I-07	

	Bulmer, P.N. Barnes	large and modulated interfacial resistance between superconductor and stabilizer		
CEC-ICMC '09	C. Varanasi, J. Burke, J. Reichart, P. Barnes, H. Wang	Second Phase Nanocolumns in YBa2Cu3O7-x films -- Effects of Porcessing Variable and Their Influence on the Flux Pinning Porperties	28-Jun-09	M3-H-02
CEC-ICMC '09	P. N. Barnes, M. Mullins, J. Connors, R. Dunning, T. Haugan, J. Clem	Potential edge-barrier pinning in YBCO thin films	1-Jul-09	M3-H-03
CEC-ICMC '09	T. J. Haugan, P. N. Barnes, M. J. Mullins, F. J. Baca, E. L. Brewster, J. N. Reichart	Enhancing transport current across grain boundaries of YBCO with nanoparticle additions	1-Jul-09	M3-H-05
IC&E-AC&C	C. Varanasi, J. Burke, L. Brunke, J. Lee, H. Wang, P. Barnes	Processing and Characterization of Second Phase Nanocolumns in Thin Film Oxide Ceramics	18-Jan-09	
MRS '09	J. Rodriguez, P.N. Barnes,	Quantum-Mechanical Current Blocking by Nano-Scale Columnar Pinning Centers in Thin Films of High-Temperature Superconductors	14-Apr-09	CC3.9
MRS '09	P. N. Barnes, M. Mullins, J. Connors, R. Dunning, T. Haugan, J. Clem	A Reconsideration of Edge-Barrier Pinning in YBCO Thin Films	14-Apr-09	CC3.10
MRS '09	F.J. Baca, P.N. Barnes, R.L .Emergo, T. Haugan, C.V. Varanasi, J. Burke, J. Reichart, J. Z Wu	Controlled Nanorod Alignment in $YBa_2Cu_3O_{7-x}$ Thin Films by Microstructural Tuning	14-Apr-09	CC4.3
MRS '09	C.V. Varanasi, J. Burke, J.	Effects of second phase compositions and	14-Apr-09	CC4.6

	Reichart, H. Wang, P.N. Barnes	processing parameters on the formation of nanocolumns in $YBa_2Cu_3O_{7-x}$		
MRS '09	T. Haugan, F.J. Baca, M. Mullins, E. Brewster, J. Reichart, P.N. Barnes, B. Maiorov, M. Sumption, H. Wang	Unusual Flux Pinning Properties of YBCO with BaZrO3 Nanoparticle Layered Additions	14-Apr-09	CC5 .11
MRS '09	Mike D Sumption, T. Haugan, P.N. Barnes, C.V. Varanasi, Mike Susner	Influence of Artificial Nanostructure Pinning on the Critical Current Density in YBa2Cu3O7-X Thin Films	14-Apr-09	CC5 .15
MRS '09	T. Haugan, P.N. Barnes, M. Mullins, F.J. Baca, E. Brewster, J. Reichart, M. Sumption	Strong Enhancment of Transport Current across Grain Boundaries of YBCO Superconductor with Nanoparticle Additions	14-Apr-09	CC7 .4
MRS '09	G. Levin, P.N. Barnes, J. Murphy	Persistent Coils Made Out of Coated Conductors	14-Apr-09	CC7 .5
MRS '09	G. Luepke, A. Lucarelli, R. Yang, F. Grilli, T. Haugan, P.N. Barnes	Dynamical Study of Flux and Current Distributions in Multi-Filamentary YBCO Thin Films	14-Apr-09	CC7 .6
MRS '09	C. V. Varanasi, J. Burke, L. Brunke J. Murphy, J. H. Lee, C. Tsai, H. Wang, M. Susner, M. Sumption, J. Reichart, P.N. Barnes	Effects of processing parameters and second phase compositions on the formation of nanocolumns in YBa2Cu3O7-x Films		
MS&T '09	T.J. Haugan, P.N. Barnes, M. Mullins, F. Baca, J. Reichart, E. Brewster, H. Wang, M.	Enhancing Critical Currents of YBCO Superconductors with Nanoparticle Additions	28-Oct-09	IntS ymC erIII. 4.20

	Sumption				
MS&T '09	T.J. Haugan, P.N. Barnes, M. Mullins, F. Baca, J. Reichart, E. Brewster	Strongly Enhancing Transport Current Flow across Grain Boundaries of Polycrystalline YBCO Superconductor with Nanoparticle Additions	28-Oct-09	MultiOxides. 2.40	
Univ. of Kansas Physics Seminar	T.J. Haugan	Enhancing Critical Currents of YBCO Superconductors with Nanoparticle Additions	17-Nov-09		invited
Univ. of Kansas Physics Seminar	F. J. A. Baca	In-Situ Control of BaZrO3 and BaSnO3 Nanorod Alignment and Microstructure in YBa2Cu3O7-x Thin Films by Strain Modulated Growth	17-Nov-09		invited
US-Japan '09 - 14th Workshop Adv. Superconductors	G. A. Levin, K.A. Novak, P.N. Barnes	The effects of superconductor-stabilizer interfacial resistance on quench of current-carrying coated conductor	14-Dec-09	Appl I.11. 30	
US-Japan '09 - 14th Workshop Adv. Superconductors	T. J. Haugan, J. N. Reichart, M. J. Mullins, F. J. Baca, E. L. Brewster, P. N. Barnes	Unusual Flux Pinning Properties of YBCO with layered $BaZrO_3$ nanoparticle additions	15-Dec-09	CCII .15. 50	
AFOSR Superconductivity Review 2009	P. Barnes	The Development of High Temperature Superconductors	1-May-09		

3.2.6 Listings for 2010

Meeting	Authors	Title	Presentation Date (exact)	Session Paper #	Invited?
Univ. of Kyoto Dept. of Electrical Engineer Seminar	T. J. Haugan	Advances in Science and Technology of High Temperature Superconductors	27-Oct-10		invited
MS&T 2010	T. Haugan, J. Reichart, F. Baca, M. Mullins, J. Olds, E. Brewster, P. Barnes	Enhancing Flux Pinning of YBCO Superconductor Thin Films with Varying Nanophase	19-Oct-10	Oct19 4:00PM	

		Additions			
MS&T 2010	D. van der Laan, F. Douglas, T. Stauffer, C. Clickner, L. Goodrich, T. Haugan, P. Barnes, D. Abraimov, F. Kametani, D. Larbalestier, M. Rupich, Y. Xie, A. Usoskin, H. Freyhardt, V. Selvamanickam	Effect of Strain on the Critical Current and Flux Pinning in YBa2Cu3O7-Delta Coated Conductors and Bi2Sr2CaCu3Ox Tapes	19-Oct-10	Oct19 3:20PM	invited
MS&T 2010	P. Varanasi, J. Burke, L. Brunke, J. Lee, H. Wang, P. Barnes	Effects of Processing Parameters on the Formation of BaSnO3 Nanocolumns and Their Influence on the Flux Pinning Properties of YBa2Cu3O7-x	19-Oct-10	Oct19 3:00PM	invited
MS&T 2010	J. Wu, R. Emergo, X. Wang, J. Baca, T. Haugan, P. Barnes	Nanoengineered Microstructures and Transport Properties in YBCO Thick Films	19-Oct-10	Oct19 2:40PM	invited
MS&T 2010	P.N. Barnes, T. Haugan, F. Baca, C. Varanasi	Inducing Self-assembly of Pinning Nanoparticles in YBa2Cu3O7-x via Ca-doping of Y2BaCuO5 Additions	19-Oct-10	Oct19 2:20PM	invited
CCA 2010	T.J. Haugan, P.N. Barnes	Development of low voltage DC superconducting power transmission cables	29-Oct-10	P-O5	
CCA 2010	T. Haugan, W.A. Jones, P.N. Barnes F.J. Baca, R.L.S. Emergo, J.R. Clem	Accounting for edge-barrier pinning in critical current measurements of bridged	28-Oct-10	O-C04	invited

		superconducting films		
DEPS 2010	T. Haugan, P.N. Barnes	Concept Design of a Lightweight, Compact Superconducting MW-class Power Transmission Cable	15-19 Nov 2010	
APS 2010	J.R. Thompson, J.W. Sinclair, D.K. Christen, C.V. Varanasi	Vortex pinning by BaSnO3--based correlated disorder in thick YBa2Cu3O~7 films: angular dependence of Jc via contact-free methods	18-Mar-10	V40.00004
APS 2010	P. Barnes, W. Jones, M. Mullins, F. Baca, T. Haugan	The Significance of Edge-Barrier Pinning in Superconducting Bridges	15-Mar-10	V40.00005
ASC 2010	R.L.S. Emergo, F.J. Baca, J.Z. Wu, T.J. Haugan, P.N. Barnes	3D Landscape of BaZrO3 Nanorods in YBa2Cu3O7-delta Films	3-Aug-10	2MB-03
ASC 2010	W.A. Jones, P.N. Barnes, M.J. Mullins, F.J. Baca, R.L.S. Emergo, J.L. Wu, T.J. Haugan	Edge-Barrier Pinning in Self Field Superconducting Thin Films	3-Aug-10	2MP1A-01
ASC 2010	J.F. Fagnard, M. Dirickx, B. Vanderheyden, P. Vanderbemden, G. Levin	Screeing of Axial DC Magnetic Fields By Using Superconducting Loops of Second Generation Coated Conductors Without Joints	3-Aug-10	2MP1C-05
ASC 2010	J. Wu, R. Lu, C. Christianson, J. Dizon, T. Haugan, P. Barnes, J. Baca	Investigating of Dynamic Behaviors of Low-Level Dissipation At YBa2Cu3O7-delta Grain Boundaries Using	3-Aug-10	2MY-08

		Low-Temperature Near-Field Scanning Microwave Microscopy			
ASC 2010	E. Cimpoiasu, J. Feldmann, T. Haugan, C. Varanasi, G. Levin, P. Barnes	Effect of Oxygen Depletion on the Pinning Strength of YBa2Cu3Ox Thin Films With Nano-Inclusions	4-Aug-10	3MP2B-09	
ASC 2010	J.N. Reichart, E.L. Thomas, T.J. Haugan, X. Song, P.N. Barnes	Minute Doping of Y1-xRExBa2Cu3O7-delta Thin Films With RE = TB and ND	4-Aug-10	3MP3A-01	
ASC 2010	F. Baca, T.G. Holesinger, B. Maiorov, L. Civale, T.J. Haugan, J. Reichart, P.N. Barnes, J.Z. Wu	Dynamic Growth Effects of Rare Earth Nanoparticles on Nanorod Formation in YBa2C3Ox Thin Films	4-Aug-10	3MP3A-10	
ASC 2010	T.J. Haugan, P.N. Barnes, G. Spanos, R.L. Holtz	Effects of Nanoscale Defects on Critical Current Density of Y1-X EUXBa2Cu3O7-x Thin Films	4-Aug-10	3MP3A-11	
ASC 2010	G.A. Levin, K.A. Novak, W.A. Jones, P.N. Barnes	Normal Zone Propagation in Pancake Coils Made Out of YBCO Coated Conductors	5-Aug-10	4LPM-03	
ASC 2010	T.J. Haugan, J.N. Reichart, M.J. Mullins, E.L. Brewster, J.S. Olds, P.N. Barnes, F.J. Baca, H. Wang	Unusual Flux Pinning Properties of YBCO With Layered BaZrO3 Nanoparticle Additions	5-Aug-10	4MX-03	
ASC 2010	P.N. Barnes, T. Haugan, T. Campbell, F.J. Baca	Inducing Self-Assembly of Nanoparticles in YBCO Via Ca-Doping	5-Aug-10	4MX-05	
ASC 2010	T.J. Haugan,	Conceptual	6-Aug-10	5LY-04	

	P.N. Barnes	Design of a Superconducting Power Transmission Cable for Specialized High Power Applications			
MRS 2010	J. Wu, J. Baca, R. Emergo, T. Haugan, P. Barnes	Exploring 3-D Landscaping of BaZrO3 Nanorods in YBa2Cu3O7-delta via Strain Engineering	5-Apr-10	L4.5	invited
MRS 2010	W.A. Jones, P.N. Barnes, M.J. Mullins, F.J. Baca, R.L. Emergo, T.J. Haugan	The Impact of Edge-Barrier Pinning in Superconducting Thin Films	5-Apr-10	L5.6	
MRS 2010	T.J. Haugan, J.N. Reichart, M.J. Mullins, F.J. Baca, E.L. Brewster, J.S. Olds, P.N. Barnes, H. Wang	Simulatneously Enhancing Intragranular and Intergranular Currents of Y-Ba-Cu-O Coated Conductors With Nanoparticle Additions	5-Apr-10	L6.1	invited
MRS 2010	H. Wang, C. Tsai, L. Chen, Y. Zhu, J.L. MacManus-Driscoll, Q.X. Jia, C.V. Varanasi, T.J. Haugan, and P.N. Barnes	Microstructure and Pinning Properties of Nanostructured YBa2Cu3O7-delta Thin Films	5-Apr-10	L6.6	invited
MRS 2010	J.N. Reichart, E. Thomas, T. Haugan, X. Song, P. Barnes	Optimization of Minute Doping of Y1-xRExBaCO Thin Films With RE = Tb and Nd	5-Apr-10	L6.8	
UT Pan-American Physics Seminar	T. J. Haugan	Superconductivity: Basic Science to Novel Technology	9-Feb-10		invited

3.2.7 Listings for 2011

Meeting	Authors	Title	Presentation Date (exact)	Session Paper #	Invited ?
AFOSR Elec. Review 2011	T.J. Haugan, J. N. Reichart, P.N. Barnes, M.J. Mullins, E. L. Brewster, F.J. Baca	Enhancing Grain Boundary Properties of Y-Ba-Cu-O Superconductor with Nanoparticle Additions	23-May-11	PA-4	Invited
AFOSR Elec. Review 2011	J.N. Reichart, J.L. Burke, T.J. Haugan, P.N. Barnes, D.C. Vier, R.A. Isaacson, S. Schultz, M.D. Sumption	Search for Advanced Superconductors	23-May-11	PA-5	
AFOSR Superconductivity Review 2011	T.J. Haugan, J.N. Reichart, M.A. Sebastian, B.T. Pierce, W.A. Jones, J.L. Burke, L.B. Brunke, P.N. Barnes, D.C. Vier, R.A. Isaacson, S. Schultz, M.D. Sumption, H. Wang	Superconductivity Research at AFRL: Search for New Materials and Improving Flux Pinning in YBCO	12-Dec-11	Afternoon	invited
AFOSR Superconductivity Review 2011	J.L. Burke, J.N. Reichart, B.T. Pierce, L.B. Brunke, T.J. Haugan, P.N. Barnes, D.C. Vier, R.A.	Search for Advanced Superconductors: Balanced Valence Compounds and Doped Carbon Films	15-Dec-11	P	

	Isaacson, S. schultz, M.D. Sumption, E. Morosan			
AFOSR Superconductivity Review 2011	M. Sebastian, J. Reichart, J. Burke, T. Haugan	Optimizing Flux Pinning of YBCO Superconductor with BaSnO3+Y2O3 Double Mixed Phase Additions	15-Dec-11	P
AFOSR Superconductivity Review 2011	J.P. Murphy, T.J. Haugan, M.J. Mullins, P.N. Barnes, M. Polak, M. Majoros, M. Sumption	AC Loss Measurement in Superconductors: Calorimetric Measurement of AC Losses with External Magnetic field	15-Dec-11	P
AFOSR Superconductivity Review 2011	G.A. Levin, T.J. Haugan,W.A. Jones, J.L. Lynn, K.A. Novak, J.P. Rodriguez, P.N. Barnes	Self-organization and Spontaneous Pattern Formation in Superconductors	15-Dec-11	P
EUCAS 2011	D.C. van der Laan, X.F. Lu, T.C. Stauffer, L.F. Goodrich, T.J.Haugan, G.E. Miller, P.D. Noyes, H.W. Weijers	REBa2Cu3O7-z coated conductor cables for electric power transmission and high-field magnet applications	20-Sep-11	2-LA-012
EUCAS 2011	T.J. Haugan, J. N. Reichart, M. A. Sebastian, J. L. Burke, and E. L. Brewster	Design of a MW-class Superconducting Power Transmission Cable for Airborne Applications	22-Sep-11	4-LB-P34
EUCAS 2011	G.A. Levin, W.A. Jones, M. Sumption	Current Leads based on Coated Conductors	22-Sep-11	4-LB-O4
EPRI 10th Superconductor	T. Haugan, D. Latypov, J.V. Holle	Design of SMES Devices for Air and Space Applications	12-Oct-11	P-13

EPRI 10th Superconductor	D. Latypov, J.V. Holle, T. Haugan	Investigating SMES Devices for Air and Space Applications	12-Oct-11	P-14
ICMC 2011	T.J. Haugan, J. Reichart, M. Mullins, M.M. Ratcliff, E. brewster, F. Baca, J. Burke, H. Wang	Systematic Studies of Flux Pinning of Y-Ba-Cu-O Superconductor with Nanoparticle Additions	14-Jun-11	M1OrB-04
ICMC 2011	W.A.Jones, P.N. Barnes, T.J. Haugan, M. Mullins, F. Baca, R. emergo, J. Wu, J. Clem	Effect of Bulk Pinning and Applied Field on Edge Barrier Pinning in Superconducting Thin Films	14-Jun-11	M1OrB-05
ICMC 2011	D.C. van der Laan, X.F. Lu, C.C. Clickner, L.R. Goodrich, T.J. Haugan	Compact GdBa2Cu3O7-delta coated conductor cables for electric power transmission and high-field magnet applications	17-Jun-11	M4OrB-05
General Use	W.A. Jones, M.J. Mullins, T.J. Haugan, P.N. Barnes, R.L.S. Emergy, J.L. Wu, F.J. Baca, J.R. Clem	Effects of Bulk Pinning and Applied Field on Edge Barrier Pinning		
General Use	T.J. Haugan	Search for Advanced superconductors		
MRS Spring 2011	Wesley A. Jones, Paul N. Barnes, Matthew J. Mullins, Francisco J. Baca, Rose Emergo, Judy Wu, Timothy J. Haugan, John R.	Edge Barrier Pinning in Superconducting Thin Films	27-Apr-11	VV6.11

	Clem				
MRS Spring 2011	Timothy J. Haugan, Paul N. Barnes, Joshua N. Reichart, Matthew J. Mullins, Francisco J. Baca, Eric L. Brewster	Enhancing Grain Boundary Properties of Y-Ba-Cu-O Superconductor with Nanoparticle Additions	27-Apr-11	VV6.7	
MRS Spring 2011	V. Solovyov, Q. Li, B. Maiorov, T. Haugan	Interaction between Artificial Defects and YBCO Matrix: Possible Origin of the Intrinsic Pinning	27-Apr-11	VV6.14	
MRS Spring 2011	Timothy J. Haugan, Joshua N. Reichart, Margaret Ratcliff, Matthew J. Mullins, Francisco J. Baca, Eric L. Brewster, Paul N. Barnes	Systematic Studies of FLux Pinning of Y-Ba-Cu-O Superconductor with Varying Nanoparticle Additions	28-Apr-11	VV8.5	
MRS Spring 2011	Joshua N. Reichart, Yongli Xu, Xueyan Song, Timothy J. Haugan, Victor A. Maroni, Zhijun Chen, Haiyan Wang, Michael D. Sumption, Paul N. Barnes	Flux Pinning of MOD and PLD Y1-xRExBa2Cu3O7-8 With Trace Amounts of RE = Nd and Tb Additions	28-Apr-11	VV7.8	
MRS Spring 2011	Judy Wu, Jack Shi, Rose	Strain-mediated Self-assembly of Nanostructures in	28-Apr-11	VV8.8	

	Emergo, Javier Baca, Timothy Haugan, Paul Barnes	YBCO Films: Modeling and Experiment			
MT-22 2011	D.C. van der Laan, X.F. Lu, G.E. Miller, P.D. Noyes, H.W. Weijers, T.C. Stauffer, L.F. Goodrich, T.J. Haugan	Performance of REBa2Cu3O7-z coated conductor high-field magnet cables in magnetic fields up to 20 T	14-Sep-11	3GP2-5	
NASA-AF HEDP Workshop	T. Haugan	Superconducting Power Machines U.S. Air Force	17-Feb-11	AM-5	invited
RZ STEM AirCamp Outreach	B. Razidlo, C. Ebbing, E. Savell, T. Haugan	Power Generation and Magnetic Levitation Train Demo	5-Jul-11		invited
RZ STEM AirCamp Outreach	T. Haugan, E. Brewster, C. Ebbing	Superconductivity Basic Science and Technology, and MagLev Train Demonstration	12-Jul-11	13:35	invited
RZ STEM Bring-Kids-to-Work Outreach	B. Razidlo, C. Ebbing, E. Savell, T. Haugan	Power Generation and Magnetic Levitation Train Demo	5-Aug-11		invited
U.S. Navy Applied Superconductivity Workshop	T. Haugan	High Temperature Superconducting Applications at AF	1-May-11	P-1	invited
W.P.A.F.B. WOW Outreach	E. Savell, C. Ebbing, T. Haugan	Magnetic Levitation of a Superconductor and Making Things Float !	15-Mar-11	19:00	invited
W.P.A.F.B. WOW Outreach	E. Savell, C. Ebbing, T. Haugan	Magnetic Levitation of a Superconductor and Making Things Float !	8-Mar-11	19:00	invited
W.P.A.F.B. WOW Outreach	B. Razidlo, C. Ebbing, E. Savell, T.	Power Generation and Magnetic	21-Apr-11	14:00	invited

	Haugan	Levitation Train Demo			

3.2.8 Listings for 2012

Meeting	Authors	Title	Presentation Date (exact)	Session Paper #	Invited ?
U. of Dayton, Dept. of Chemical and Materials Engineering Seminar	T. J. Haugan	Superconductivity: Basic Science to Novel Technology	1-Nov-12	2:00 PM	invited
ASC 2012	B.T. Pierce, J.L. Burke, L.B. Brunke, C.R. Ebbing, D.C. Vier, T.J. Haugan	Search for superconductivity in doped carbon thin films	8-Oct-12	1MPN-01	
ASC 2012	G.A. Levin, J. Murphy, T. Haugan, J. Souc, J. Kováč, P. Kováč	AC Losses of Copper Stabilized Multifilament Y-Ba-Cu-O Coated Conductors	9-Oct-12	2JF-02	invited
ASC 2012	L.B. Brunke, W.A. Jones, M.J. Mullins, T.J. Haugan	Experimental Investigation of the Edge Barrier Pinning Effect of Bridged Superconducting Thin Films	9-Oct-12	2MPR-07	
ASC 2012	L. Wéra, J. Fagnard, G. Levin, B. Vanderheyden, P. Vanderbemden	Magnetic shielding with YBCO coated conductors: influence of the geometry on its performances	10-Oct-12	3MPQ-06	
ASC 2012	J.P. Murphy, M.J. Mullins, P.N. Barnes, T.J. Haugan, G.A. Levin, M. Majoros, M.D. Sumption, E.W. Collings, M. Polak, P. Mazola	Calorimetric measurements of AC losses in HTS coils and tapes in a stator environment	11-Oct-12	4JE-06	

ASC 2012	D.M. Latypov, T.J. Haugan	Development of high energy density SMES devices	11-Oct-12	4LPC-07	
ASC 2012	M.P. Sebastian, J.N. Reichart, J.L. Burke, L.B. Brunke, T.J. Haugan, H. Wang, C.-F. Tsai	Optimizing Flux Pinning of YBCO Superconductor With BaSnO3+Y2O3 Dual Mixed Phase Additions	11-Oct-12	4MJ-02	
ASC 2012	T.J. Haugan, J.N. Reichart, M.P. Sebastian, M.M. Ratcliff, E.L. Brewster, J.L. Burke, L.B. Brunke, C.-F. Tsai, H. Wang	Systematic studies to enhance flux pinning of YBCO superconductor at low temperatures < 30 K	11-Oct-12	4MJ-03	
ASC 2012	T. J. Haugan, J.L. Burke, D.C. Vier, J.N. Reichart, C.R. Ebbing, P.N. Barnes, E. Morosan, M.A. Susner, M.D. Sumption	Search for Superconductivity in RE-M-C-O Oxycarbonate Compouns	12-Oct-12	5MC-04	
Materials and Mechanisms of Superconductivity (M2S 2012)	T. Haugan, B. Pierce, D. Vier, J. Burke, L. Brunke	Search for Superconductivity in Doped Amorphous Carbon Thin Films	1-Aug-12	P3-13	
Materials and Mechanisms of Superconductivity (M2S 2012)	T. Haugan, J. Reichart, P. Barnes, E. Morosan, M. Sumption , D. Vier, J. Burke, C. Ebbing	Search for Superconductivity in RE-M-C-O Oxy-carbonate Compounds	1-Aug-12	P3-14	
NASA-Glenn NRA Award Review Year 1	T. J. Haugan	AC Loss Measurement in Superconductors: Calorimetric measurement of ac losses with magnetic field	25-Jul-12	4:00 PM	invited

Ohio State Univ. Seminar	T. J. Haugan	Superconductivity : Basic Science to Novel Technology	22-May-12	2:00 PM	invited
U.S. Navy Applied Superconductivity Review	T. J. Haugan	High Temperature Superconducting Applications at AF	9-May-12	10:45 AM	invited
APS 2012	B.T. Pierce, J.L. Burke, L.B. Brunke, D.C. Vier, T.J. Haugan	Search for Advanced Superconductors: Doped Amorphous Carbon Thin Films	29-Feb-12	S1 322	
AFRL/NASA LEAPTECH 2012	T. J. Haugan	Hyperconducting and Superconducting Technologies for LEAPTECH	25-Jan-12	10:00 AM	invited
Energy Materials & Applications 2012	M.A. Sebastian, J.N. Reichart, T.J. Haugan, J.L. Burke, H. Wang, C.F. Tsai	Optimizing Flux Pinning of YBCO Superconductor With BaSnO3+Y2O3 Double Mixed Phase Additions	19-Jan-12	S8-005	
Energy Materials & Applications 2012	B.T. Pierce, A.J. Steckl, T.J. Haugan	Liquid Hydrogen for Cryogenic Cooling and Aviation Fuel Additive	20-Jan-12	S8-P028	
Energy Materials & Applications 2012	T.J. Haugan, M.A. Sebastian, J.N. Reichart, M.M. Ratcliff, B.T. Pierce, J.L. Burke, E.L. Brewster	Optimizing Nanophase Additions to YBCO Superconductor to Enhance Low Temperature Flux Pinning	19-Jan-12	S3-002	

3.2.9 Listings for 2013

Meeting	Authors	Title	Presentation Date (exact)	Session Paper #	Invited?
16th US-Japan Workshop on Advanced	T. J. Haugan	Cryogenic Technologies for Hybrid-Electric	11-Jul-13	TH 6.7	invited

Superconductors		and All-Electric Aircraft Propulsion			
16th US-Japan Workshop on Advanced Superconductors	B.T. Pierce, J.L. Burke, L.B. Brunke, C.R. Ebbing, D.C. Vier, and T.J. Haugan	Search for Superconductivity in Doped Carbon Allotropes	11-Jul-13	TH 7.1	
16th US-Japan Workshop on Advanced Superconductors	B.T. Pierce, T.J. Haugan	Sizing Study of Liquid Hydrogen Storage Vessels for Aerospace Applications	11-Jul-13	TH 7.2	
16th US-Japan Workshop on Advanced Superconductors	M.A. Sebastian, J. Reichart, J.L. Burke, C.F Tsai, H. Wang, T.J. Haugan	Optimizing Flux Pinning of YBCO Superconductor with $BaSnO_3$+Y_2O_3 Mixed Phase Additions	11-Jul-13	TH 7.3	
16th US-Japan Workshop on Advanced Superconductors	M.A. Sebastian, J. Reichart, M. Ratcliff, J.L. Burke, C.F Tsai, H. Wang, T.J. Haugan	Flux Pinning of YBa_2Cu_3O7 (YBCO) Superconductor with Ultra-Large $Y_2BaCuO5$ (Y211) Nanoparticle Additions	11-Jul-13	TH 7.4	
16th US-Japan Workshop on Advanced Superconductors	J.P. Murphy, T.J. Haugan, P.N. Barnes, M.J. Mullins, M. Polak, M.D. Sumption	Measurement of Combined AC Losses in HTS: Calorimetric Measurement of AC Losses in an External Magnetic Field	11-Jul-13	TH 7.5	
16th US-Japan Workshop on Advanced	T.J. Haugan	Cryogenic and Superconducting Technologies for	11-Jul-13	TH 7.7	

Superconductors		Hybrid-Electric Distributed Propulsion (HEDP)			
16th US-Japan Workshop on Advanced Superconductors	D. Latypov, T.J. Haugan	Development of High Energy Density SMES Devices	11-Jul-13	TH 7.8	
16th US-Japan Workshop on Advanced Superconductors	T.J. Haugan	Cryogenic and Superconducting Technologies for 3.2 MW Hybrid-Electric Aircraft Propulsion	11-Jul-13	TH 7.9	
U.S. Navy Applied Superconductivity Review	T. J. Haugan, B. Fitzpatrick	Superconductor Research and Development at AFRL/RQQ	11-Jun-13	W 1	invited
APS 2013	O.P. Isahaku,-Iranhwe, T. Haugan, A. Animalu	Searching for High-Tc Superconductivity in Low-Z, Low-Ne Materials	20-Mar-13	N35.00005	
Energy Materials & Applications 2013	J. Wu, J. Shi, R. Emergo, J. Baca, X. Wang, T. Haugan	Strain-mediated self-assembly of secondary phase nanostructures in YBCO thick films via interfacial strain engineering	23-Jan-13	EMA-S12-010-2013	invited
Energy Materials & Applications 2013	M.A. Sebastian, J.N. Reichart, M. M. Ratcliff, J.L. Burke, T.J. Haugan, H. Wang, C.F. Tsai	Flux Pinning of YBa2Cu3O7-delta Superconductor with Ultra-large Y2BaCuO5 Nanoparticle Additions	23-Jan-13	EMA-S12-P028-2013	
Energy Materials & Applications 2013	L. Brunke, W. Jones, M. Mullins, T. Haugan	Experimental Investigation of the edge barrier pinning effect of bridtged superconducting thin films	23-Jan-13	EMA-S12-P030-2013	
Energy Materials	B. Pierce,	Search for	23-Jan-13	EMA-S12-	

& Applications 2013	J.L. Burke, L.B. Brunke, C.R. Ebbing, D.C. Vier, and T.J. Haugan	Superconductivity in Doped Carbon Thin Films		P031-2013	
Energy Materials & Applications 2013	G.A. Levin, J. Murphy, T. Haugan, M. Mullins, P. Barnes, M. Majoros, M. Sumption, T. Collings, M. Polak, P. Mazola, J. Šouc, J. Kováč, P. Kováč	AC Losses of Multfilament Coated Conductors and Coils	24-Jan-13	EMA-S12-016-2013	
Energy Materials & Applications 2013	T. J. Haugan	Development of Superconduting and Cryogenic Power Systems and Impact for Aircraft Propulsion	24-Jan-13	EMA-S12-016-2013	invited

4 RESULTS – SCIENTIFIC PRESENTATIONS

4.1 Summary of Publications for Different Research Topic Categories for 11-Aug-2005 to 11-Aug-2013

A summary of publications for each research topic is given following. There was a good overall balance especially up until 2009.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	Totals
Search for New Superconductors									1	**1**
Basic Issues of YBCO Conductors	5	8	4	6	4	3	2	1	1	**34**
Flux Pinning	5	7	8	7	4	2	3	1	1	**38**
AC Loss and Stability	1	6	9	3	4	3	1		3	**30**
Fundamental Research Topics		2	3	2	2	1	1	1		**12**
Totals	**11**	**23**	**24**	**18**	**14**	**9**	**7**	**3**	**6**	**115**

4.2 Listing of Scientific Publications for 11-Aug-2005 to 11-Aug-2013

The lists of publications are given following, grouped into calendar years.

4.2.1 Listings for 2005

Journal Articles	Author(s)	Paper Title	Vol.	Page #	Year	Tech Report #
Appl. Phys. Lett.	J.Z. Wu, R.L.S. Emergo, J.Z. Wu, T. Haugan, T. A. Campbell, and P. Barnes	Tuning porosity of YBa2Cu3O7-x vicinal films by insertion of Y2BaCuO5 nanoparticles	**87**	232503-232505	2005	
Appl. Phys. Lett.	C. Varanasi, P.N. Barnes, J. Burke, J. Carpenter, T. J. Haugan	Controlled Introduction of Flux Pinning Centers in YBa2Cu3O7-x Films During Pulsed Laser	**87**	262510	2005	

		Deposition				
J. Appl. Phys.	G. A. Levin, P. N. Barnes, N. Amemiya, S. Kasai, K. Yoda, Z. Jiang, A. Polyanskii	Magnetization Losses in Multiply Connected YBa2Cu3O6+X Coated Conductors	**98**	113909	2005	
J. Mater. Res.	T. Aytug, M. Paranthaman, K.J. Leonard, H.Y. Zhai, M.S. Bhuiyan, E.A. Payzant, A. Goyal, S. Sathyamurthy, D.B. Beach, P.M. Martin, D.K. Christen, X. Li, T. Kodenkandath, U. Schoop, M.W. Rupich, T.J. Haugan, P. N. Barnes, H. E. Smith	Assessment of chemical solution synthesis and properties of $Gd_2Zr_2O_7$ thin films as buffer layers for second generation high-temperature superconductor wires	**20**	2988	2005	
Physica C	T.J. Haugan, P.N. Barnes, T.A. Campbell, A. Goyal, A. Gapud, L. Heatherly, and S. Kang	Deposition of (Y2BaCuO5/YBa2Cu3O7-x) x N multilayer films on Ni-based textured substrates	**425**	21 - 26	2005	AFRL-PR-WP-TP-2006-202
Cer. Trans.	S. Sathiraju, T. Campbell, I. Maartense, J.P. Murphy, J.C. Tolliver, G.A. Levin, T.J. Haugan T.L. Peterson, P.N. Barnes	Pulsed Laser Deposition of (Y1‑xCax)Ba2NbO6 (x = 0.0, 0.05, 0.1, 0.2, 0.4) Buffer Layers	**160**	43-50	2005	
Cer. Trans.	S. Sathiraju, C.V. Varanasi, N.A. Yust, L.B. Brunke, and P.N. Barnes	Growth of Ba2YNbO6 Buffer Layers by Pulsed Laser Deposition on Biaxially Textured Ni-alloy and Cu‑ alloy Substrates	**160**	55-62	2005	
Cer. Trans.	J.W. Kell, T.J. Haugan, P.N. Barnes, M.F.	Processing and Characterization of	**160**	15-20	2005	

	Locke, and T.A. Campbell C.V. Varanasi and L.B. Brunke	(Y1-xTbx)Ba2Cu3O7 -z Superconducting Thin Films Prepared by Pulsed Laser Deposition			
Cold Facts	A. Chaney, B.C. Harrison, T. Haugan, and P. Barnes	Educational Outreach in Air Force	**21**	9	2005
Studies of High Temperature Superconductors	T.J. Haugan, J.C. Tolliver, J.M. Evans, J.W. Kell	"Crystal Chemical Substitutions of YBa2Cu3O7-d to Enhance Flux Pinning"	**49**	193-211	2005
Functional Growth of Epitaxial Oxides, edited by Amit Goyal, Winnie Wong-Ng, Yue Kuo; Pennington, NJ : Electrochemical Society	T. Haugan, P. Barnes, R. Nekkanti, J.M. Evans, L. Brunke, I. Maartense, J.P. Murphy, A. Goyal, A. Gapud, and L. Heatherly	Deposition of (2111.0nm/12310nm) xN Multilayer Coated Conductors on Ni-based Substrates		359	2005
Appl. Phys. Lett.	J.Z. Wu, R.L.S. Emergo, J.Z. Wu, T. Haugan, T. A. Campbell, and P. Barnes	Tuning porosity of YBa2Cu3O7-x vicinal films by insertion of Y2BaCuO5 nanoparticles	**87**	232503-232505	2005
Appl. Phys. Lett.	C. Varanasi, P.N. Barnes, J. Burke, J. Carpenter, T. J. Haugan	Controlled Introduction of Flux Pinning Centers in YBa2Cu3O7-x Films During Pulsed Laser Deposition	**87**	262510	2005
Appl. Phys. Lett.	J.Z. Wu, R.L.S. Emergo, J.Z. Wu, T. Haugan, T. A. Campbell, and P. Barnes	Tuning porosity of YBa2Cu3O7-x vicinal films by insertion of Y2BaCuO5 nanoparticles	**87**	232503-232505	2005
J. Appl. Phys.	G. A. Levin, P. N. Barnes, N. Amemiya, S. Kasai, K. Yoda, Z. Jiang, A. Polyanskii	Magnetization Losses in Multiply Connected YBa2Cu3O6+X Coated Conductors	**98**	113909	2005

4.2.2 Listings for 2006

Journal	Author(s)	Paper Title	Vol.	Page #	Year	Tech Report #
Appl. Phys. Lett.	M. Polak, E. Demencik, L. Jansak, P. Mozola, D. Aized, C.L.H. Thieme, G.A. Levin, P.N. Barnes	AC losses in a $YBa_2Cu_3O_{7-x}$ coil	**88**	232501	2006	
Appl. Phys. Lett.	P.N. Barnes, J.W. Kell, B.C. Harrison, T.J. Haugan, C.V. Varanasi, M. Rane, F. Ramos	Minute doping with deleterious rare earths in $YBa_2Cu_3O_{7-\delta}$ films for flux pinning enhancements	**89**	12503	2006	
Appl. Phys. Lett.	G.A. Levin, P.N. Barnes, J.W. Kell, N. Amemiya, Z. Jiang, K. Yoda, and F. Kimura	Multifilament $YBa_2Cu_3O_{6+x}$ -coated conductors with minimized coupling losses	**89**	12506	2006	
Adv. Cryo. Eng.	Chakrapani V. Varanasi, Chuck Leon, Andrew D. Chaney, Nicholas A. Yust, Paul N. Barnes	Tensile Strength Testing of Copper Alloy Substrates for Use in Coated Conductors	**824**	758-762	2006	
Adv. Cryo. Eng.	B.C. Harrison, H. Fang, J. Carpenter, P. Klenk, C.V. Varanasi, P.N. Barnes	Sm and Nd Substitutions in YBCO Films Produced Through Metal Organic Deposition	**52**	771-776	2006	
Adv. Cryo. Eng.	G.A. Levin and P.N. Barnes	The Integration of $YBa_2Cu_3O_{6+x}$ Coated Conductors into Magnets and Rotating Machinery	**52**	433-439	2006	
Adv. Cryo. Eng.	P.N. Barnes, B.C. Harrison, J.W. Kell, G.A.	Improving YBCO Coated Conductors for	**824**	425-432	2006	

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	Levin, and M.D. Sumption	Applications			
IEEE Trans. Appl. Supercond.	M. Polak, E. Demencik, Lubomil Jansak, Elo Usak, Pavol Mozola, Cees L. H. Thieme, D. Aized, George A. Levin, Paul N. Barnes	Properties of a YBCO pancake coil operating with AC current at frequencies up to 1000 Hz	**16 (2)**	1423-1426	2006
Int. Workshop CCA, Proc.	T. J. Haugan, P. N. Barnes, T. A. Campbell, N. Pierce, J. W. Kell, M. F. Locke, S. Sathiraju, I. Maartense, R. Wheeler	Flux Pinning of YBCO with nanoparticle additions, Ca-doping, and minute-quantity chemical substitutions	**N/A**	N/A	2006
Int. Workshop CCA, Proc.	P.N. Barnes, J.W. Kell, B.C. Harrison, T.J. Haugan, J.L. Burke, and C. Varanasi	Nanoparticulate Flux Pinning Centers for $YBa_2Cu_3O7\text{-}x$ Films	**N/A**	N/A	2006
Cer. Trans.	T. J. Haugan, J. M. Evans, I. Maartense, P. N. Barnes	Superconducting Properties of (Y1-XGdX)Ba2Cu3O7-d Composites Processed in Partial Oxygen Atmospheres	**191**	99-110	2006
Cer. Trans.	Chakrapani Varanasi, Paul Barnes, Jack Burke, Gerry Landis	Ni-20%Cr Coatings on Biaxially Textured Copper and Copper-Iron Alloy Substrates for YBa2Cu3O7-x Coated Conductor Applications	**191**	111-119	2006
JPCS	M. Polak, E. Usak, L. Jansak, E. Demencik, G.A. Levin, P.N. Barnes,	Coupling losses and transverse resistivity of multifilament YBCO coated superconductors	**43**	591-594	2006

	D. Wehler, B. Moenter					
JPCS	M. Majoros, B.A. Glowacki, A.M. Campbell, G.A. Levin, P.N. Barnes	Transport AC losses in striated YBCO coated conductors	**43**	564-567	2006	
Mat. Res. Soc. Symp. Proc.	B. Craig Harrison, Joseph W. Kell, Paul N. Barnes, Timothy J. Haugan, Chakrapani V. Varanasi, Manisha V. Rane, Frank Ramos, and Iman Maartense	Pr Doped YBCO Films Produced by Pulsed Laser Deposition	**946E**	49-54	2006	
Mat. Res. Soc. Symp. Proc.	A. Lucarelli, A. Frey, R. Yang, G. Luepke, T.J. Haugan, G.A. Levin, and P.N. Barnes	Time Resolved Magneto-Optical Imaging in High Frequency AC Currents of $YBa_2Cu_3O_{7-delta}$ Thin Films	**946E**	65-70	2006	
Physica C	Chakrapani V. Varanasi, Leon Chuck, Lyle Brunke, Jack Burke, Andrew D. Chaney, Paul N. Barnes	A simplified test method to compare the yield strengths of Ni based metallic substrates under development for use in $YBa_2Cu_3O_{7-x}$ coated conductors	**52**	758-762	2006	
Supercond. Sci. Technol.	A. Lucarelli, G. Lüpke, T.J. Haugan, G.A. Levin, and P.N. Barnes	Time-Resolved Magneto-Optical Imaging of Y1Ba2Cu3O7-delta Thin Films in High Frequency AC Current Regime	**19**	667-670	2006	
Supercond. Sci. Technol.	Chakrapani V. Varanasi, P.N. Barnes, J. Burke, L	Flux Pinning Enhancement in $YBa_2Cu_3O_{7-x}$ Films with $BaSnO_3$	**19**	L37-L41	2006	AFRL-RZ-WP-TP-2008-

	Brunke, I. Maartense,T.J. Haugan, E. A.Stinzianni, K. A.Dunn, P. Haldar	Nanoparticles				2231
Supercond. Sci. Technol.	Chakrapani V. Varanasi, Paul N. Barnes, Nicholas A. Yust	Biaxially Textured Copper and Copper-Iron Alloy Substrates for Use in YBa2Cu3O7-x Coated Conductors	**19**	85-95	2006	AFRL-PR-WP-TP-2006-218
Supercond. Sci. Technol.	C.V. Varanasi, L. Brunke, J. Burke, I. Maartense, N. Padmaja, H. Efstathiadis, Chaney, P.N. Barnes	Biaxially Textured Constantan Alloy (Cu 55 wt%, Ni 44 wt %, Mn 1 wt %) Substrates for $YBa_2Cu_3O_{7-x}$ Coated Conductors	**19**	896-901	2006	
Tech Report - AFRL	P. N. Barnes, B. C. Harrison	Scientific Presentations on Superconductivity from 2002-2005			2006	AFRL-PR-WP-TM-2006-2076
Virt. J. App. Supercon.	C. Varanasi, P.N. Barnes, J. Burke, J. Carpenter, T. J. Haugan	Controlled Introduction of Flux Pinning Centers in YBa2Cu3O7-x Films During Pulsed Laser Deposition	**87**	262610-26252	2006	

4.2.3 Listings for 2007

Journal	Author(s)	Paper Title	Vol.	Page #	Year	Tech Report #
Appl. Ceramic Tech.	Paul N. Barnes	Advancing YBCO Coated Conductors for Use on Air Platforms	**4 [3]**	242-249	2007	AFRL-RZ-WP-TP-2008-2016
Appl. Phys. A - Materials Science & Processing	A. Lucarelli, A. Frey, R. Yang, G. Luepke, F. Grilli, T. Haugan, G.	AC current driven dynamic vortex state in YBa2Cu3O7-x	**88**	601-604	2007	

	Levin, P. Barnes				
Appl. Phys. Lett.	S. I. Kim, F. Kametani, Z. Chen, A. Gurevich, T. Haugan, P. Barnes, and D. C. Larbalestier	On The Through-Thickness Critical Current Density of a YBCO Film Containings a High Density of Insulating, Vortex-Pinning Nano-precipitates	**90 (25)**	252502	2007
Book Chapter in "Flux Pinning and AC Loss Studies on YBCO Coated Conductors"	G.A. Levin and P.N. Barnes	Second Generation Superconducting Wires For Power Applications	**Ch.15**	299-327	2007
Book Chapter in "Flux Pinning and AC Loss Studies on YBCO Coated Conductors"	T. J. Haugan	In-Situ Approach to Introduce Flux Pinning in YBCO	**Ch.15**	59-77	2007
IEEE Trans. Appl. Supercond.	Paul N. Barnes, Joseph W. Kell, Brandon C. Harrison, Timothy J. Haugan, Jack L. Burke, and Chakrapani V. Varanasi	Nanoparticulate Flux Pinning Centers for $YBa_2Cu_3O_{7-\delta}$ Films	**17(2)**	3717-3719	2007
IEEE Trans. Appl. Supercond.	T.J. Haugan, P.N. Barnes, T.A. Campbell, N.A. Pierce, F.J. Baca, I. Maartense	Flux pinning of Y-Ba-Cu-O Films Doped with $BaZrO_3$ Nanoparticles by Multilayer and Single Target Methods	**17(2)**	3724-3728	2007
IEEE Trans. Appl. Supercond.	E. Demencik, P. Usak, M. Polak,	Hall probe based system for study of AC transport current	**17(2)**	3175-3178	2007

	Bratislava, Slovakia; G.A. Levin, P.N. Barnes	distribution in YBCO coated conductors at frequencies up to700 Hz			
IEEE Trans. Appl. Supercond.	B. Maiorov, Q.X. Jia, H. Zhou, H. Wang, Y. Li, A. Kursunovic, J.L. MacManus-Driscoll, T. Haugan, P.N. Barnes, S.R. Foltyn, and L. Civale	Effects of the Variable Lorentz Force on the critical current in anisotropic superconducting thin films	**17(2)**	3697-3700	2007
IEEE Trans. Appl. Supercond.	M. Polak, J. Kvitkovic, P. Mozola, P.N. Barnes, G.A. Levin	Characterization of individual filaments in a multifilamentary YBCO coated conductor	**17(2)**	3163-3166	2007
IEEE Trans. Appl. Supercond.	G.A. Levin, P.N. Barnes, N. Amemiya,	Low ac Loss Multifilament Coated Conductors	**17(2)**	3148-3150	2007
IEEE Trans. Appl. Supercond.	C. Kwon, J. L. Young, R. G. James, George Levin, Timothy J. Haugan, and Paul N. Barnes	Local Current Transport and Current Sharing Between Filaments in Striated Coated Conductors with Artificial Defects	**17(2)**	3191-3194	2007
IEEE Trans. Appl. Supercond.	Chakrapani Varanasi, Vijay Nalladega, S. Sathish, Timothy Haugan, and Paul N. Barnes	Use of Ultrasonic Force Microscopy to Image the Interior Napnoparticles in YBa2Cu3O7-x Fims	**17(2)**	3709-3712	2007
J. Appl. Phys.	C. Kwon, J. L. Young, R. G. James, George Levin, Timothy J. Haugan, and Paul N. Barnes	Effects of Local Artificial Defects in Mulit-filamentary Coated Conductors with Patterned Links	**101(8)**	083908/1-6	2007
J. Appl. Phys.	C. V. Varanasi, J. Burke, L.	Enhancement and Angular	**102**	63909/1-5	2007

	Brunke, H. Wang, M. Sumption, P. N. Barnes	Dependence of Transport Critical Current Density in Pulsed Laser Deposited $YBa_2Cu_3O_{(7-X)}$ + BaSnO3 Films in Applied Magnetic Fields				
J. Electr. Mat.	Chackrapani Varanasi, Leon Chuck, Lyle Brunke, Jack Burke, Andrew D. Chaney, and Paul N. Barnes	Yield Strengths of Bi-axially Textured Metallic Substrates (Ni and its alloys) Determined by Using a Simplified Test Method	**36 (10)**	1265-1269	2007	
J. Electr. Mat.	Rongtao Lu, Judy Z. Wu, Chakrapani Varanasi, Jack Burke, Iman Maartense, and Paul N. Barnes	Textured Ion-Beam Assisted Deposition: Magnesium Oxide Template on Non-Metallic Flexible Ceraflex for Epitaxial Growth of Perovskite Films	**36(10)**	1258-1264	2007	
J. Electr. Mat.	T. Haugan, P. Barnes, T. Campbell, N. Pierce, F. Baca, M. Locke	Superconducting Properties of (Mx/YBa2Cu3o7-delta y) N Multilayer Films with Variable Layer Thickness x	**36(10)**	1234-1242	2007	
Supercond. Sci. Technol.	E. Demencik, P. Usak, S. Takacs, I. Vavra and M. Polak	Visualization of Coupling Current Paths in Striated YBCO Coated Conductors at Frequencies up to 400 Hz	**20**	87-91	2007	AFRL-RZ-WP-TP-2008-2232
Supercond. Sci. Technol.	George A. Levin, Paul N. Barnes, and John S. Bulmer	Current Sharing Between Surperconducting Film and Normal Metal	**20**	757-764	2007	
Supercond. Sci. Technol.	George A. Levin, and Paul N. Barnes	Normal Zone in $YBa_2Cu_3O_{(6+x)}$ - Coated	**20**	1101-1107	2007	

		Conductors				
Supercond. Sci. Technol.	C.V. Varanasi, P.N. Barnes, J. Burke,	Enhanced Flux Pinning Force and Uniquely Shaped Flux Pinning Force Plots Observed in $YBa_2Cu_3O_{7-x}$ Films with $BaSnO_3$	**20**	1-5	2007	
Supercond. Sci. Technol.	M. Polak, E. Demencik, J. Kvitkovic, G.A. Levin, and P.N. Barnes	The Current Distribution in a Striated YBCO Tape Subjected to Both Magnetization and a Transport Current	**20**	994-1001	2007	
Supercond. Sci. Technol.	M. Polak, J. Kvitkovic, P. Mozola, E. Usak, P.N. Barnes, and G.A. Levin	Frequency Dependence of Hysteresis Loss in YBCO Tapes	**20**	S293-S298	2007	

4.2.4 Listings for 2008

Journal	Author(s)	Paper Title	Vol.	Page #	Year	Tech Report #
Appl. Phys. Lett.	J. Wang, J. Kwon, J. Yoon, H. Wang, T.J. Haugan, F.J. Baca, N.A. Pierce, and P.N. Barnes	Flux pinning in YBa2Cu3O7−delta thin film samples linked to stacking fault density	**92**	82507	2008	AFRL-RZ-WP-TP-2008-2258
Appl. Phys. Lett.	George A. Levin , Paul N. Barnes, John Murphy, Lyle Brunke, J. David Long, John Horwath,	Persistent Current in Coils Made out of YBCO-coated Conductors	**93**	62504	2008	AFRL-RZ-WP-TP-2008-2243

	and Zafer Turgut					
Appl. Phys. Lett.	J.Z. Wu, R.L.S. Emergo, Z. Wang, G. Xu, T. J. Haugan, and P. N. Barnes	Strong Nanopore pinning enhances J_c in $YBa_2Cu_3O_{7-delta}$ films	**93**	062506	2008	
Appl. Phys. Lett.	C.V. Varanasi, J. Burke, H. Wang, J.H. Lee , P.N. Barnes	Thick YBaCuO+BaSnO films with enhanced critical current density at high magnetic fields	**93**	92501	2008	AFRL-RZ-WP-TP-2008-2241
IEEE Int. Symp. Appl. Ferroelectrics	J. Wang, J. Kwon, J. Yoon, H. Wang, T.J. Haugan, F.J. Baca, N.A. Pierce, and P.N. Barnes	Deposition temperature dependence of YBCO transport properties	**2**	NA008-1	2008	
IEEE Trans. Appl. Supercond	M. Polak, P.N. Barnes, J. Kvitkovic, G.A. Levin, P. Mozola, and P. Usak	Properties of an experimental coil wound with YBCO coated conductor carrying an AC current with frequencies up to 864 Hz	**18**	1240-1244	2008	
IEEE Trans. Appl. Supercond.	P. Usak, M. Polak, J. Kvitkovic, P. Mozola, P.N. Barnes, G.A. Levin,	Current Distribution in the Winding of a Superconducting Coil	**18**	1597-1600	2008	
Power and Energy Society General Meeting - Conversion and Delivery of Electrical	P. Barnes, G. Levin, E. Durkin	Superconducting Generators for Airborne Applications and YBCO Coated Conductors	**27**	1-4	2008	AFRL-RZ-WP-TP-2008-2245

Energy in the 21st Century, IEEE Proceedings						
J. Mater. Res.	C.V. Varanasi, J.Burke, L. Brunke, H. Wang, J.H. Lee, P.N. Barnes	Critical current density and microstructure variations in YBaCuO + BaSnO films with different concentrations of BaSnO	**23**	3363-3369	2008	
J. Appl. Phys.	C. Varanasi, J. Burke, P. Barnes	Thick $YBa_2Cu_3O_{7-x}$ + Films with Enhanced Critical Current Density at High Magnetic Fields	**93**	92501	2008	AFRL-RZ-WP-TP-2008-2241
Phys. Rev. B	M.D. Sumption, T.J. Haugan, P.N. Barnes, T.A. Campbell, N.A. Pierce, and C.Varanasi	Magnetization creep and decay in $YBa_2Cu_3O_{7-x}$ thin films with artificial nanostructure pinning	**77**	94506	2008	
Phys. Rev. B	J.P. Rodriguez, P.N. Barnes, and C.V. Varanasi	In-field critical current of type-II superconductors caused by strain from nanoscale columnar inclusions	**78**	52505	2008	
Physica C	C. V. Varanasi, J. Burke, R. Lu, J. Wu, L. Brunke, L. Chuck, H. E. Smith, I. Maartense, and P. N. Barnes	Biaxially Textured $YBa_2Cu_3O_{7-x}$ Films Deposited on Polycrystalline Flexible Yttria-Stabilized Zirconia Ceramic Substrates	**468**	1070-1077	2008	AFRL-RZ-WP-TP-2008-2242
SAE Int. J. Aerosp.	T. J. Haugan, J. D. Long,	Design of Compact Lightweight Power	**1(1)**	1088-1094	Apr. 2009	

	L.A Hampton, and P.N. Barnes	Transmission Devices for Specialized High Power Applications			
Supercond. Sci. Technol.	A. Lucarelli, A. Frey, R. Yang, G. Lupke, T.J. Haugan, G.A. Levin, and P.N. Barnes	Dynamic investigation of the transport current in YBa2Cu3O7−δ thin films	**21**	115003	2008
Supercond. Sci. Technol.	T.J. Haugan, T.A. Campbell, N.A. Pierce, M.F. Locke, I. Maartense, and P.N. Barnes	Microstructural and Superconducting Properties of (Y1-xEux)Ba2Cu3O7-δ Thin Films: x = 0 to 1	**21**	25014	2008
Supercond. Sci. Technol.	R.A. Kleismit, A.L Campbell, G. Kozlowski, T.J. Haugan, R.R. Biggers, I. Maartense, S.C. Hopkins, P. Barnes, and T.L. Peterson	Electromagnetic characterization of YBa2Cu3O7-δ thin films with calcium doping for bi-crystal grain boundary conductivity enhancement	**21**	35008	2008
Supercond. Sci. Technol.	R.L.S Emergo, J.Z. Wu, T.J. Haugan, and P.N. Barnes	Anisotropy of the resistivity and critical current density of porous vicinal YBa2Cu3O7−δ films	**21**	085008	2008

4.2.5 Listings for 2009

Journal	Author(s)	Paper Title	Vol.	Page #	Year	Tech Report #
Appl. Phys. Lett.	F. J. Baca, P. N. Barnes, R. L. Emergo, T. J. Haugan, J. N. Reichart, and J. Z. Wu	Control of BaZrO3 Nanorod Alignment in YBa2Cu3O7-x Thin Films by Microstructural Modulation	**94**	102512	2009	AFRL-RZ-WP-TP-2010-2091
IEEE Trans. Appl. Supercond.	F. J. Baca, R. L. Emergo, J. Z. Wu, T. J. Haugan, J. N. Reichart, and P. N. Barnes,	Microstructural Characterization of YBa2Cu3O7 Films with BaZrO3 Nanorods Grown on Vicinal SrTiO3 Substrates	**19**	3371-3374	2009	AFRL-RZ-WP-TP-2010-2082
IEEE Trans. Appl. Supercond.	T. J. Haugan, F. J. Baca, M. J. Mullins, N. A. Pierce, T. A. Campbell, E. L. Brewster, P .N. Barnes, H.Wang, M. D. Sumption	Temperature and Magnetic Field Dependence of Critical Current Density of YBCO with Varying Flux Pinning Additions	**19**	3270-3274	2009	AFRL-RZ-WP-TP-2010-2083
IEEE Trans. Appl. Supercond.	C. Varanasi, J. Burke, L. Brunke, J Lee, H. Wang, P. Barnes	Comparative Study Between Similarly Processed YBa2Cu3O7-x Films with Y2BaCuO5 or BaSnO3 Additions	**19**	3152-3155	2009	
IEEE Transactions on Applied Superconductivity	Milan Polak, Paul N. Barnes, Pavol Mozola, and George A. Levin	Critical Current in YBCO Coated Conductors in the Presence of a Macroscopic Defect	**19**	2921-2924	2009	AFRL-RZ-WP-TP-2010-2084
IEEE Transactions on Applied Superconductivity	George A. Levin, Paul N. Barnes, Jose P. Rodriguez,	Stability and normal zone propagation speed in	**19**	2504-2507	2009	AFRL-RZ-WP-TP-2010-

	Jake A. Connors, and John S. Bulmer	YBCO coated conductors with increased interfacial resistance				2085
J. Appl. Phys.	A. Lucarellil, R. Yang, F. Grilli, T. Haugan, P. Barnes, G. Lupke	Dynamic Field and Current Distrubutions in Mulilt-Filamentary YBa2Cu3O7-d Thin Films with Magnetic Coupling	**106**	063904	2009	AFRL-RZ-WP-TP-2010-2088
J. Mater. Res	S. Sathiraju, P.N. Barnes, R.A. Wheeler	Formation of the YBa2Cu2NbOy phase in thin films	**24**	212-216	2009	AFRL-RZ-WP-TP-2010-2086
High Temperature Superconductors, Book Chapter	C.V. Varanasi, P.N. Barnes	Flux Pinning Enhancement in YBa2Cu307-x Films for Coated Conductor Applications	**Ch. 5**	105-128	2009	
Phys. Rev. E	G. A. Levin, P. N. Barnes, J. P. Rodriguez*, J. A. Connors** and J. S. Bulmer	Emergence of dissipative structures in current-carrying superconducting wires	**79 (5)**	056224-1 - 056224-11	2009	AFRL-RZ-WP-TP-2010-2087
Phys. Rev. L	D.C. van der Laan, T.J. Haugan and P.N. Barnes	Effect of compressive uni-axial strain on the Critical current Density of Grain Boundaries in Superconducting YBa2Cu3O7-δ	**103**	027005	2009	AFRL-RZ-WP-TP-2010-2092
Physica C	P.N. Barnes, F. J. Baca, T.J. Haugan, J. Burke, C.V. Varanasi, R. L. Emergo, J. Z. Wu, R. Wheeler, F. Meisenkothen, S. Sathiraju	Inducing self-assembly of Y2BaCuO5 nanoparticles via Ca-doping for improved pinning in YBa2Cu3O7-x	**469**	2029-2032	2009	AFRL-RZ-WP-TP-2010-2089
Supercond. Sci.	M. Polak, S.	Effect of	**22**	025016	2009	

Technology	Takacs, P. N. Barnes, G. A. Levin	resistive filament interconnections on coupling losses in filamentary YBa2Cu3O7 coated conductors				
Supercond. Sci. Technology	A. Lucarelli, F. Grilli, G. Lüpke, T. J. Haugan, P.N. Barnes	Finite-element simulations of field and current distributions in multifilamentary superconducting films	**22**	105015	2009	AFRL-RZ-WP-TP-2010-2090
WSTIAC Quarterly	L. Hampton, P.N. Barnes, T.J. Haugan, G.A. Levin, E. Durkin	Compact Superconduting Power Systems for Airborne Applications	**9(1)**	75-77	2009	AFRLI-RZ-WP-TP-2010-2061

4.2.6 Listings for 2010

Journal	Author(s)	Paper Title	Vol.	Page #	Year	Tech Report #
Appl. Physics Letters	Wesley A Jones, P.N. Barnes, M.J. Mullins, F.J.Baca, R.L.S. Emergo, J. Wu, T.J. Haugan, and J.R. Clem	Impact of edge-barrier pinning in superconducting thin films	**97**	262503	2010	Appl. Physics Letters
M.S. Thesis, U. of Dayton Dept. of Mechanical Engineering	Matthew J. Mullins	Verification of AC Hysteretic Thermal Losses of a Superconducting Tape Device Using a Novel Calibration Method			2010	M.S. Thesis, U. of Dayton Dept. of Mechanical Engineering
PH.D. Dissertation, U. of Kansas Dept. of Physics	F.J.A. Baca	In-situ Control of BaZrO3 and BaSnO3 Nanorod Alighment and Microstructure in YBa2Cu3O7-x	**UMI 3396415**		2010	PH.D. Dissertation, U. of Kansas Dept. of Physics

		Thin Films by Strain Modulated Growth				
Adv. Cryogenic Engineering Materials	J. Burke, C.V. Varanasi, L. Brunke H. Wang, J.H. Lee, P.N. Barnes	Microstructure and critical curent Density of YBa2Cu3O7-x + BaSnO3 Thick Films Grown with Pre-Mixed Pulsed Laser Ablation Target	**56**	355-361	2010	Adv. Cryogenic Engineering Materials
Adv. Cryogenic Engineering Materials	C. V. Varanasi, J. Reichart, J. Burke, L. Brunke, J. H. Lee, H. Wang, M. Susner, M. Sumption, P.N. Barnes	Second Phase (BaGeO3, BaSiO3) Nanocolumns in YBa2Cu3O7-x Films	**56**	362-369	2010	Adv. Cryogenic Engineering Materials
Adv. Cryogenic Engineering Materials	M. Polak, P.Mozola, P.N.Barnes,and G.A.Levin	The Effect Of A Filament Interruption On Current-Voltage Curves And Critical Currents Of Filamentary YBCO Tapes With Superconducting Bridges	**56**	380-387	2010	Adv. Cryogenic Engineering Materials
Proceedings 2012 20th International Conf. Electrical Machines, IEEE Conf.	M. Lokhandwalla, K.S. Haran, J.P. Alexander	Scaling Studies of High Speed High Temperature Superconducting Generator	**ISBN 978-1-4673-0142-8**	751	2012	Proceedings 2012 20th International Conf. Electrical Machines, IEEE Conf.
J. Appl. Phys.	J.F. Fagnard, M. Dirickx, B. Vanderheyden, P. Vanderbemden, G.A. Levin, and P.N. Barnes	Use of 2G coated conductors fof efficient shielding of DC magnetic fields	**108**	013910	2010	J. Appl. Phys.
Physica C	R. Goswami, T.J. Haugan, P.N. Barnes, G. Spanos, R.L. Holtz	Effects of Nanoscale Defects on Critical Current Density of (Y1-	**470**	318	2010	Physica C

		xEux)Ba2Cu3O7-delta Think Films				
Supercond Sci. Technology	D.C. van der Laan, T. J. Haugan, P.N. Barnes, D. Abraimov, F. Kametani, D.C. Larbalestier, M.W. Rupich	The effect of strain on grains and grain boundaries in YBa2Cu3O7-delta coated conductors	**23**	14004	2010	Supercond Sci. Technology
Supercond Sci. Technology	G. Levin, K. Novak, P. Barnes	The Effects of Superconductor-Stabilizer Interfacial Resistance on the Quench of a Current-Carrying Coated Conductor	**23**	14021	2010	Supercond Sci. Technology

4.2.7 Listings for 2011

Journal	Author(s)	Paper Title	Vol.	Page #	Year	Tech Report #
Ceramic Transactions ACerS	F. J. Baca, P.N. Barnes, T. J. Haugan, C.V. Varanasi, R. L. Emergo, J. Z. Wu	Altering Self-Assembly of second phase additions in $YBa_2Cu_3O_{7-x}$ for pinning enhancement	**226**	119-127	2011	
IEEE Transactions on Applied Superconductivity	R. Lu, C. Christianson, J. Dizon, J. Wu, T. Haugan, P. Barnes, and F. J. Baca	Investigation of Dynamic Behaviors of Low-Level Dissipation at YBa2Cu3O7 Grain Boundaries Using Low-Temperature Near-Field Scanning Microwave Microscopy	**21(3)**	3238	2011	
IEEE Transactions on Applied	E. Cimpoiasu, T. J.	Effect of Oxygen Depletion on the Pinning	**21(3)**	3218	2011	

Superconductivity	Haugan, C. V. Varanasi, G. A. Levin, and P. N. Barnes	Properties of YBa2Cu3Ox Films with Nanoinclusions				
IEEE Transactions Applied Superconductivity	W.K. Chan, J. Schwartz	Three-Dimensional Micrometer-scale	**21(6)**	3628	2011	
Materials Research Society E-Proceedings	J.N. Reichart, E.L. Thomas, T.J. Haugan, X. Song, B. M. Ruter-Schoppman, P.N. Barnes	Optimization of minute doping of Y1-xRExBa2Cu3O7-? thin films with RE = Tb and Nd	**1254**	1254-L06-08	2010	
Physical Review B	Sung Hun Wee, Eliot D. Specht, Claudia Cantoni, Yuri L. Zuev, Victor Maroni, Winne Wong-Ng, Timothy J. Haugan, and Amit Goyal	Formation of stacking faults and their correlation with flux-pinning and critical current density for Sm-doped YBa2Cu3O7-δ films	**83**	224520	2011	
Superconductor Science & Technology	G.A. Levin, W.A. Jones, K.A. Novak, P.N. Barnes	The effects of Superconductor-Stabilizer Interfacial Resistance on quenching of a pancake coil made out of coated conductors	**24**	035015	2011	

4.2.8 Listings for 2012

Journal	Author(s)	Paper Title	Vol.	Page #	Year	Tech Report #
Journal Applied Physics	D. Latypov, J. Bulmer	Radiation and near field in	**111**	114907	2012	

		resistance-inductor circuit transients				
Phys. Rev. B	V.F. Solovyov, Q Li, W. Si, B. Maiorov, T.J. Haugan, J.L. MacManus-Driscoll, H. Yao, Q.X. Jia, E.D. Specht	Influence of defect-induced biaxial strain on flux pinning in thick YBa2Cu3O7 layers	**86**	94511	2012	
Superconductivity Science & Technology	D.C. van der Laan, L.F. Goodrich, T.J. Haugan	High-current dc-power transmission in flexible RE-Ba2Cu3O7-delta coated conductor cables	**25**	014003	2011	

4.2.9 Listings for 2013

Journal	Author(s)	Paper Title	Vol.	Page #	Year	Tech Report #
IEEE Transactions on Applied Superconductivity	G.A. Levin, J. Murphy, T.J. Haugan, J. Šouc, J. Kováč, P. Kováč	AC Losses of Copper Stabilized Multifilament YBCO Coated Conductors	**23(3)**	6600604	2013	
IEEE Transactions on Applied Superconductivity	M.P. Sebastian, J.N. Reichart, J.L. Burke, L.B. Brunke, T.J. Haugan, H. Wang, C.-F. Tsai	Optimizing Flux Pinning of YBCO Superconductor With BaSnO3+Y2O3 Dual Mixed Phase Additions	**23(3)**	8002104	2013	
IEEE Transactions on Applied Superconductivity	J.P. Murphy, M.J. Mullins, P.N. Barnes, T.J. Haugan, G.A. Levin, M.	Experimental setup for calorimetric measurements of AC losses in HTS	**23(3)**	4701505	2013	

	Majoros, M.D. Sumption, E.W. Collings, M. Polak, P. Mazola	samples due to AC current and external magnetic fields			
IEEE Transactions on Applied Superconductivity	L. Wéra, J. F. Fagnard, G. A. Levin, B. Vanderheyden, and P. Vanderbemden	Magnetic Shielding With YBCO Coated Conductors: Influence of the Geometry on Its Performances	**23(3)**	8200504	2013
IEEE Transactions on Applied Superconductivity	B.T. Pierce, J.L. Burke, L.B. Brunke, T.J. Bullard, D.C. Vier, T.J. Haugan	Search for Superconductivity in Doped Amorphous Carbon Films	**23(3)**	7000205	2013
Advanced Functional Materials	F.J. Baca, T. Haugan, P. Barnes, T. Holesinger, B. Maiorov, R. Lu, X. Wang, J. Reichart, J. Wu	Interactive Growth Effects of Rare-Earth Nanoparticles on Nanorod Formation in YBa2Cu3Ox Thin Films	**23(38)**	4826	2013

5 CONCLUSIONS

The RQQM research team contributed significantly to the scientific research community in the research topics described in this report. For example, a first publication on flux pinning in 2004 [T. Haugan, et al, *Nature*, v. 430, p. 867, 2004], is acknowledged as the first publication demonstrating strong increase of flux pinning from inclusion of nanoparticles into YBCO thin films, and has been cited over 300 times so far. The RQQM research team continued this avenue of research from 2005-2013, publishing an additional thirty-eight papers in this field, that studied and optimized new types of pinning mechanisms. As a consequence of world-wide research on flux pinning, very significant improvement of J_e were achieved which significantly improves performance and/or reduce refrigeration costs for power system devices such as gyrotron magnets and power transmission cables.

6 RECOMMENDATIONS

The development of new materials and improved conductors would have large positive impact for applications. As an example, the use of liquified-natural-gas (LNG) stored at 112 Kelvin (K) temperature is being implemented into many industries such as truck transportation and ship power, and is being tested for aircraft since it is approximately two times lower cost gas than other aviation fuels such as JP-8 jet-fuel. If utilized on aircraft, LNG could provide almost unlimited and free cooling to allow superconductors to operate, if superconducting wire conductors could be developed to operate above 112 K.

While there has been emphasis on developing new materials and conductors in the decade of 2000-2010, what is mostly lacking now is detailed study of applications and power system components, and the technological readiness level (TRL) of many cryogenic/superconducting components is still < 5 for airborne or specific power levels.

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ACRONYM	DESCRIPTION
AC	Alternating Current
AF	Air Force
AFB	Air Force Base
AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratory
B	Magnetic Field
BCS	Bardeen-Cooper-Schrieffer (Theory)
BSCCO	Bi-Sr-Ca-Cu-O
Bi-2212	$Bi_2Sr_2CaCu_2O_{8-z}$
Bi-2223	$Bi_2Sr_2Ca_2Cu_3O_{10-z}$
BSO	Ba-Sr-Ti-O
BZO	Ba-Zr-O
CORC	Cable-on-round-conductor
DE	Directed Energy
DOE	Department of Energy
FY	Fiscal Year
GB	Grain Boundary
H	Magnetic Inductance [T]
IEEE	Institute of Electrical and Electronics Engineers
I_c	Critical Current [A]
J_c	Current Density [A/cm^2]
J_e	Engineering Current Density [A/cm^2]
LNG	Liquified Natural Gas
MW	Megawatt
MOCVD	Metal Organic Chemical Vapor Deposition
MOD	Metal-Organic-Deposition
MRI	Magnetic Resonance Imaging
NHFML	National High Magnetic Field Laboratory
NIST	National Institute of Standards and Technology
Q	Heat [Watts]
RQ	Aerospace Systems Directorate
RQQ	Power and Controls Division
RQQM	Mechanical and Thermal Systems Branch
RRR	Residual-resistivity-ratio
SAM	Spin-around-magnet
SEM	Scanning Electron Microscopy
SBIR	Small Business Innovative Research
SMES	Superconducting Magnetic Energy Storage
STTR	Small Business Technology Transfer Research
TEM	Transmission Electron Microscopy
T_c	Superconducting Transition Temperature
U	Potential Energy
YBCO	Y-Ba-Cu-O or $YBa_2Cu_3O_{7-z}$
Y211	Y_2BaCuO_{5-z}