Project Title:	Systematic Evaluation of Jc Decrease in Thick Film Coated Conductors
Organization(s):	**University of Houston**
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FY 2004 Funding:	$75 K

Project Purpose and FY 2004 Objectives: The original objectives of the project were significantly curtailed due to budget reductions. The purpose of this project however, remains as addressing the thickness dependence of Jc, in thick film YBCO coated conductors. To accomplish this we are fabricating and characterizing a series of thick film YBCO samples (from 0.5 to 8 μm thickness) on oxide and RABiTS substrates by high growth rate photo-assisted MOCVD. The oxide substrates, although not commercially viable, play an important role in helping to better elucidate the Jc vs. thickness problem by partially eliminating the question of quality of cube texturing of the substrate.

The FY-04 objectives of the project under its significantly reduced scope from the original proposed work are to fabricate a series of thick YBCO samples (from 1μm to 8 μm) on $LaAlO_3$ substrates. This objective was fully met with over 20 different samples of thick film YBCO made ranging in thickness from 1.5 μm to 15 μm.

FY-04 Performance and FY 2005 Plan: Thick YBCO film growth yielded a series of YBCO films with thicknesses mainly from 3 to 10 μm thickness. Some thinner films were grown as were several films of up to 15 μm thickness. The YBCO films were grown by photo-assisted MOCVD on $LaAlO_3$ (LAO) substrates utilizing both single precursor liquid source delivery and multiple precursor solid source delivery. Both systems gave similar quality films and both have been able to grow thick films. The growth rates used were conservative at about 0.2 – 0.3 μm per minute. Higher growth rates have previously been shown to be effective, and will be used in future work.

The intriguing part of the work is that the thick film samples grown by photo-assisted MOCVD have all exhibited extremely high crystalline quality. SEM micrographs for nominally 10 μm thick YBCO samples show high film density throughout the film thickness with a minimum of observed macro-defects. XRD data reveals a high degree of atomic ordering both in plane and out of plane as shown by pole figure data with a FWHM of ~1.5^o. Selected are electron diffraction data show extremely high crystalline quality YBCO and excellent crystalline orientation between the YBCO and the $LaAlO_3$ substrate. TEM bright field data indicates some stacking faults at the YBCO-substrate interface with, however, a sharp interface between the YBCO and the substrate. In addition, the top surface of the YBCO samples is seen to be well structured with no defects, supporting the SEM data of high-density YBCO films. Such data indicating extremely high crystalline quality YBCO films is not unexpected for growth of YBCO on crystalline oxide substrates, although this has not been previously exhibited for such thick film samples. The Jc data for these high quality thick films, however, is consistently low: ~ 2 – 5 x 10^5 A/cm^2. The high degree of crystalline quality, the high film density and the absence of voids and large defects in the films indicate that poor film microstructure cannot be responsible for the low Jc values. However, on the other hand, the extremely high crystalline quality of the MOCVD-grown films may be responsible for the low Jc through the lack of pinning centers in the films much like in high quality single crystal bulk samples, i.e., the photo-assisted MOCVD YBCO films are too good.

FY 2005 Plan: The FY-05 plan will e modified to add to the proposed schedule of further characterization of thick films grown on oxide substrates and extending thick film growth to metal substrates, the attempt at several approaches to increase pinning centers in the MOCVD–grown thick films. These will be done in collaboration with groups that have studied pinning center enhancement in bulk YBCO materials by radioactive decay techniques, and those that have expertise in pinning center generation by ion implantation techniques. It is expected that this additional effort will not only help clarify the supposition of too good of crystalline quality for MOCVD grown thick YBCO films, but also

will identify viable approaches to enhance pinning and hence Jc in thick film YBCO for use in commercial coated conductor wire fabrication. This additional reprogramming of effort in FY-05 is expected to be accommodated under additional industry support, and under a request for additional government funds.

Research Integration: The advancement of MOCVD processing for coated conductor applications has been closely integrated from the beginning with industry through a partnership with Metal Oxide Technologies Inc. (MetOx). We have successfully transferred the photo-assisted MOCVD growth technology to MetOx for wire development, and have continued to transfer technology to MetOx for advancement of their coated conductor wire effort. We will within this program, move the thick film YBCO growth and optimization technology to MetOx, and under partial funding support from MetOx will work toward identifying commercially viable techniques for enhancing Jc in MOCVD-grown YBCO coated conductors.

ORNL: We will begin to supply thick film samples to ORNL for additional microstructure characterization and corroboration of HTS properties, and will fabricate and send for characterization, thick film YBCO samples on RABiTS substrates supplied by ORNL. In addition, we expect to jointly investigate increased pinning techniques for YBCO thick films.