

# Session III

## Flux Pinning and Thick YBCO

Increase critical currents at field, temperature, and orientation

- Status
- Needs
- Progress and new directions

# AMSC

- Ic development focused on cable, motor and military applications
- 380A/cm-w achieved in 1.4  $\mu\text{m}$  YBCO at 77K, sf
- Nanodot added to YBCO to improve in-field performance
- Ho nanodot addition into 1.4  $\mu\text{m}$  YBCO reaches  $> 100\text{A/cm-w}$  at 65K, 3T
- $J_c$  of 2G wire w/Ho nano-additions (0.8  $\mu\text{m}$  YBCO) exceeds that of 1G at 27K

# SuperPower

- Advantage: High throughput due to high deposition rates and large deposition zone.
- Short term stability of MOCVD process improved
- Multipass process developed for YBCO deposition
- $I_c$  of
  - 104 A/cm<sup>2</sup> achieved over 97m (10000 A.m milestone)
  - 206 over 8.25 m
  - 265 A over 1 m
  - 407 A over 0.07m
- Transitioning to MgO IBAD
  - 193 A/cm<sup>2</sup> achieved over 1m

# ORNL

- BZO added to PLD YBCO
  - Self-assembled stacks of nano-dots along c axis (columnar defects)
  - Significant enhancement in  $J_c$  for H//c. Lower  $\alpha$
  - Maximum effect at 4%(v/o)
- Fast conversion of ex situ BaF2 precursor  $I_c > 350\text{A/cm}$ 
  - Y2O3 doping increases  $I_c$  to 400A/cm
  - improved field performance over wide range of angles

# LANL

## 2 ways to increase $J_c$ in the $H^{-\alpha}$ regime

- Decrease  $\alpha$  by:
  - Interface modification (STO outgrowths) ( $\alpha \sim 0.4$ )
  - BZO nano-particles: ( $\alpha \sim 0.3$ )  
Large c-axis peak due to dislocations starting at nanoparticles.  $I_c(65K, 3T//c) = 132 \text{ A/cm}$ .
- Increase  $J_c$  self field
  - YBCO/CeO<sub>2</sub> multilayer:  
 $I_c(75K, sf) = 880 \text{ A/cm}$   
 $I_c(75K, 1T) = 116 \text{ A/cm (H//c); } 102 \text{ A/cm (worst orientation)}$

# BNL

- Processing and properties of ex situ PVD BaF<sub>2</sub> YBCO films
- Experiments and modeling to understand the nucleation and growth
  - Randomly oriented, (103), grains are more deleterious in thick films
    - Formation and growth are inter-related
  - Approaches to enhance c-axis nucleation
    - Faster growth rate + dense array of c-axis nuclei
    - Uniform substrate surface acts as catalyst
- Achieved  $J_c = 3.8 \times 10^5$  A/cm<sup>2</sup> in 1 T, for 3 μm

# ANL

- Described possible sources of flux pinning
  - Surfaces at large defects and interfaces
  - Strain around point and line defects
  - Unseen defects (“dark matter”)
- Approaches to study pinning sources and mechanisms
  - Basic calculations
  - Lattice strains by X-ray/neutrons diffuse scattering
  - New TEM techniques for defect identification
  - Local atomic environment: XAFS; optical spectroscopies: crystal field effects (good for 4f elements)