



All-MOCVD Technology for YBCO Layer/Buffer Layer Fabrication for Coated Conductors

*A. Molodyk, M. Novozhilov, S. Street,
A. Delaney, L. Castellani, and A. Ignatiev*

**Metal Oxide Technologies Inc.
Houston, TX 77040**

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Outline

- Cost-to-performance ratio of coated conductors
- Technology: low cost
- Technology: scale up
- Technology: high YBCO deposition rate
- Thick YBCO film capability
- MetOx MOCVD YBCO on ORNL RABiTS
- MetOx MOCVD YBCO on LANL IBAD
- All-MetOx, all-MOCVD architecture
- MetOx MOCVD buffer evolution
- Conclusions

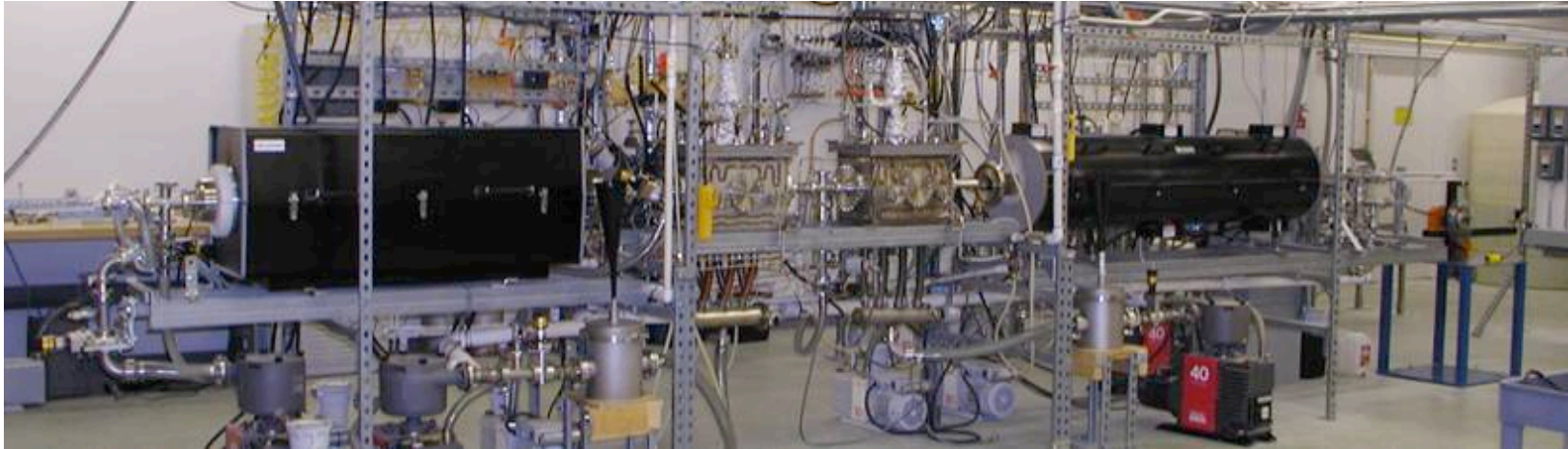


Cost-to-performance ratio of coated conductors

$\$/\text{kA}\cdot\text{m} \leftarrow \text{Technology cost} / J_c \times \text{YBCO thickness}$

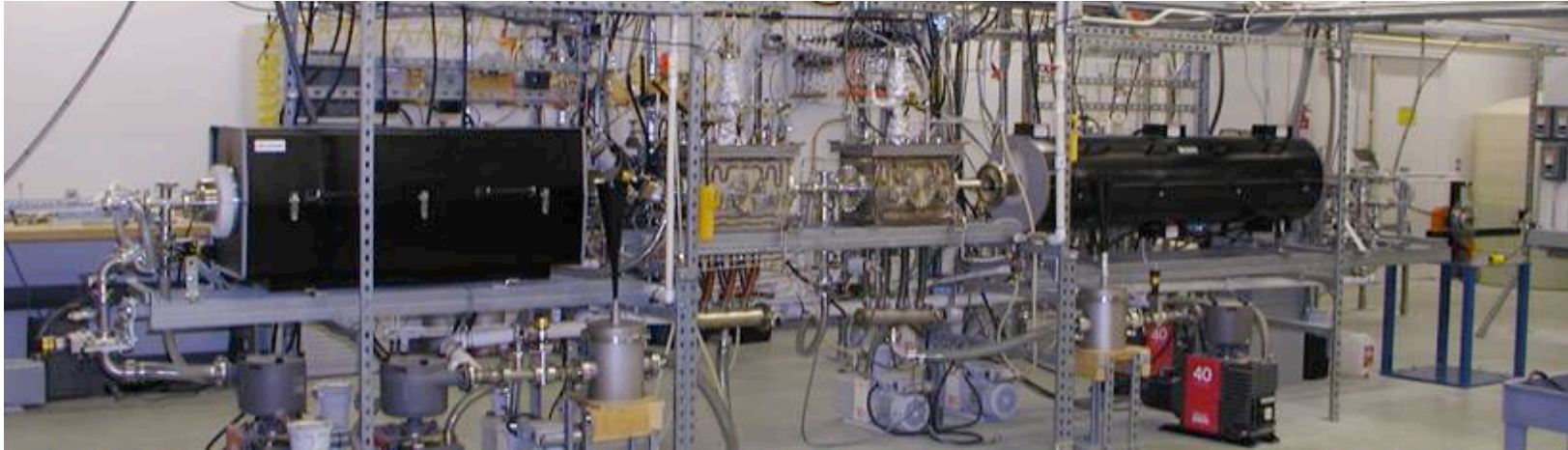
Approach	Technology cost	J_c level	Thick YBCO
MOCVD YBCO/PVD IBAD	High ↓	High ↑	Possible ↑
MOD YBCO/PVD RABiTS	High ↓	High ↑	Problematic ↓
MOCVD YBCO/MOCVD RABiTS	Low ↑	Moderate ↓	Possible ↑

Technology: low cost



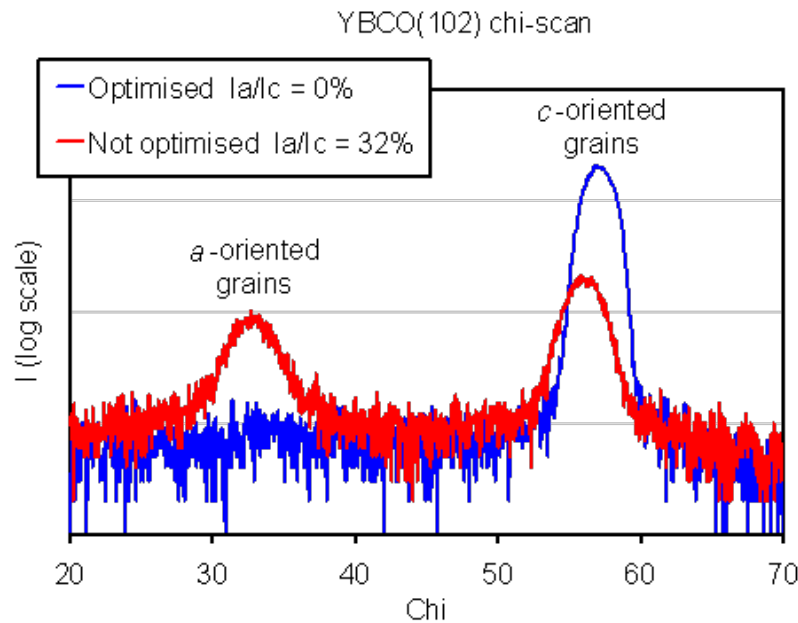
- All-MOCVD
- Low capital and operational cost
- Low vacuum
- Almost no start up/idle time (10 min vacuum, 30 min pre-heat)
- Modular design provides manufacturing flexibility
- In-house precursor synthesis

Technology: scale up

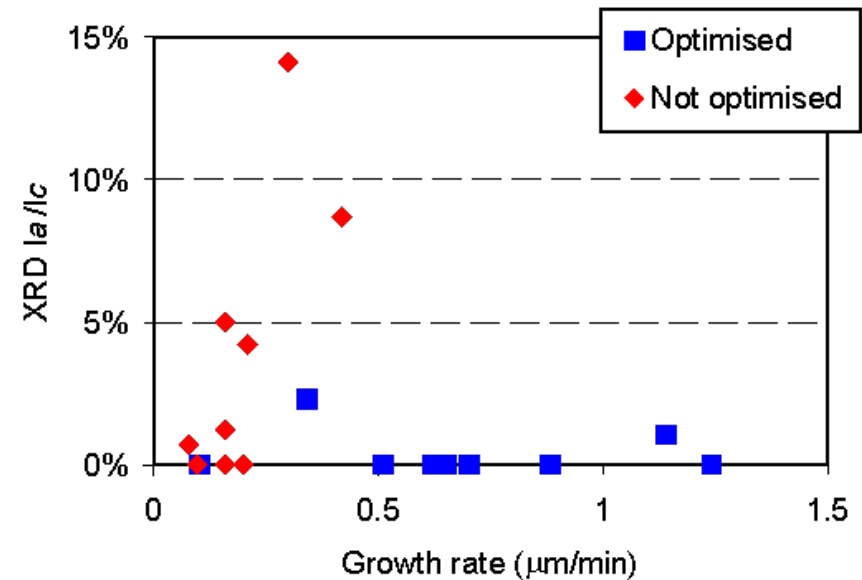


- Improve material utilisation rate in vapour deposition via gas flow modelling and wider deposition zone
- Real time and post-deposition reel-to-reel Quality Control
- Implement feedback on all critical parameters
- Transfer from R&D to industrial class hardware and instrumentation
- Further scale up by installing more deposition modules rather than by making larger modules

Technology: high YBCO deposition rate



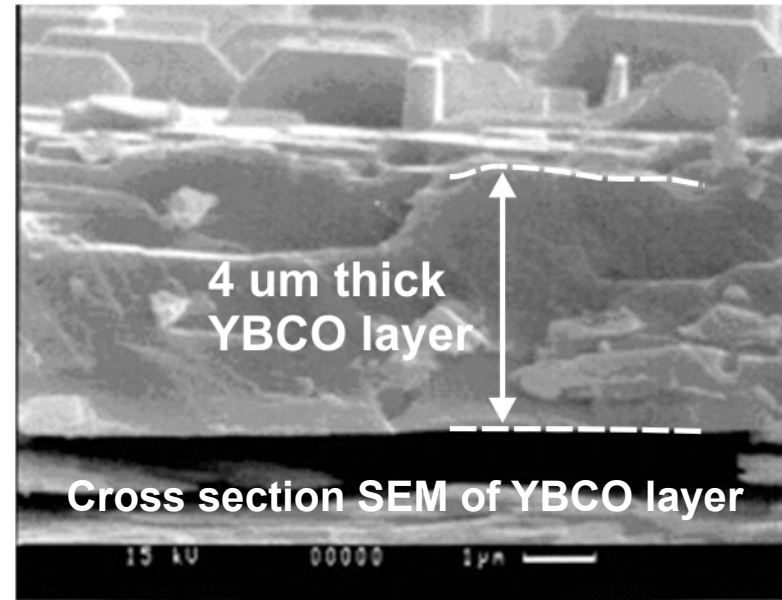
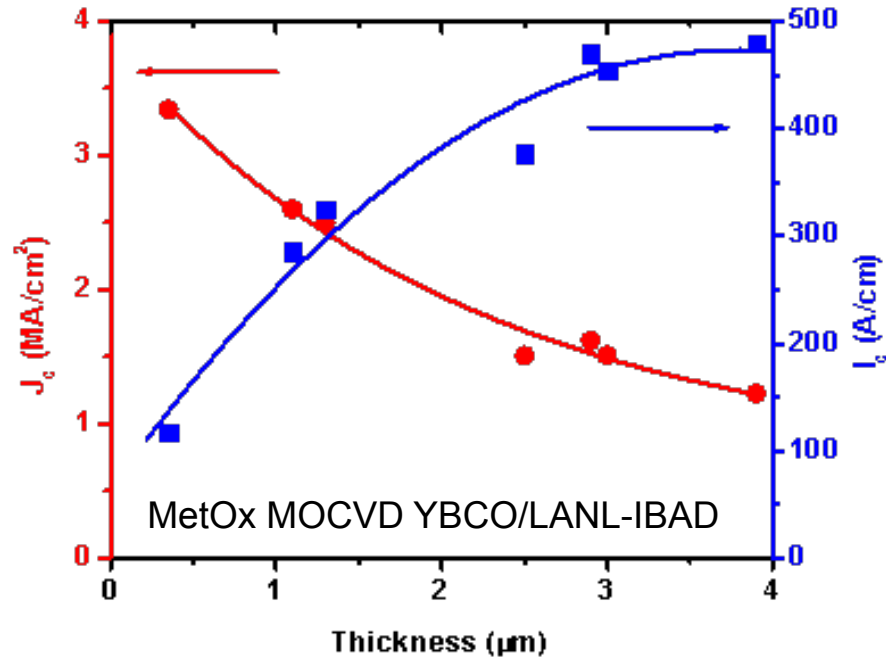
The amount of a -oriented YBCO crystallites was determined using chi-scanning of (102)YBCO reflex



Growth rates of highly textured superconducting YBCO films as high as **1.25 $\mu\text{m}/\text{min}$** have been demonstrated

Next step: Demonstrate $J_c > 1 \text{ MA}/\text{cm}^2$ at growth rates $> 1 \mu\text{m}/\text{min}$

Thick YBCO film capability

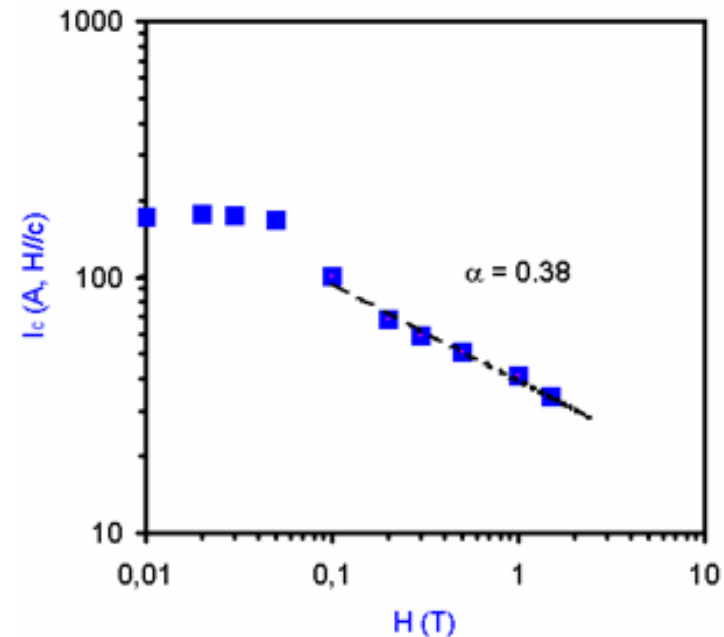
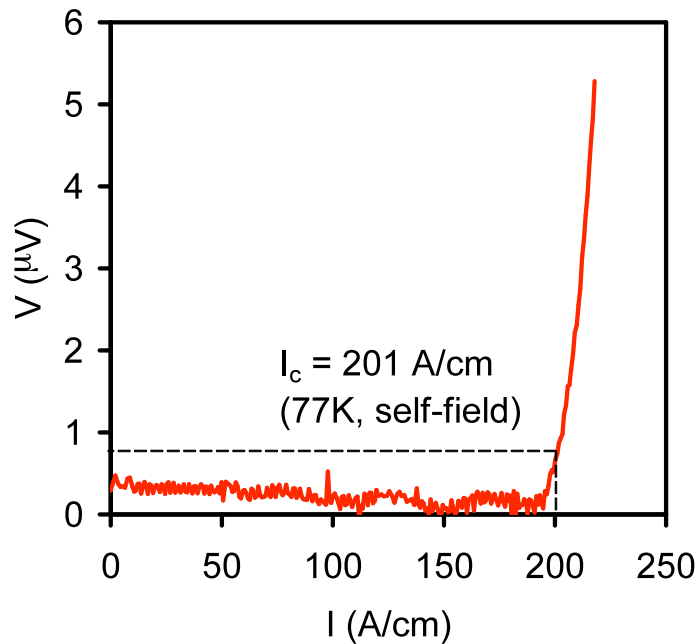
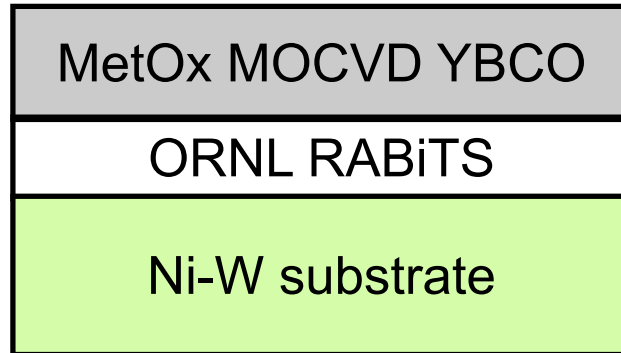


High I_c is achieved thanks to successful fabrication of thick YBCO films

YBCO J_c performance

- MetOx YBCO MOCVD process is optimised and qualified using established PVD buffer architectures from ORNL (RABiTS) and LANL (IBAD)
- MetOx proprietary MOCVD buffer layer has been extensively developed

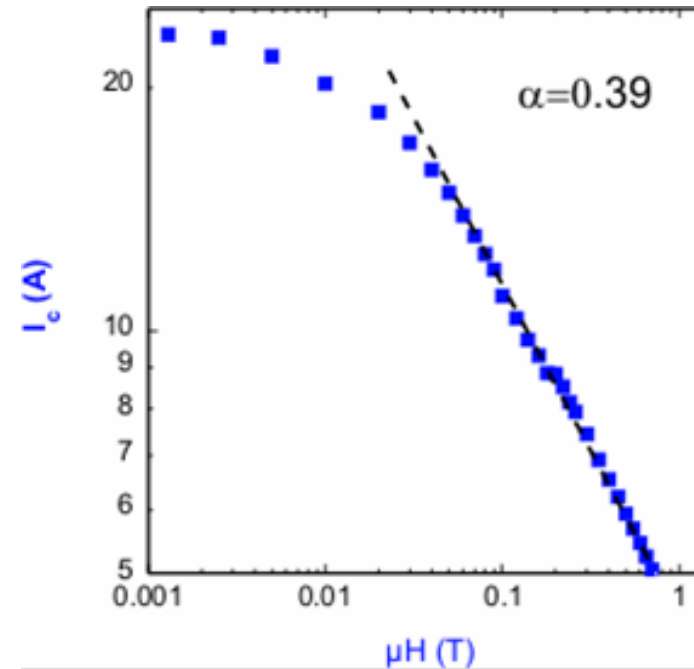
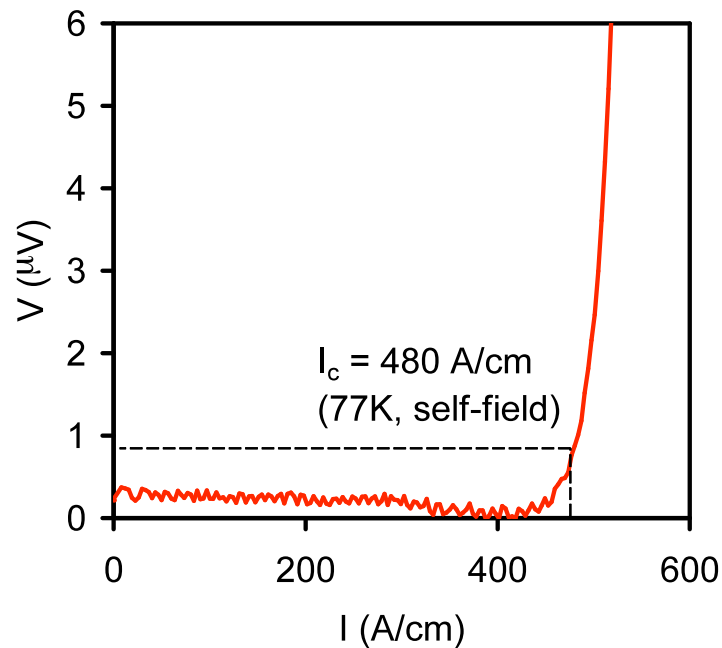
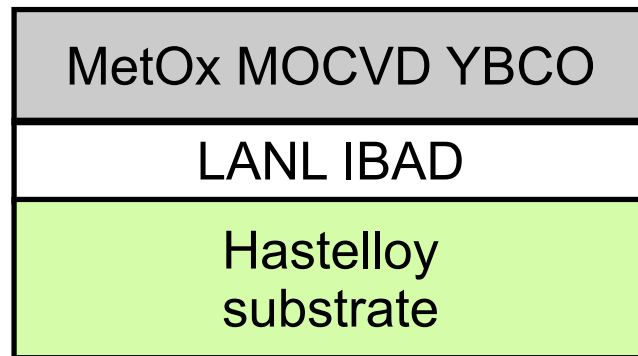
MetOx MOCVD YBCO on ORNL RABiTS



Max I_c	Max J_c	$\Delta\Omega$	$\Delta\Phi_{\text{true}}$
201 A/cm	1.54 MA/cm ²	3-6°	5-7°

High quality YBCO layers were fabricated on ORNL RABiTS substrates by MetOx MOCVD process

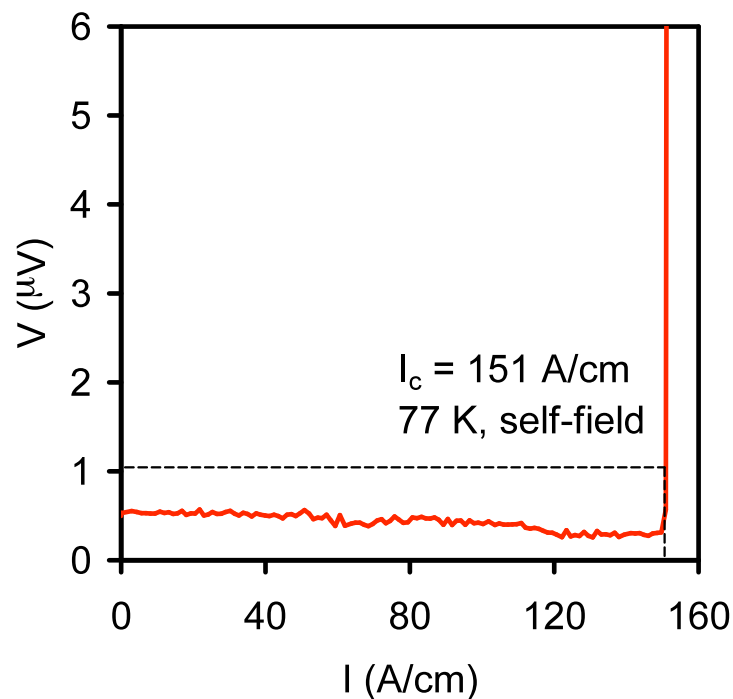
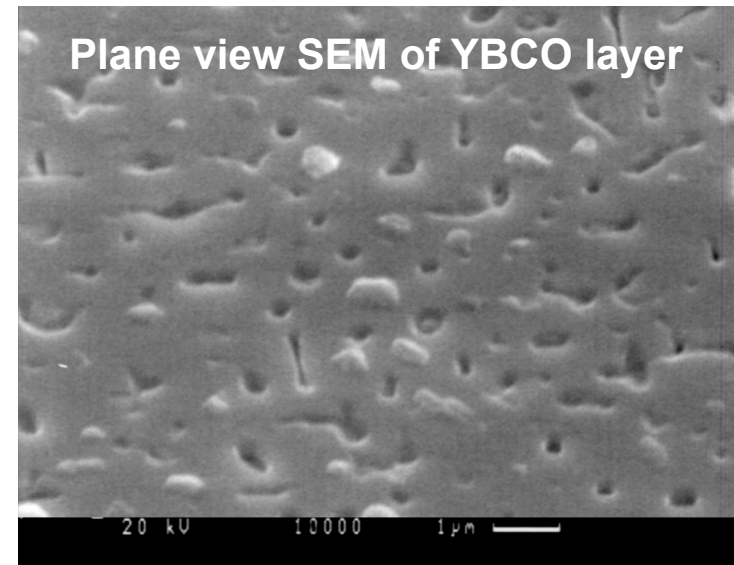
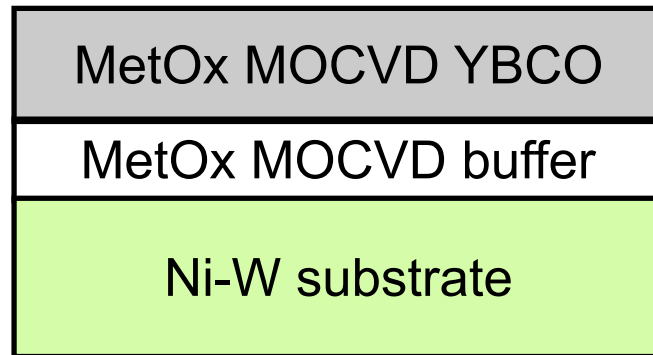
MetOx MOCVD YBCO on LANL IBAD



Max I_c	Max J_c	$\Delta\Omega$	$\Delta\Phi_{\text{true}}$
480 A/cm	3.34 MA/cm ²	1-2°	2-2.5°

The highest performance of MetOx MOCVD YBCO layers was achieved on LANL IBAD substrates

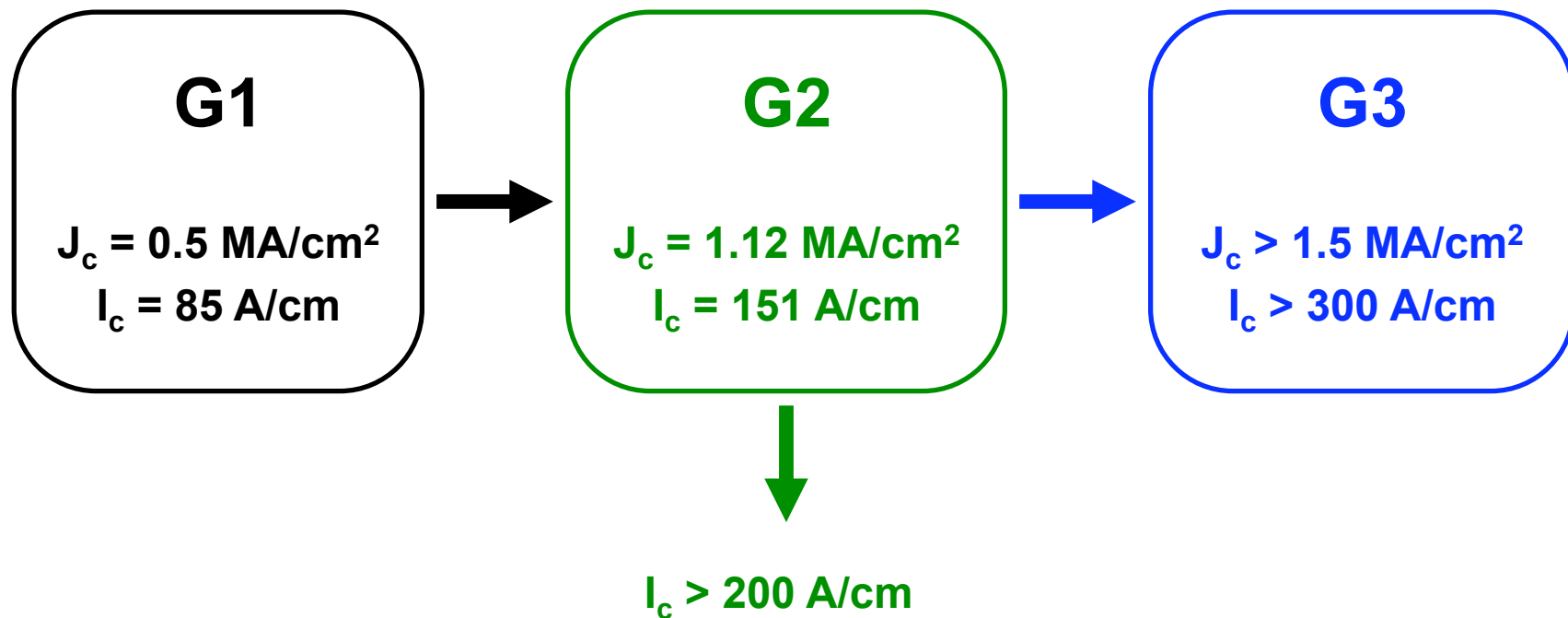
All-MetOx, all-MOCVD architecture



Max I_c	Max J_c	$\Delta\Omega$	$\Delta\Phi_{\text{true}}$
151 A/cm	1.12 MA/cm ²	3-6°	5-7°

MetOx modified MOCVD process delivers the highest I_c/J_c performance reported for all-MOCVD coated conductors on Ni-W substrate

MetOx MOCVD buffer evolution



Conclusions

- MetOx modified MOCVD process represents one of the **lowest possible capital and operational cost** approaches to RE-123 coated conductor fabrication
- MetOx modified MOCVD process delivers the **highest I_c/J_c performance reported for all-MOCVD** coated conductors on Ni-W substrate
- All-MOCVD approach to coated conductors has the potential to offer the **best cost-to-performance** ratio with the improvement of YBCO J_c supported by MOCVD buffer