CEPC 2026

October 22 to 26, 2026, Shanghai

Recent Development of HTS materials for high-field Magnets

蔡传兵，周迪帆，刘志勇，黄荣铁等

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Outline

上创超导 Shanghai Creative SuperConductor

1. Introduction of Shanghai Creative superconductor
2. Recent progress of MOD-derived tape thick REBCO layer
3. Tipical applications of HTS tapes supplied by SCSC
4. Latest Expansion Progress

发展历程

上创超导

技术孵化期 → 产业发展期 → 商业化运行期

业务发展

2011年
- 国家863科研成果转化
- 战略新兴产业重大专项

2013年
- 千米级带材生产装备自主研发与试产
- 国内首根千米级带材生产下线

2014年
- 与上海大学共建上海市高温超导重点实验室
- 获中国侨联创新团队奖

2017年
- 工信部技术成果鉴定并中标工业强基项目
- 获上海市科学技术发明奖

2019年
- 成立院士专家工作站
- 承接我国首条高温超导电缆示范工程订单

2020年
- 厚膜、强磁通钉扎带材批量供应
- 1000A-cm@77K，大幅度领先国内同行

2021年
- 获高新技术企业
- 国内首条高温超导电缆示范工程投运

2023年
- 获专精特新企业
- 获聚变磁体、加速器、特种电缆、电机等下游的商业化订单

2025年
- 上创聚能成立，安徽、江苏新产线开启建设
- 40mm宽新产线落地，多领域订单批量获取

资本路径

2014年 天使轮
上海创业投资有限公司 Shanghai Venture Capital Co.Ltd
聚惠领域 分享南上海新发展 总部园

2019年 Pre A轮
沐盟集团 MOOM COMMONWEALTH

2023年 A轮
寶頂創投 PT CAPITAL
精翊电器

2025年 A+轮
国鑫投资 GUOXIN INVESTMENT
金浦投资 GP Capital
洪泰基金
安徽国控集团 ANHUI STATE-OWNED CAPITAL HOLDING GROUP

创始人：国内高温超导材料领军人物

创始人/董事长/CEO
蔡传兵博士



- **上海市领军人才，国家重点研发计划首席，上海市高温超导重点实验室主任；中国材料学会超导分会常务委员；中国电工技术学会理事**
- **从事超导研发30余年，1998年获中国科学院上海冶金所博士，日本政府(科技厅)博士后研究员；1998-2005年间工作于日本大阪大学、日本铁道综合技术研究所、英国伯明翰大学、德国莱布尼兹固体材料研究所**
- **2005 年获首届浦江人才计划引进回国。2007 -2009年间多次前往德国从事超导带材合作研究。2011年创办上创超导，获上海市千人计划支持**

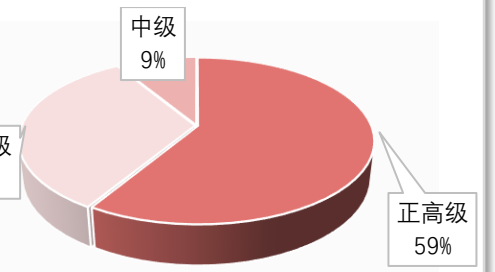
上海市高温超导重点实验室

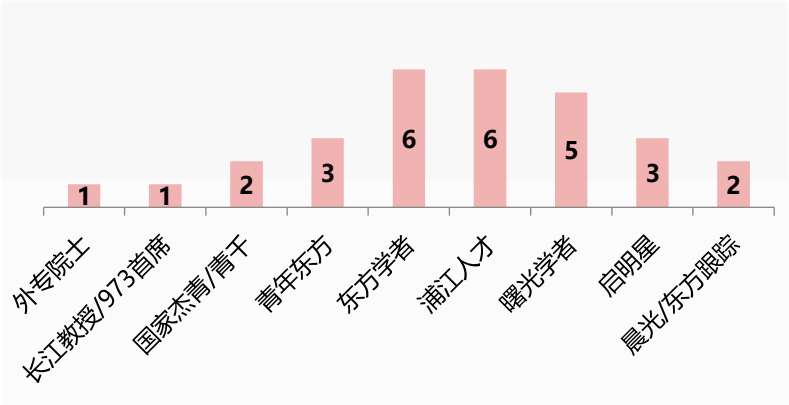
厚积薄发的基础科研优势

学术委员会主任

第一届：李言荣院士

第二届：陈仙辉院士



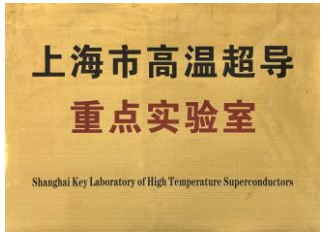










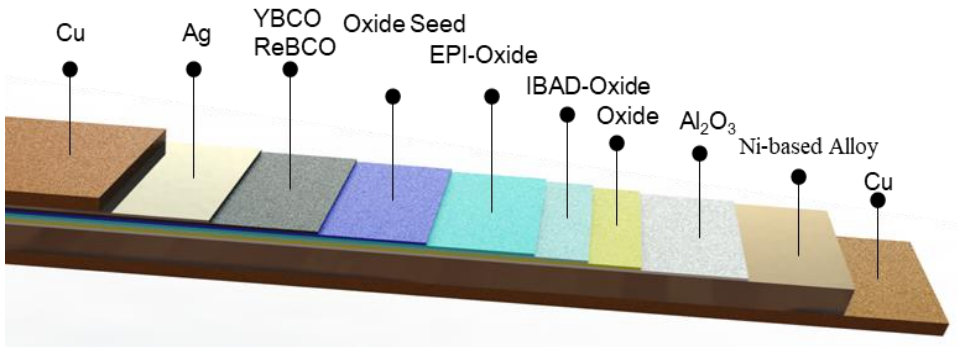




结构创新：上创超导采用全球独创结构生产第二代高温超导-钇钡铜氧带材

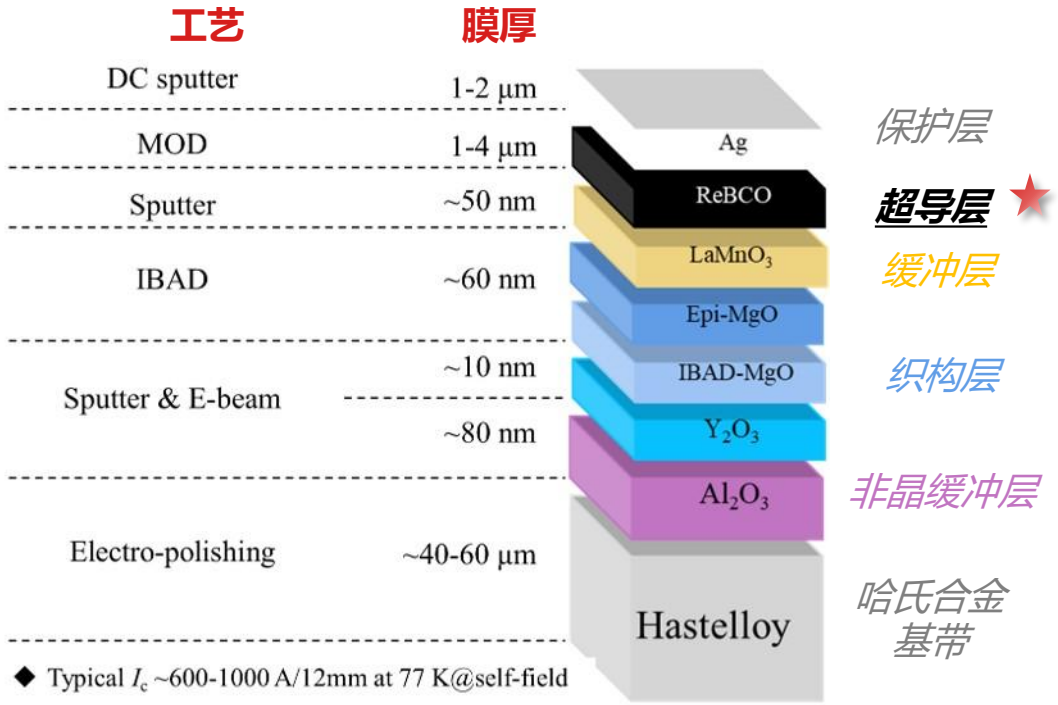
上创超导

第二代高温超导-ReBCO带材



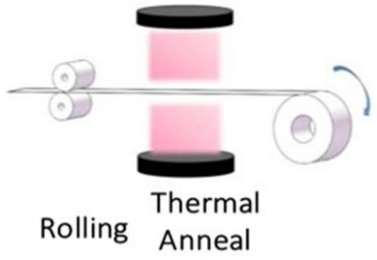
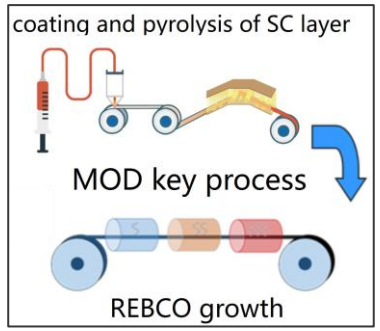
	镀铜带材	铜封装带材
宽度（mm）	4/6/12	4/6/12
临界弯曲直径（mm）	11~15	15~20
接头电阻率（nΩ·cm²）	30~50	30~50
拉伸应变（%）	0.4	0.7~0.8
临界拉应力强度（Mpa@77k）	>600	>450

带材结构图



SCSC-MOD: a unique technical route!

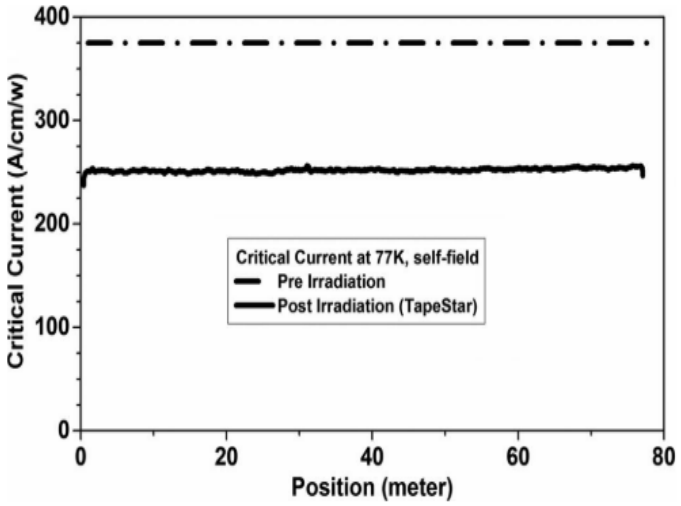
上创超导 Shanghai Creative SuperConductor

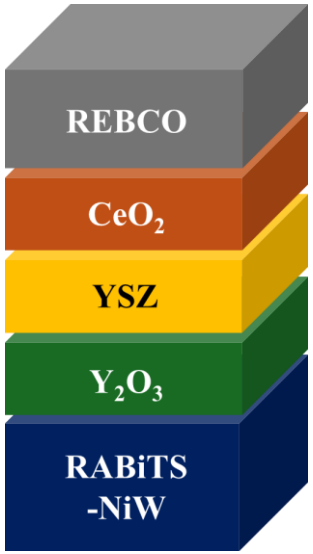
Substrate (texture、non-texture)	Buffer layer (texture development)	HTS Layer (epitaxial growth)		Typical Manufacturer
RABiTS工艺  	Epi-CeO/ YSZ or LZO	*Ex-Situ*	RCE	SuNAM、THEVA
			MOD  	AMSC、SWCC、Sumitomo
IBAD工艺  	LMO/ epi-MgO/ IBAD-MgO			SCSC( )
		In-Situ	PLD	Fujikura、SuperOX, SST、Faraday、Bruker
			MOCVD	SuperPower、SAMRI

MOD：AMSC vs. SCSC

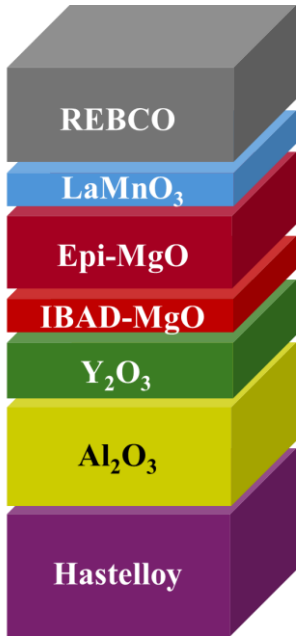
上创超导 Shanghai Creative SuperConductor

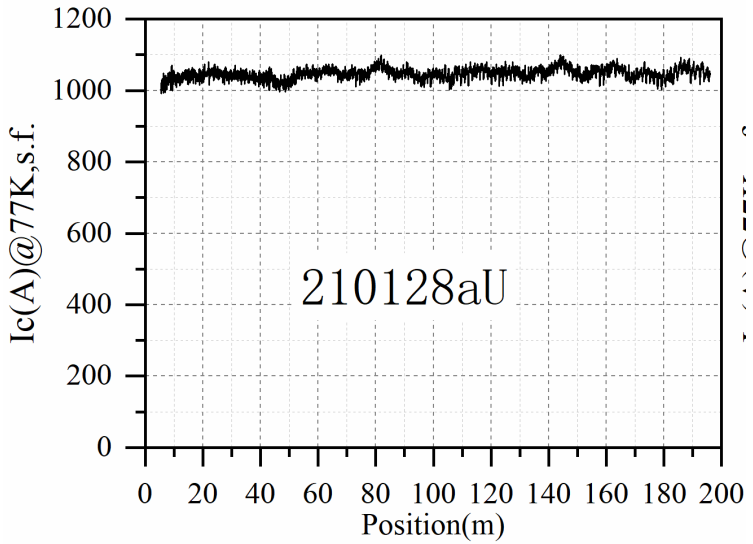
AMSC	SCSC
REBCO （~1.5μm）	**REBCO（1.5-3.5 μm）**
RABiTS （$NiW/Y_2O_3/YSZ/CeO_2$）	**IBAD** （$Hastelloy/Al_2O_3/Y_2O_3/MgO/LaMnO_3$）
Ic：350-500A/12mm-w (77K, s.f.)	**Ic：800-1100A/12mm-w (77K, s.f.)**





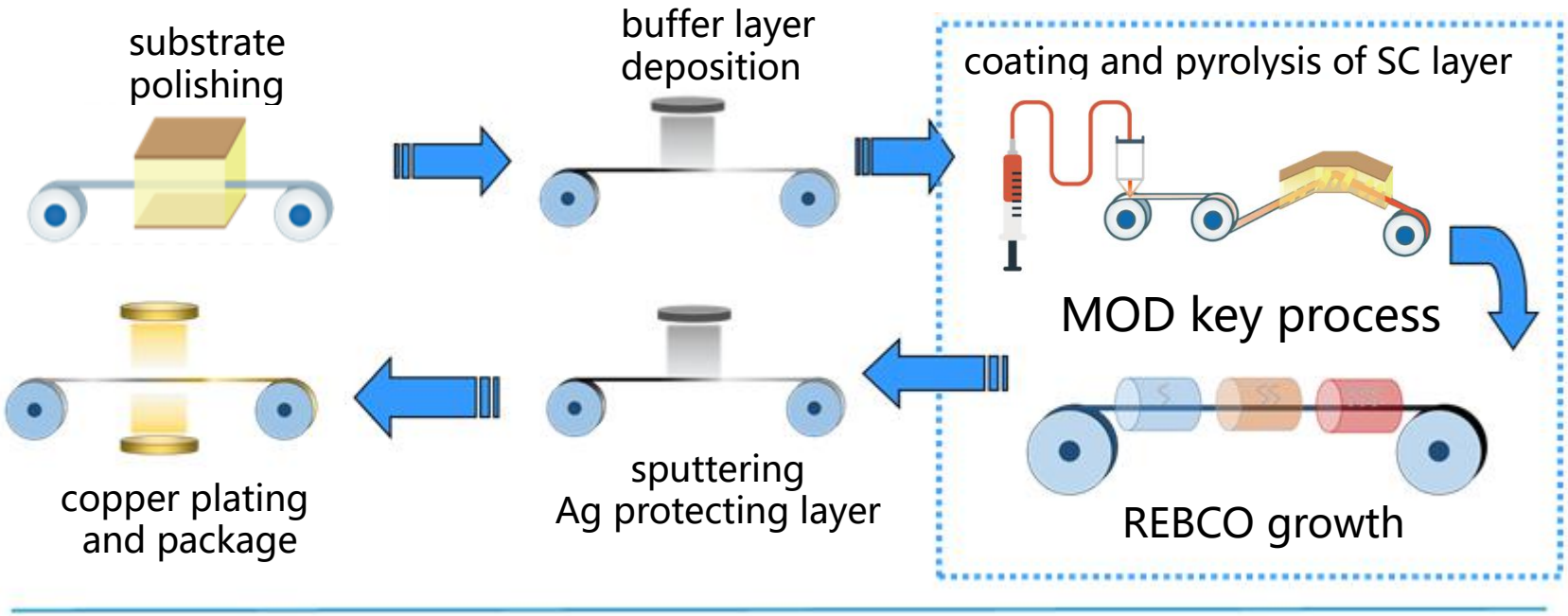
IEEE T APPL SUPERCON. 26 (2016) 6601904





IEEE T APPL SUPERCON. 34 (2023) 6600505

SCSC: industrial production lines



Low-cost MOD route

- No high vacuum
- Easy control of composition
- 100% utilization of solution
- Wider tape & thicker HTS
- Large scale production

- Substrate polish
- Texture formation of buffer layers
- Coating and growth of HTS layer
- Sliting &Package








Latest developed MOD production lines



MOD-HTS process(1):
Coating and Low-temperature pyrolysis



MOD-HTS process(2):
High-temperature crystallization

- Wider tapes of 20-40 mm; Double lanes designed;
- Multiple production lines; yield up to 400 km/year reached.

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2 Recent progress of MOD-derived tape thick REBCO layer

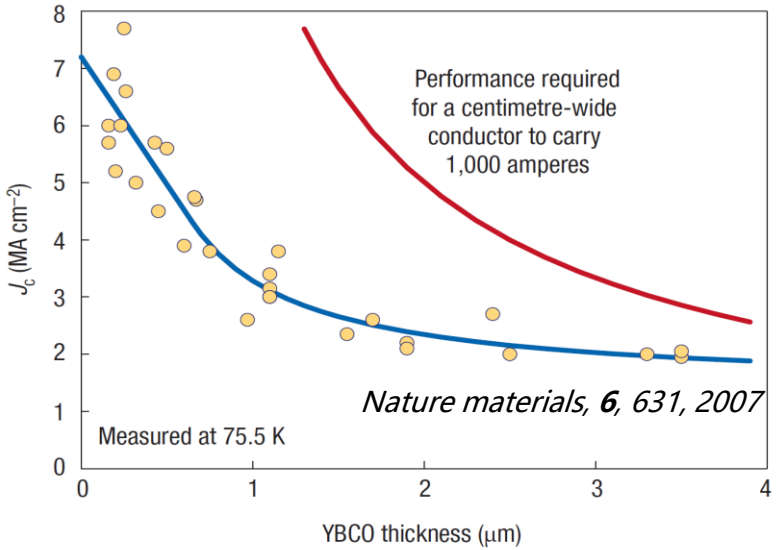
3 Tipical applications of HTS tapes supplied by SCSC

4 Latest Expansion Progress

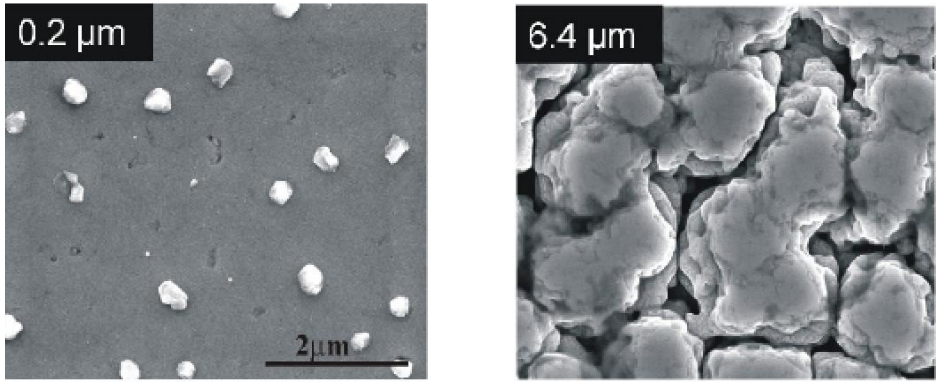
Challenge in thickening REBCO layer

上创超导 Shanghai Creative SuperConductor

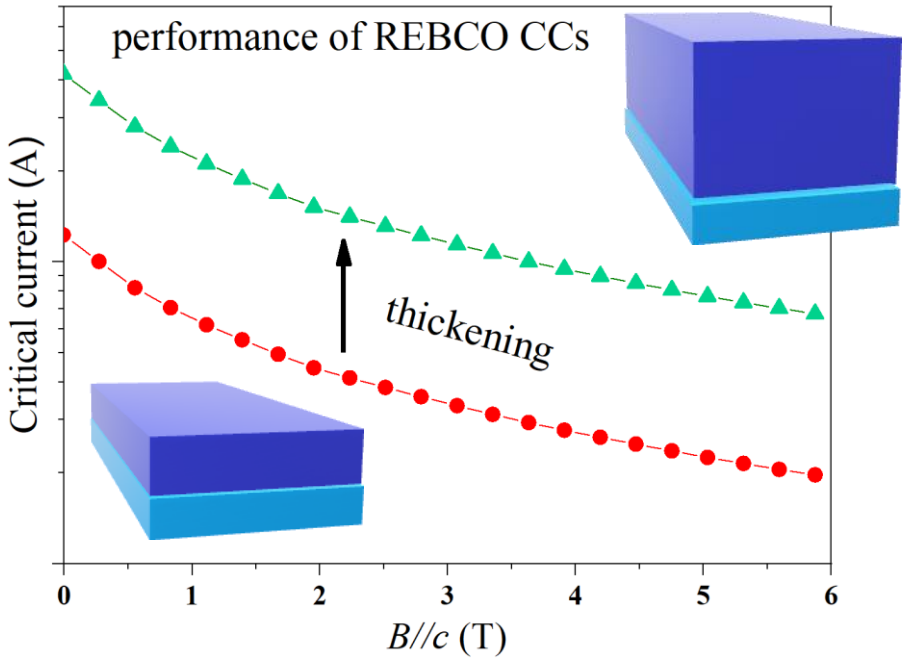
Thickness effect of the J_c of REBCO film



Structural deterioration: a-axis, pores, etc



Supercond. Sci. Technol. 22 085013, 2009



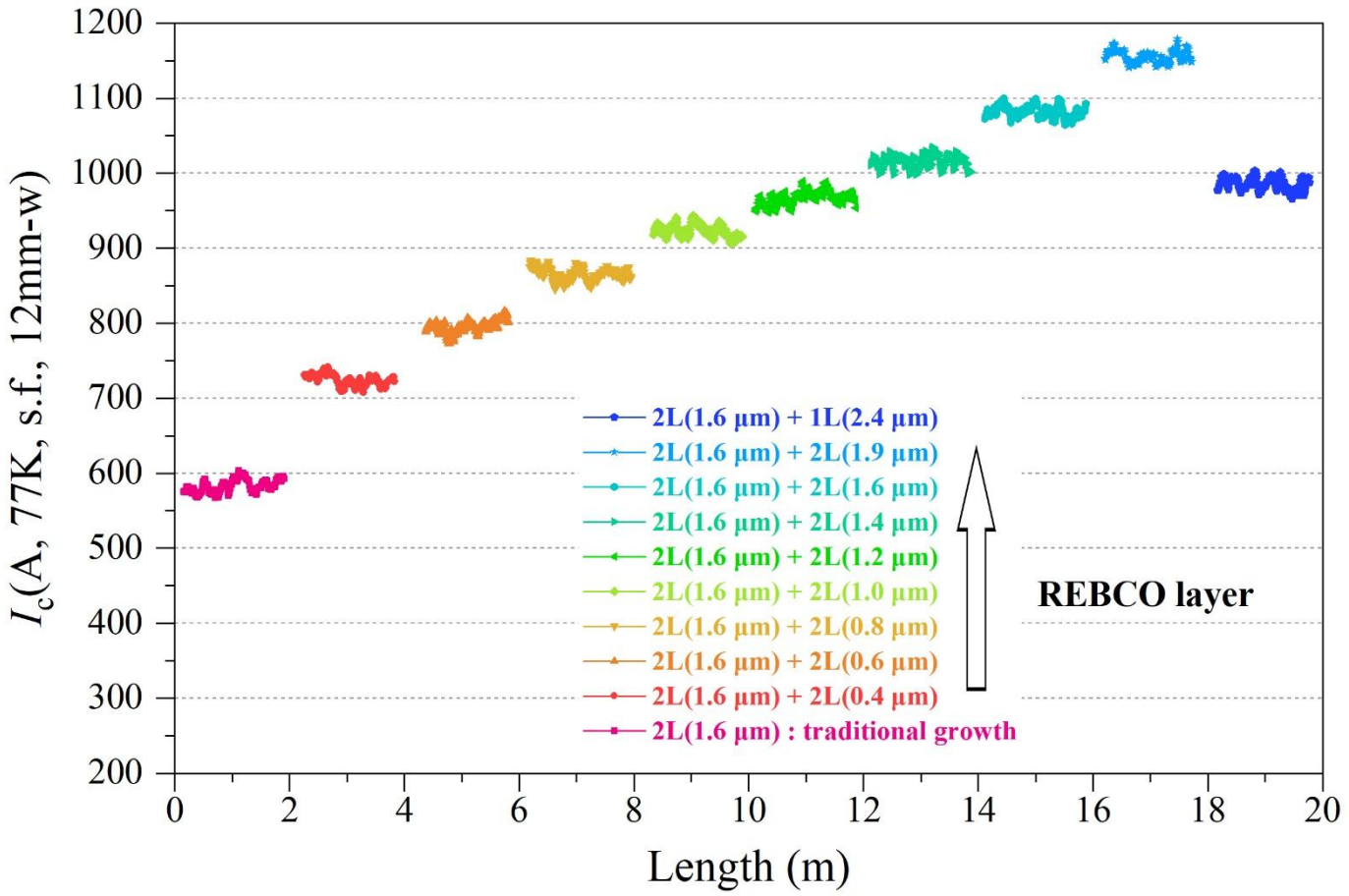
Benefits of thick film

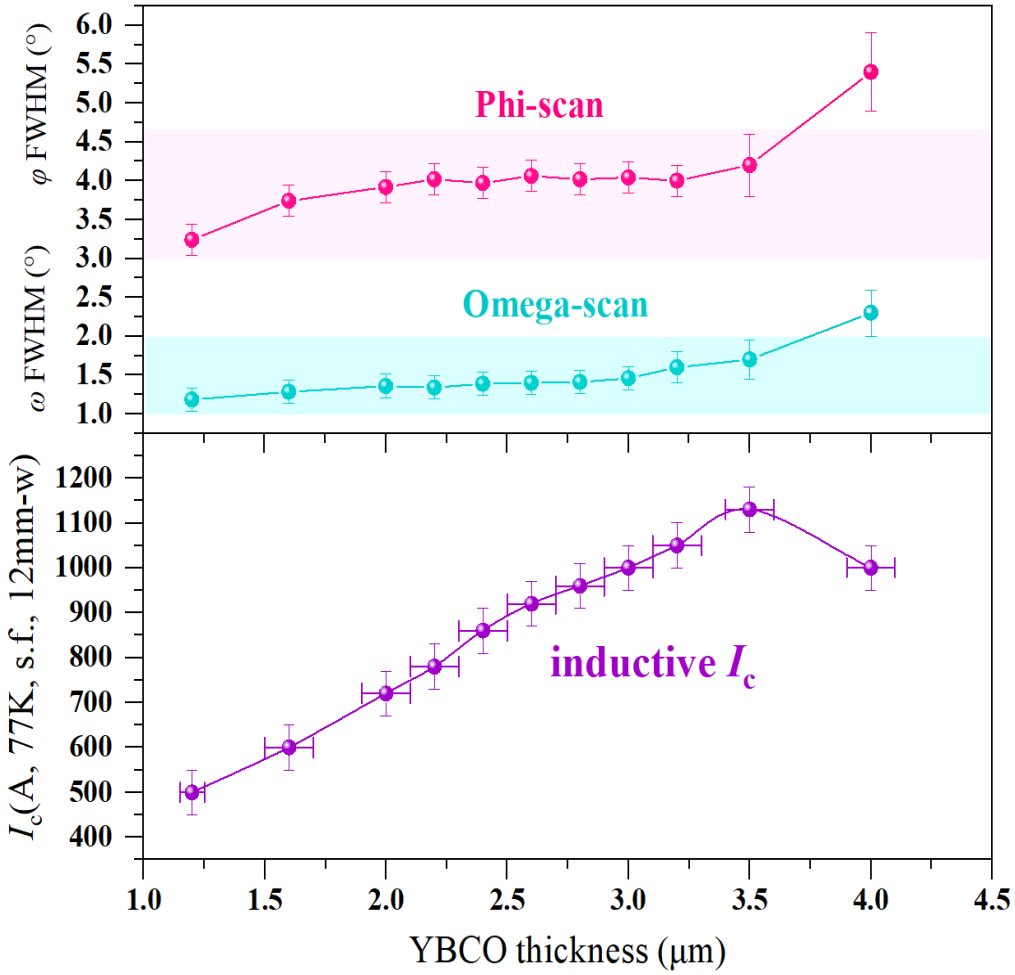
- Higher performance
- Higher efficient
- Lower cost

Performance of SCSC tape with thick-REBCO layer

上创超导 Shanghai Creative SuperConductor

- ✓ Ic(77K) increased linearly with thickness, depending on the textures
- ✓ Ic(77K) decreased as in-plane and out-of-plane deteriorated

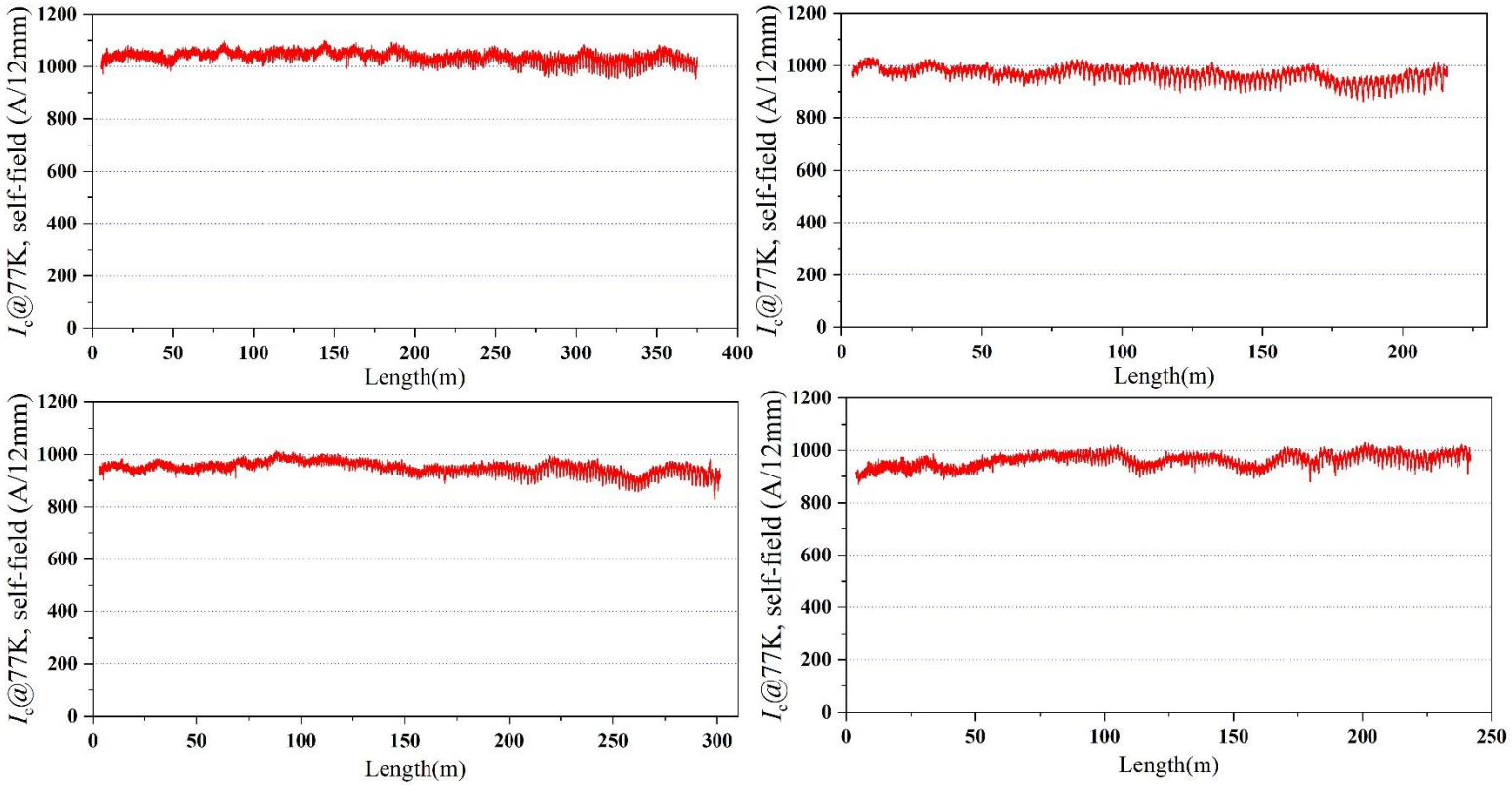


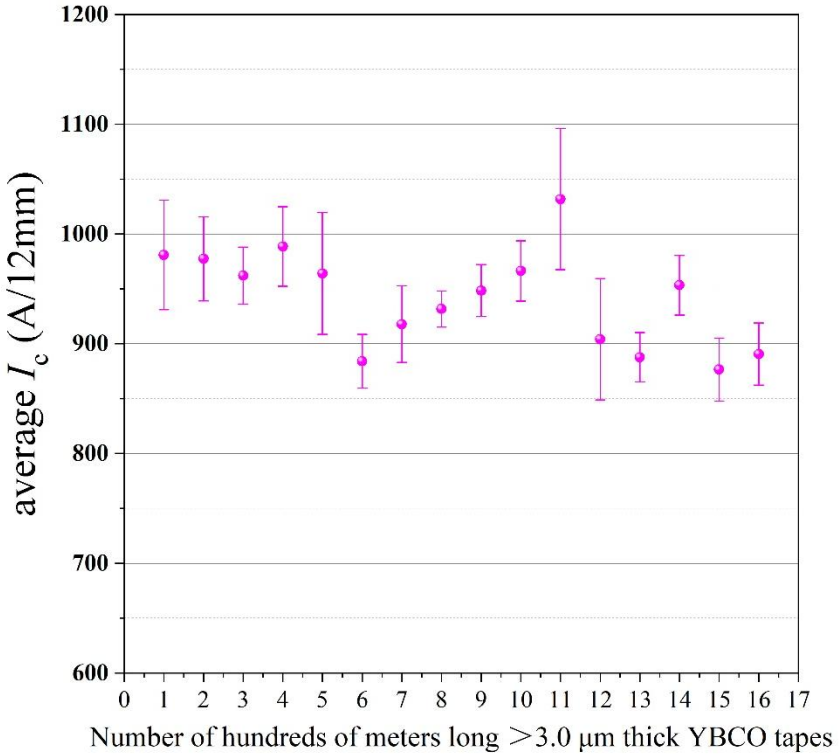


State of the art for SCSC long tape with thick-HTS

Up-scaling long tape of thick REBCO

- ✓ HTS thickness ~3.2 μm;
- ✓ I_c at 77K : 850-1100A/12mm;
- ✓ Tape length~ 400 m;
- ✓ Yield per year ~ 350 km

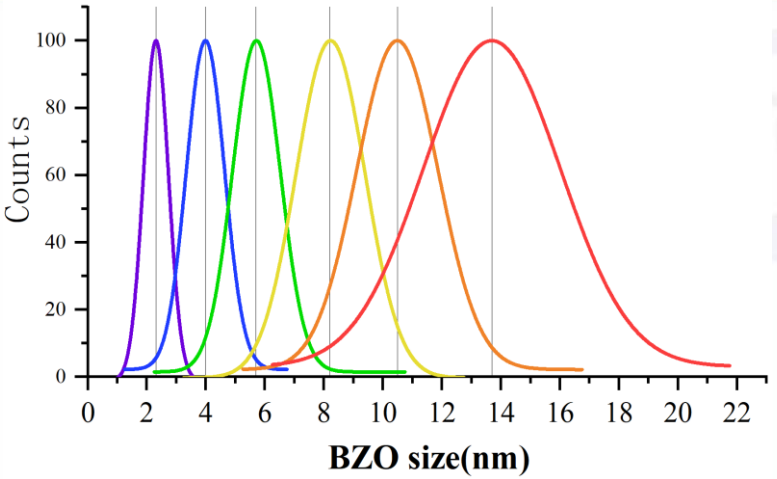


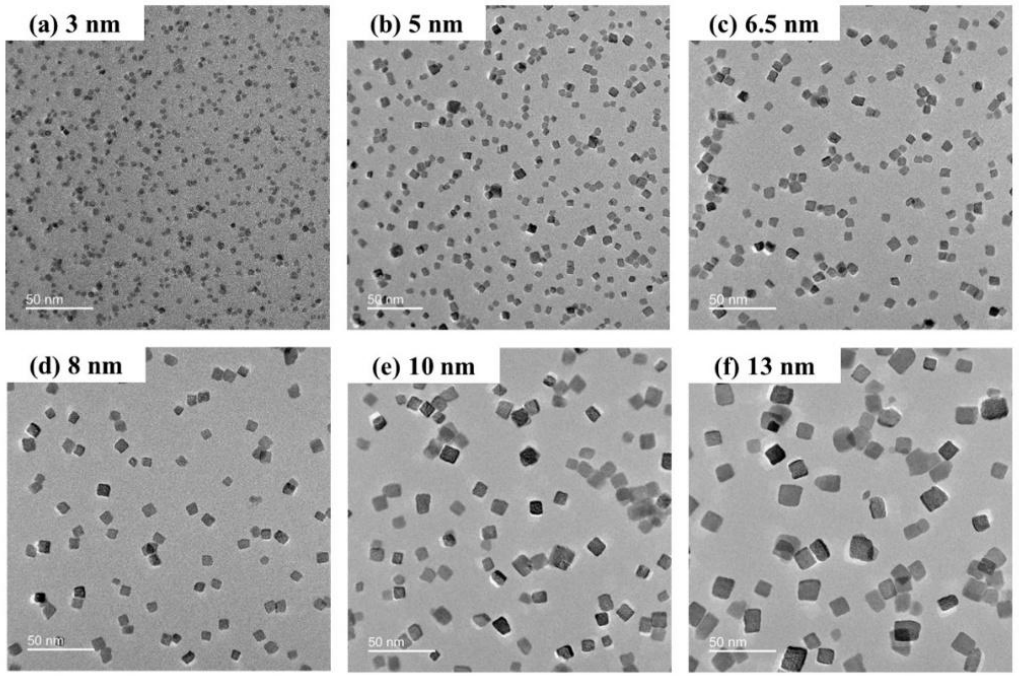


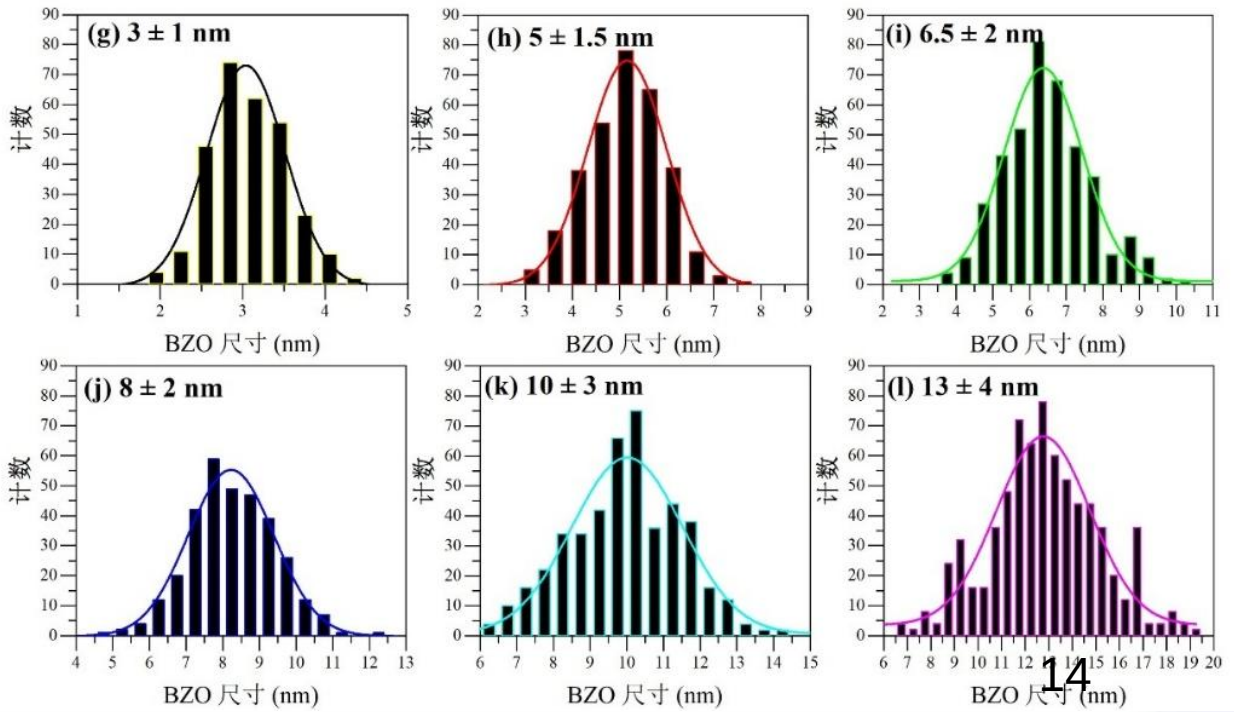
Preformed nanocrystal addition technology

- Highly controllable preparation of preformed BMO (M = Zr, Hf) nanocrystals (3-13 nm)

1. Narrow Size Distribution;
2. Uniform single-particle morphology ;



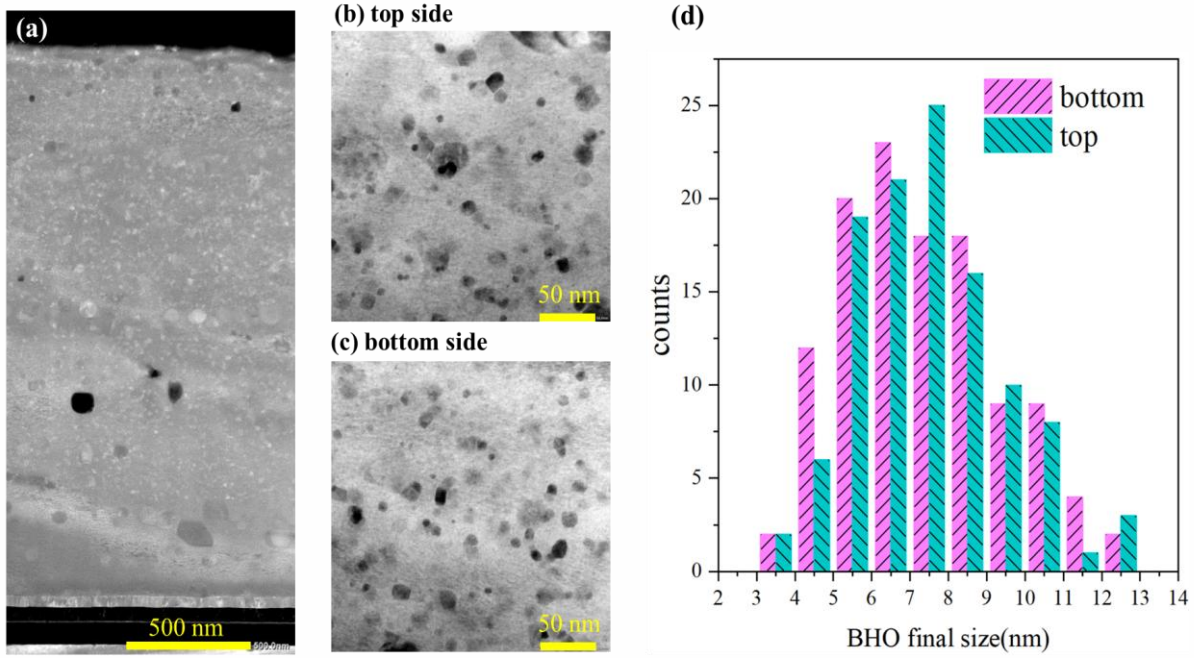




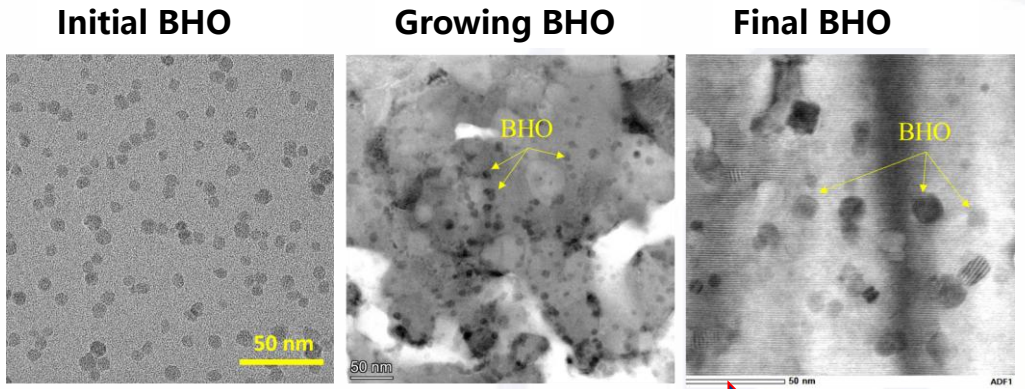
Preformed nanocrystal coarsening regulation

■ The size distribution characteristics of nanocrystals in the film

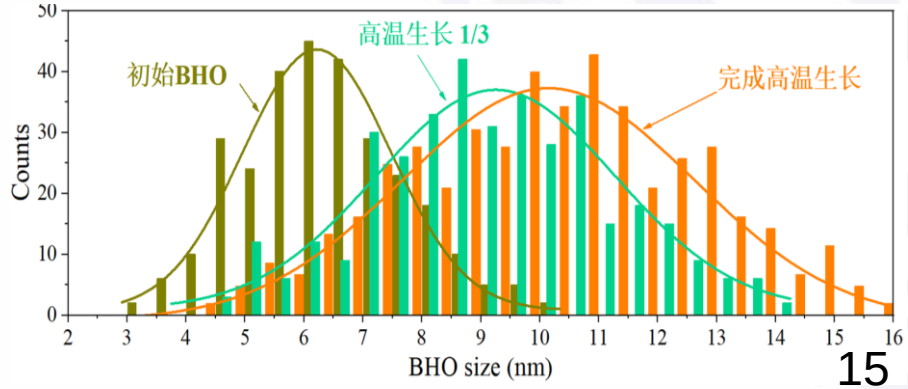
① The size distribution of the nanocrystals is uniform throughout the middle and lower parts of the film.



② The size of BHO nanocrystals undergoes a gradual enlargement process.

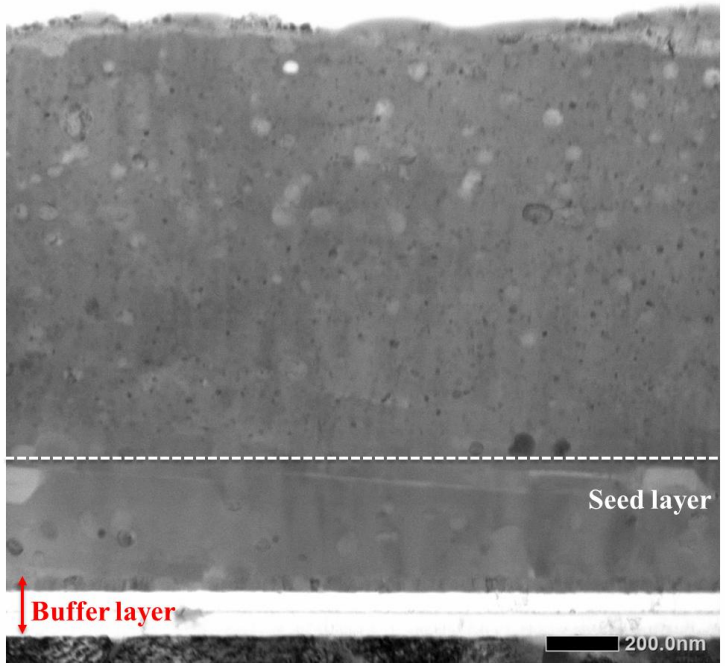


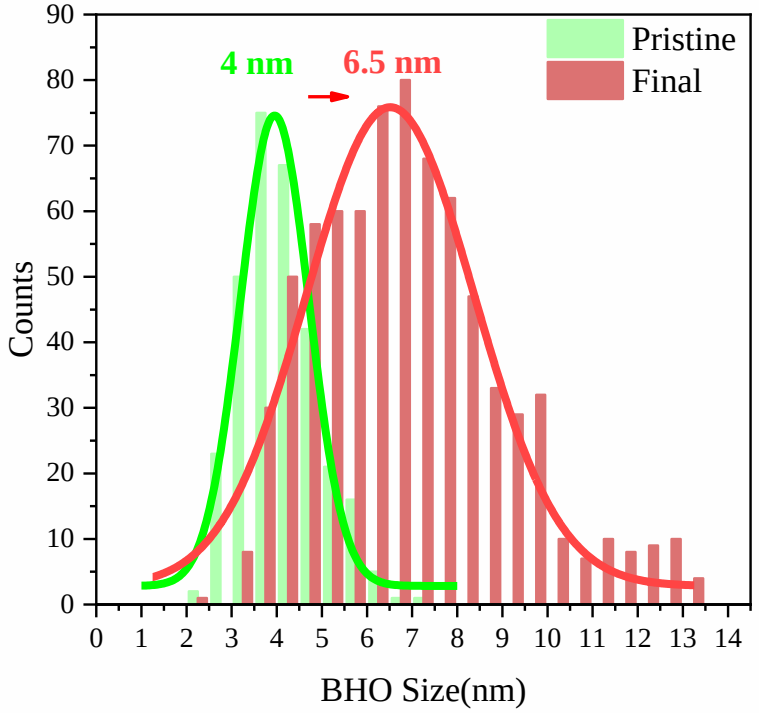
Size variation

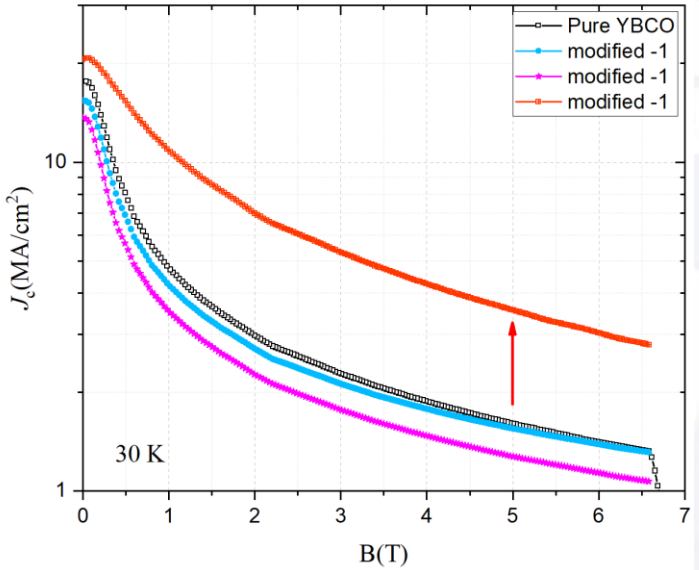


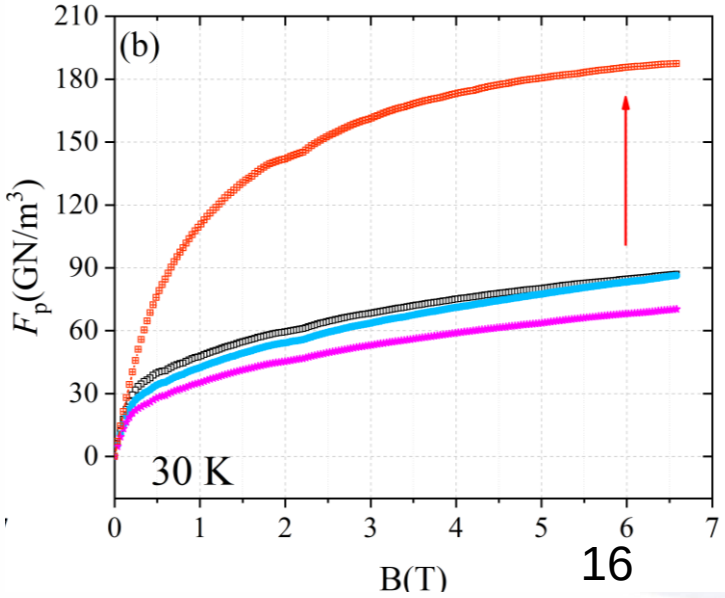
Preformed nanocrystal coarsening regulation

- The new method controls the size of small-sized BHO to be approximately 4 nm, and its final size is around 6.5 nm.
- Effectively enhance the in-field performance at low temperatures, Jc~5.4MA/cm²@30 K,3 T

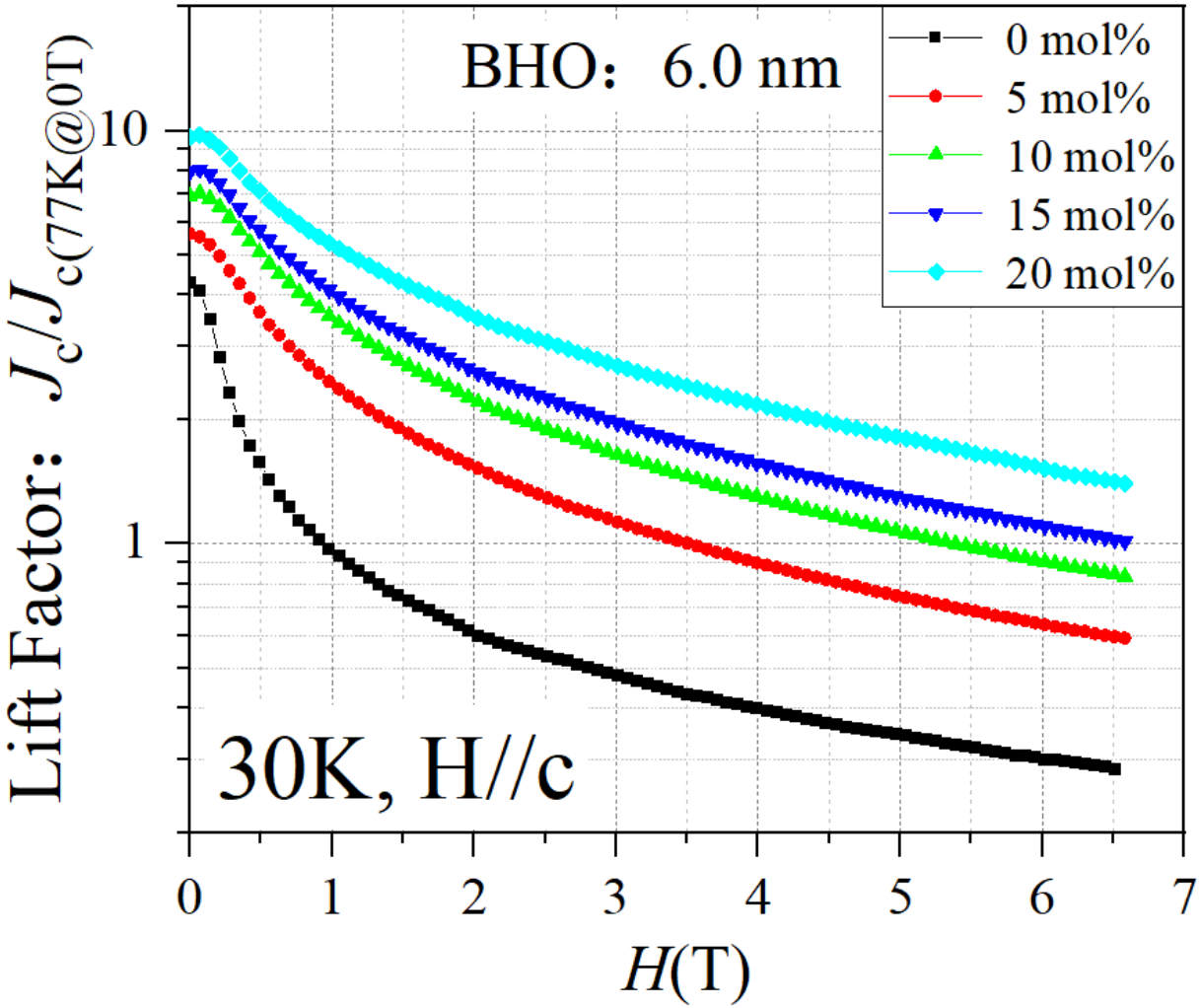


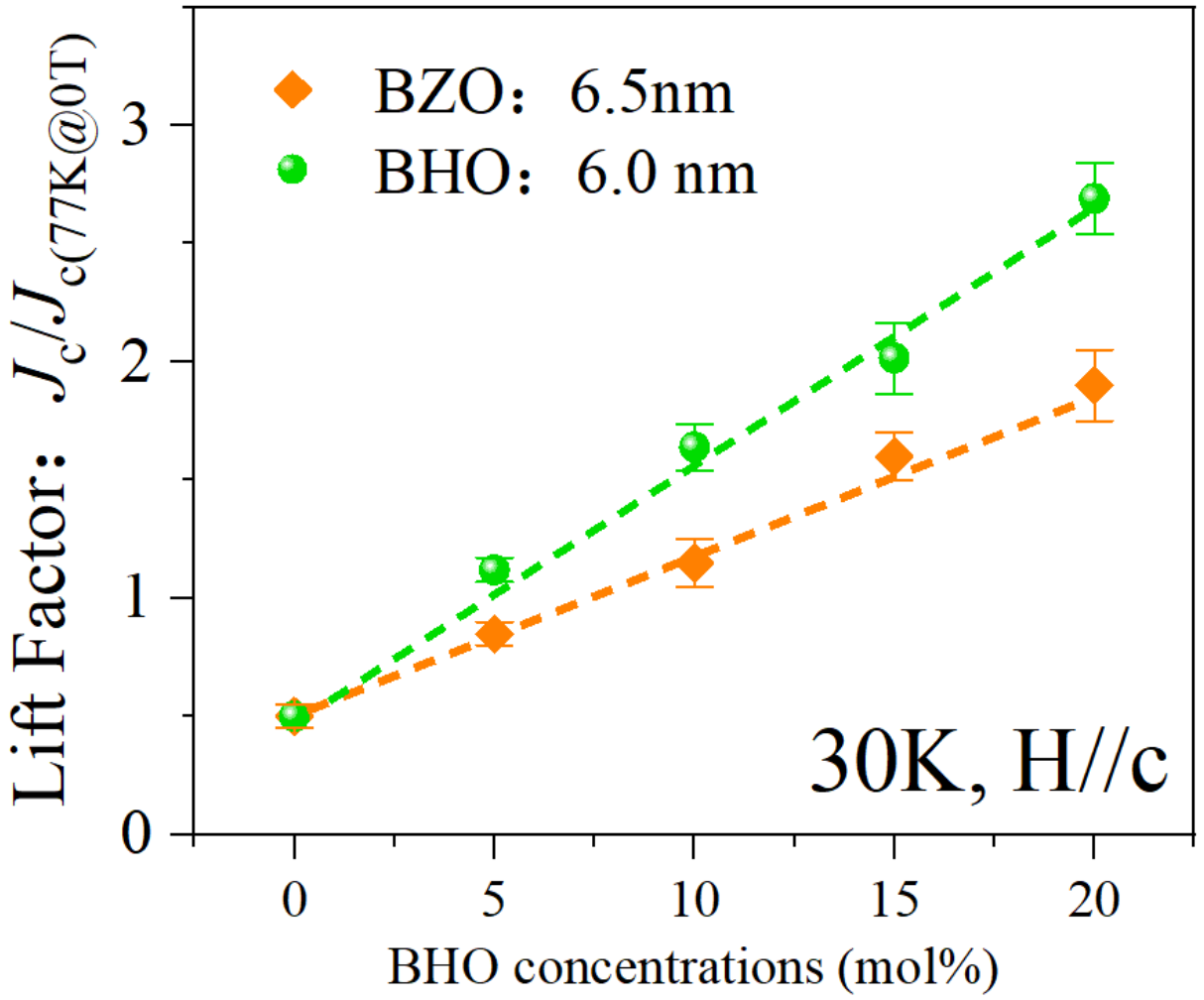






Stronger: Doping Level VS Lift Factor





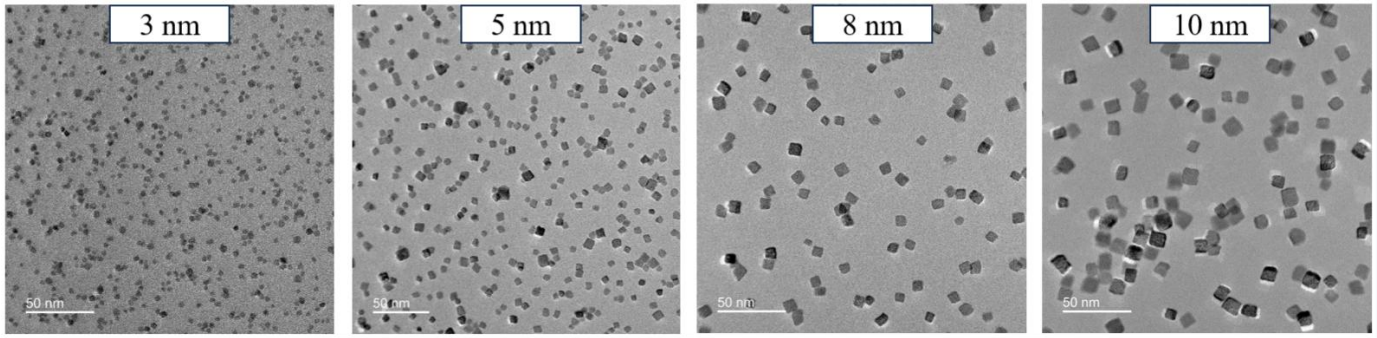
- The positive doping effect of 5 mol% BHO is greater than that of BZO.

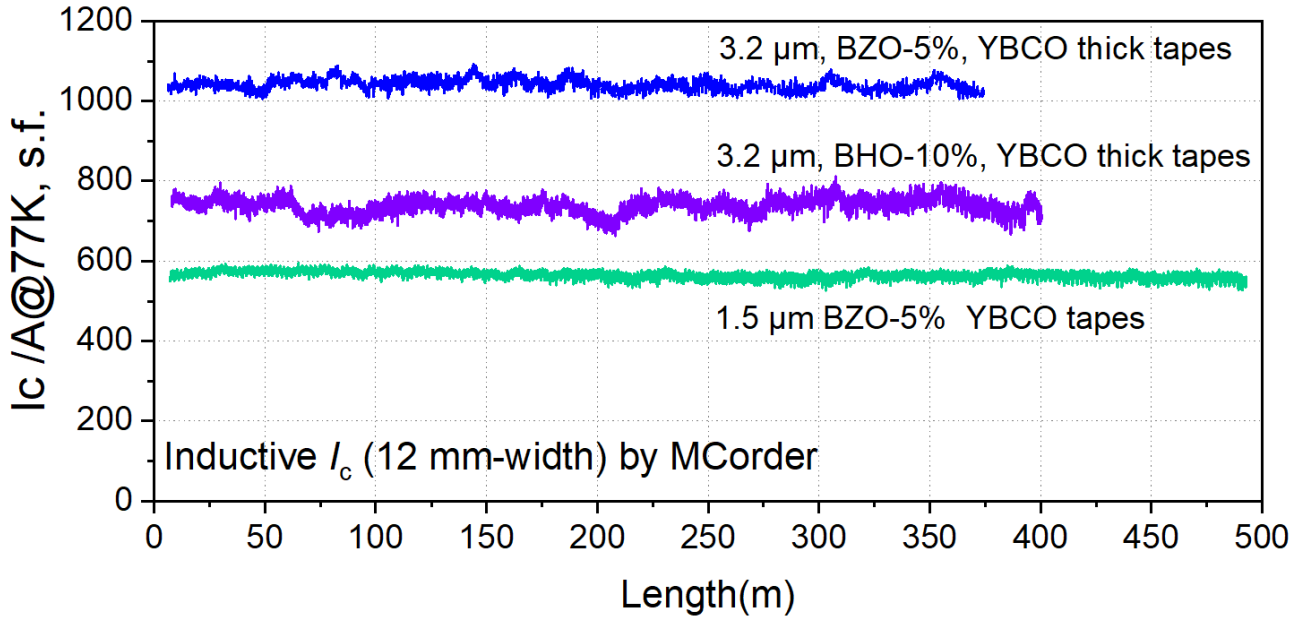
Combination of nano-addition and thick film

上创超导 Shanghai Creative SuperConductor

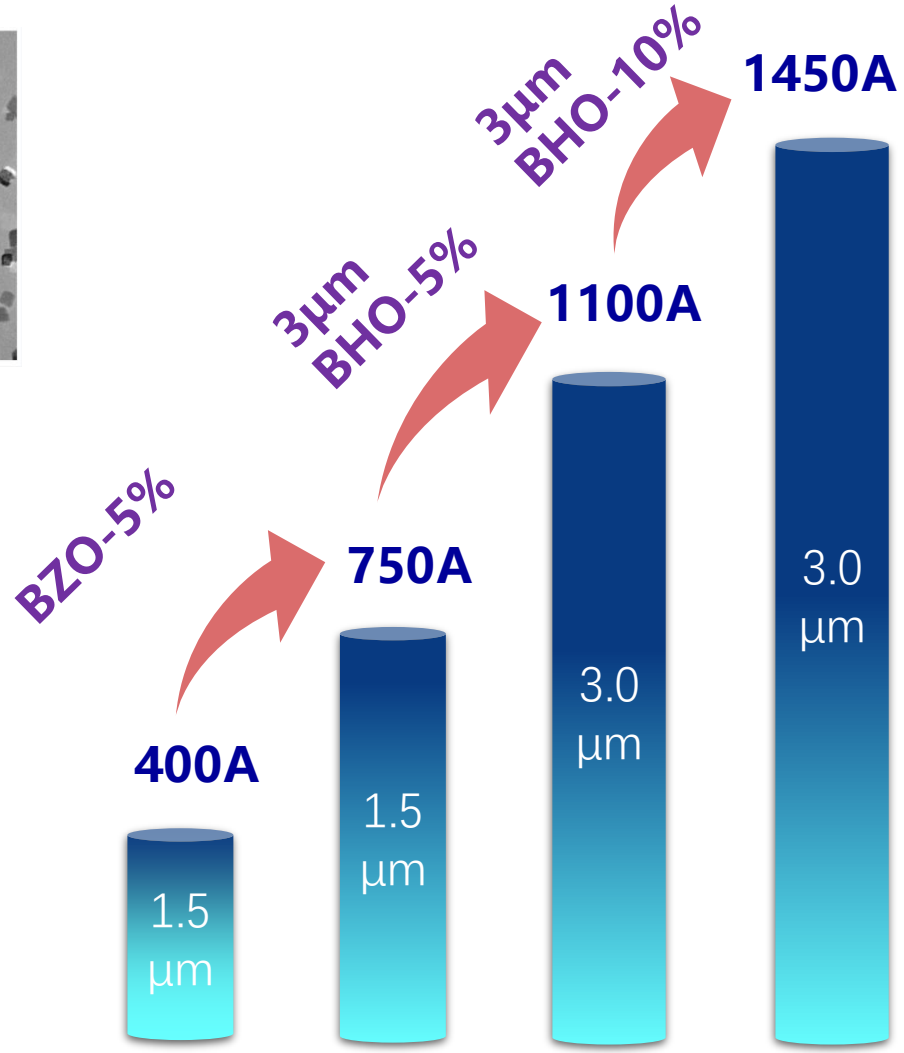
✓ **Significantly improving the in-field performance**

BZO
BHO

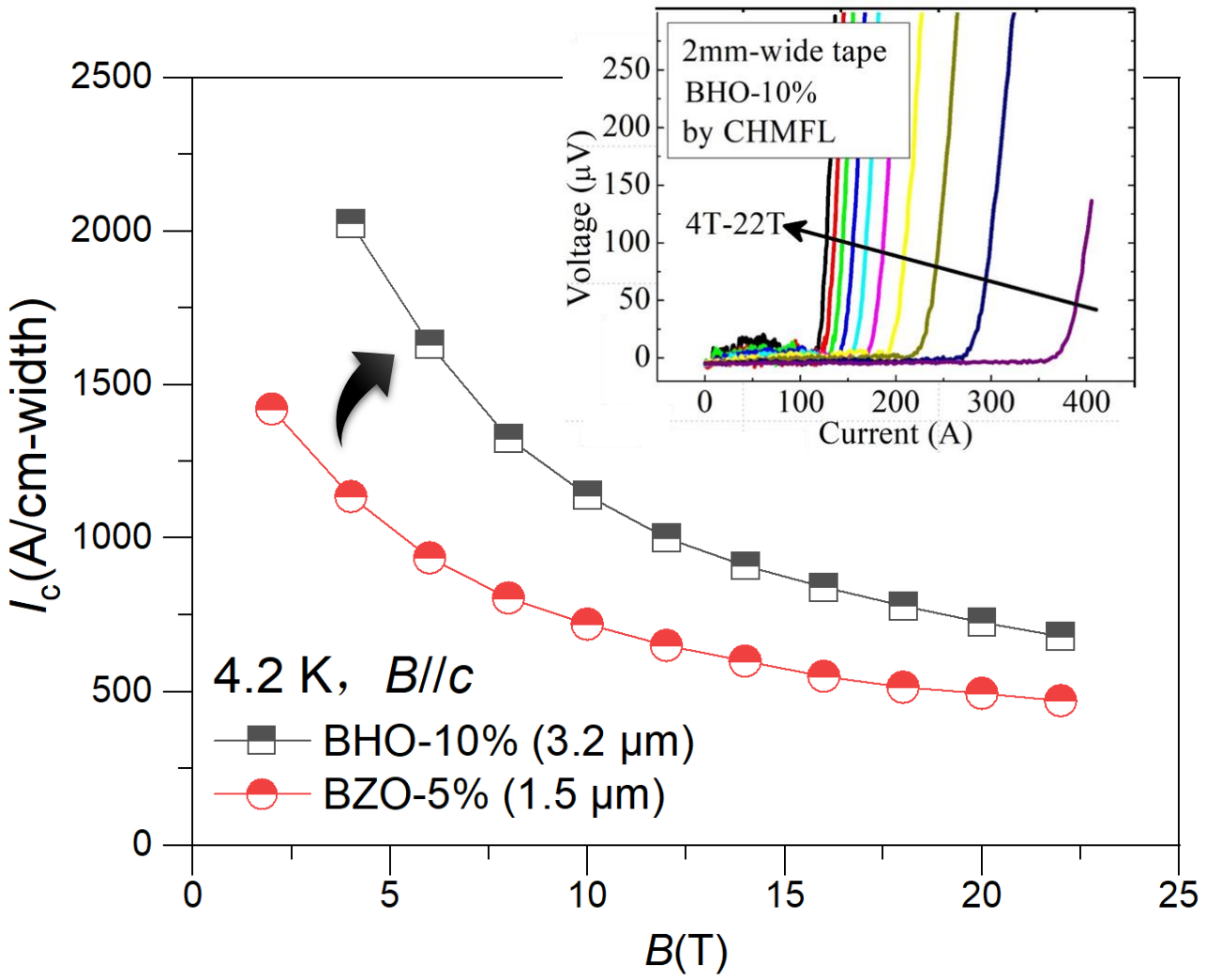


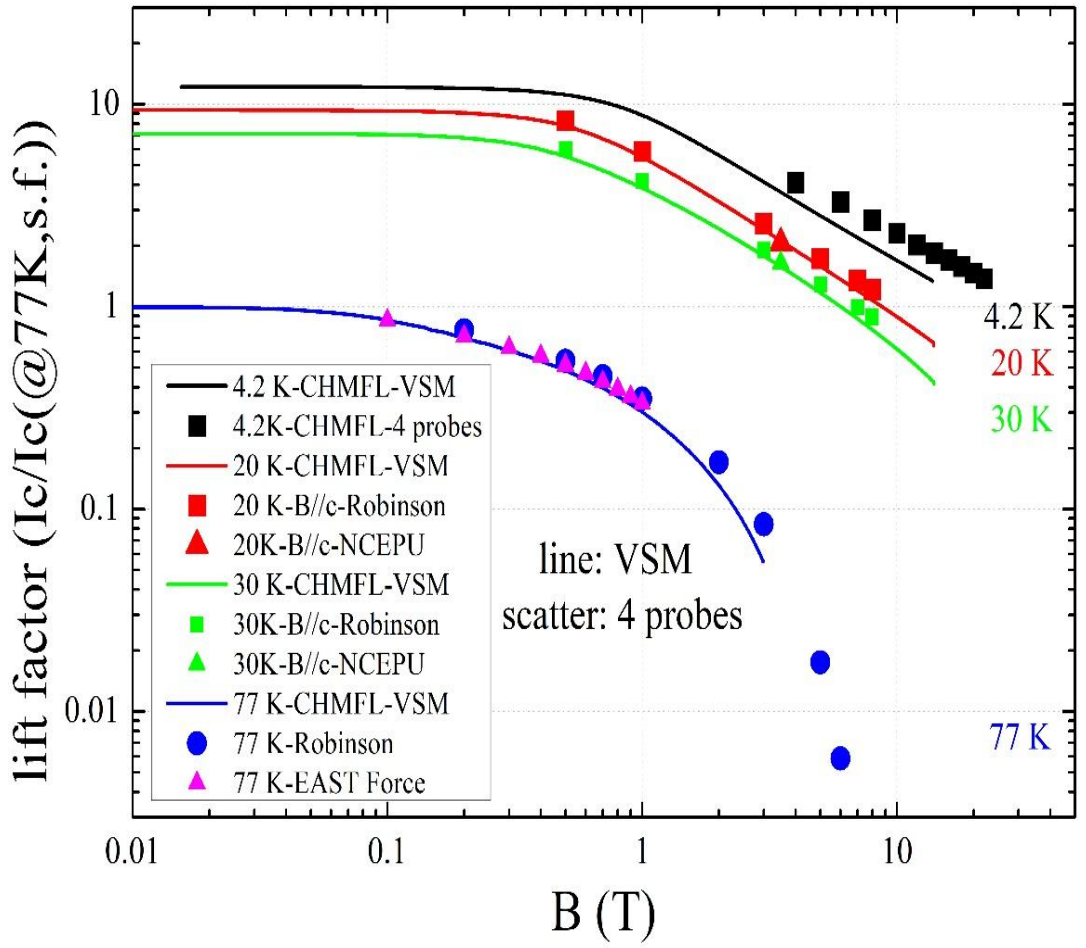


◆ **30K@3T (12mm-w)**



Improved in-field behavior for 4.2K and high field

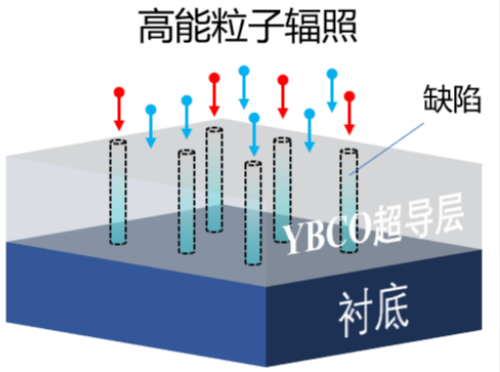




- I_c at 22T was improved from 470A/cm to 680A/cm at 4.2K, much big progress for commercial tapes

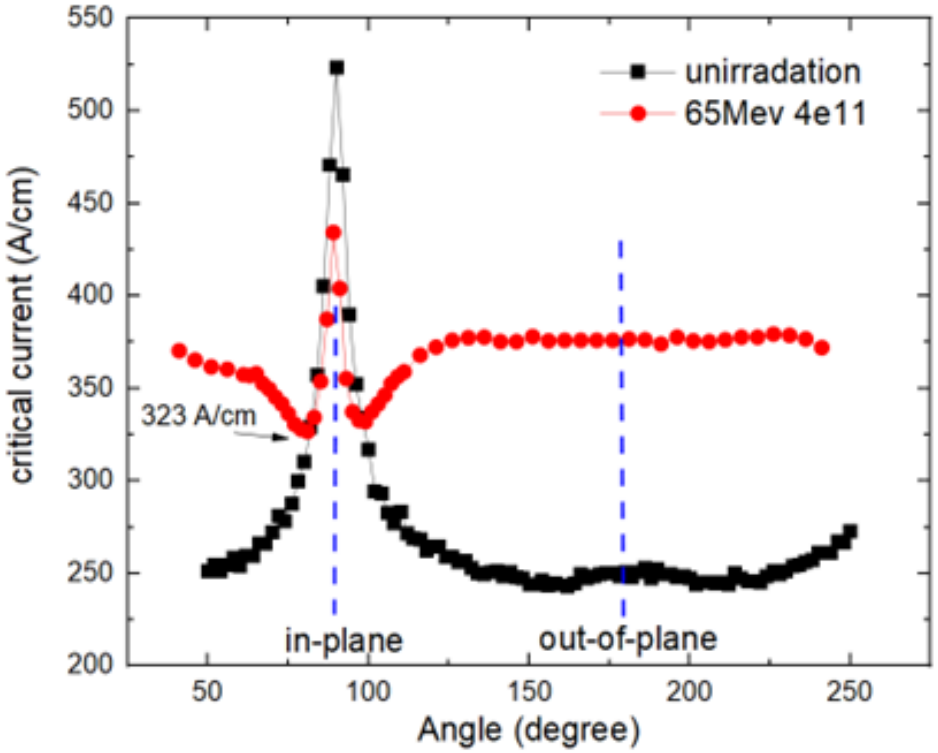
Measured by
- High Magnetic Field Laboratory of the Chinese Academy of Science (CHMFL)

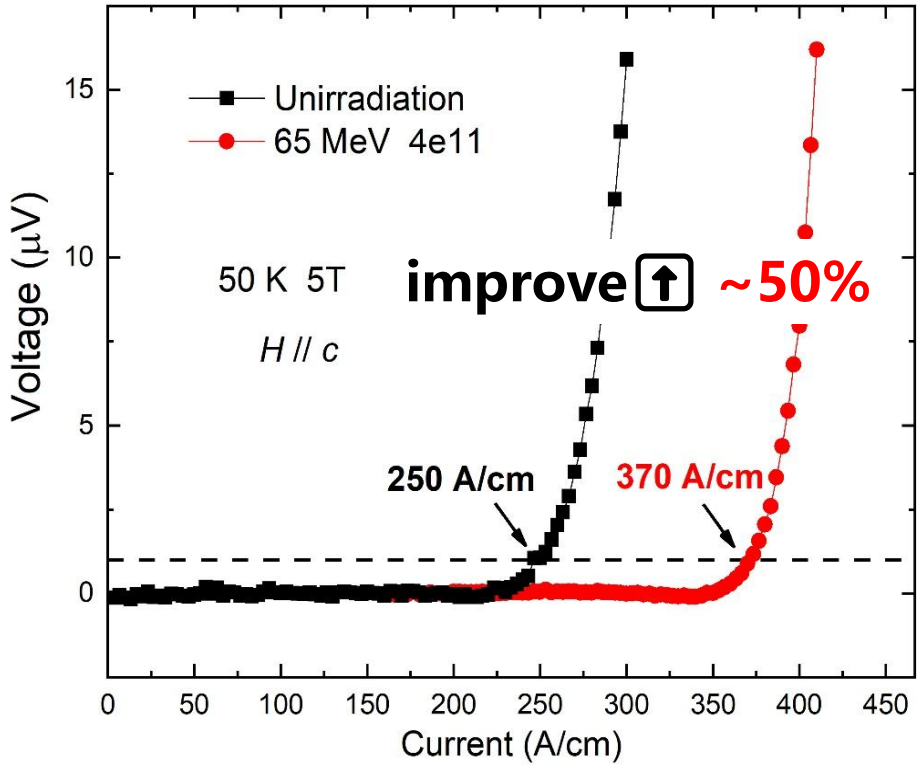
Synergistic effects of BHO-MOD REBCO & heavy ion irradiation



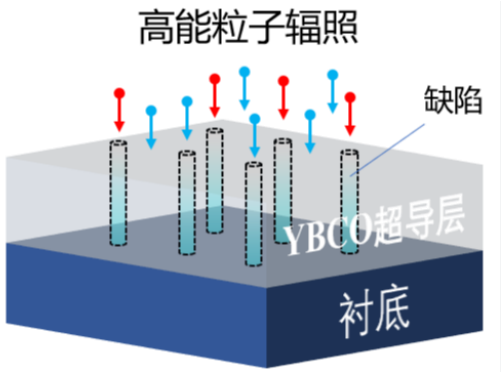
✓ **Xe ion irradiation at different energies significantly improves the mid-temperature field performance of the MOD-REBCO.**

Thanks to Professor Yanwei Ma and his team, IECAS.



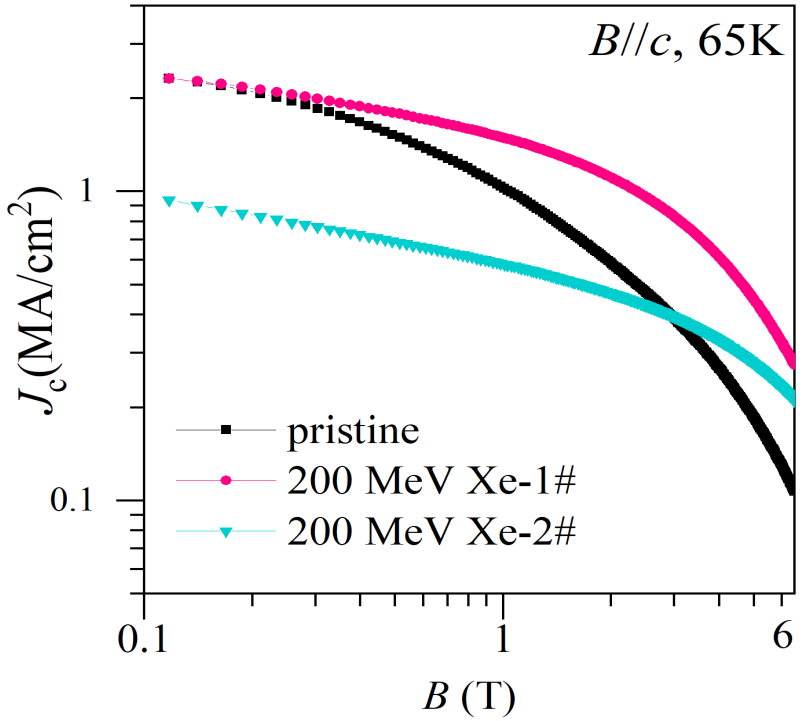


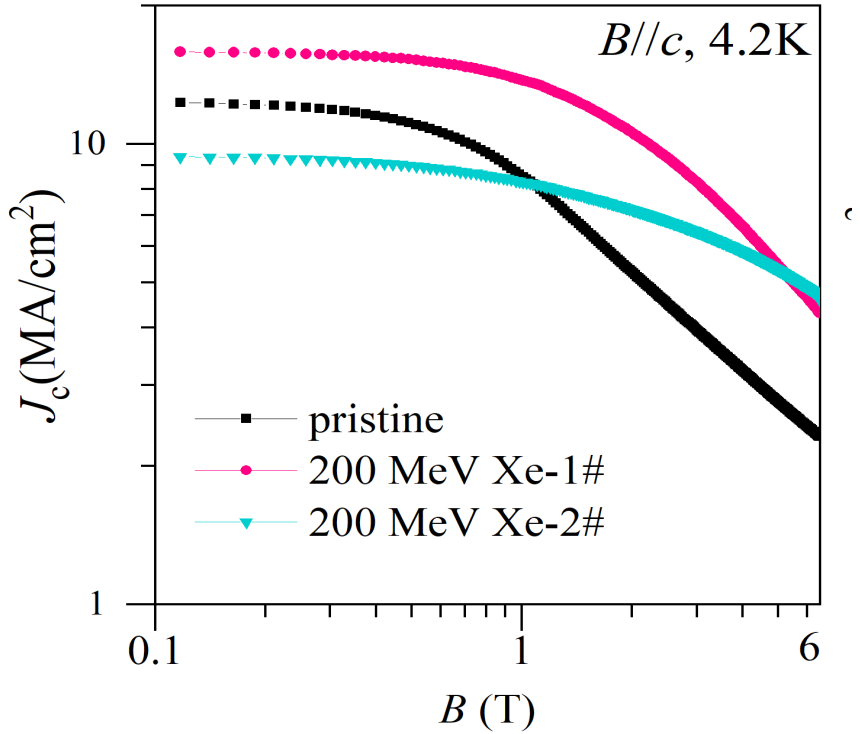
Synergistic effects of BHO-MOD REBCO & heavy ion irradiation



- ✓ **Xe ion irradiation at different energies significantly improves the mid & low-temperature field performance of the MOD-REBCO.**

Thanks to Professor Jie Liu and her team, IMP, CAS.





Outline

上创超导 Shanghai Creative SuperConductor

1 Introduction of Shanghai Creative superconductor

2 Recent progress of MOD-derived tape thick REBCO layer

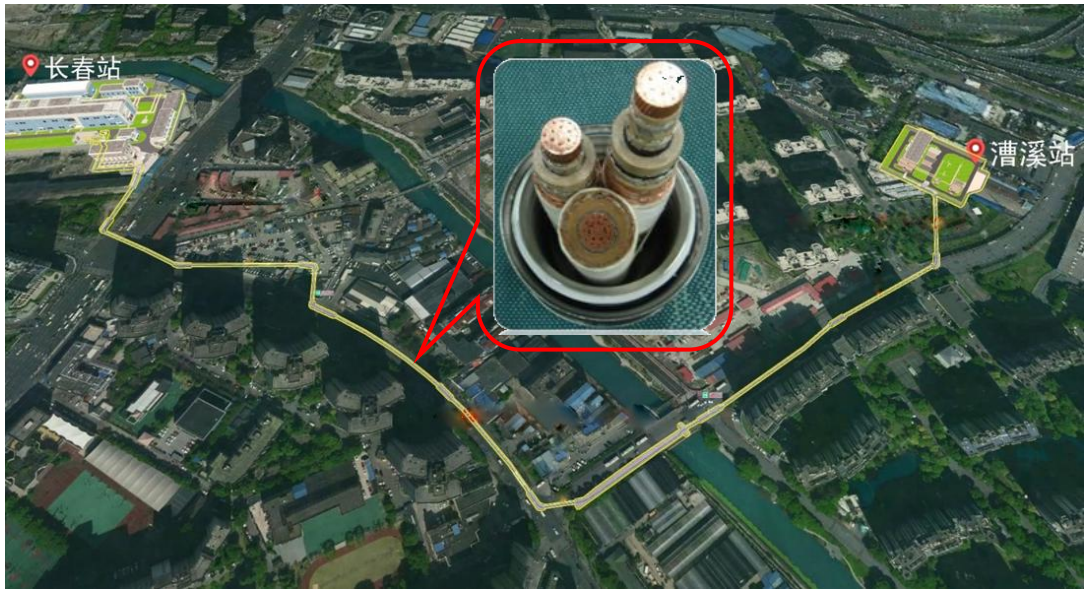
3 Tipical applications of HTS tapes supplied by SCSC

4 Latest Expansion Progress

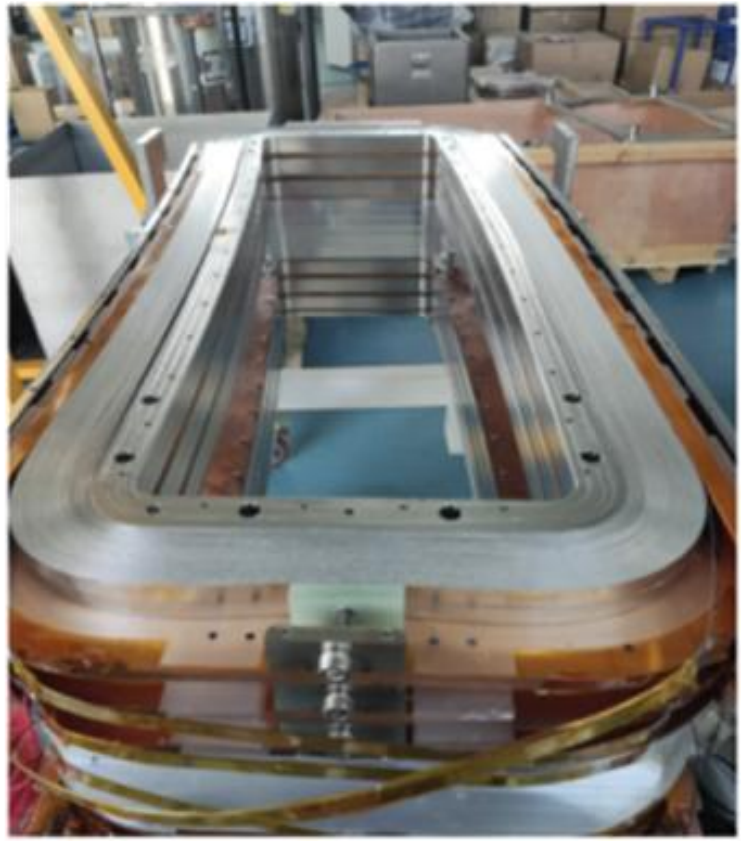
Typical Applications of thin REBCO tape of SCSC

Km-class HTS cable demon project in Shanghai

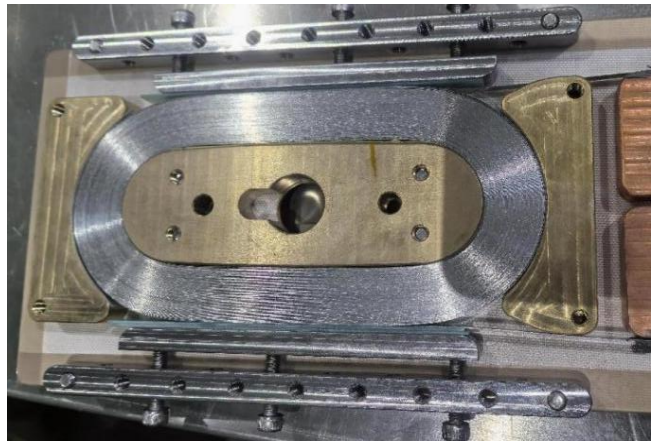
- Length: **1.2km**
- **Rated Current: 2.2kA**
- **Rated Voltage: 35kV**
- **Materials: HTS tapes form SST and SCSC**
- Cable Structure: **Three-phase integrated contracting**
- **Terminal type: Trinity**

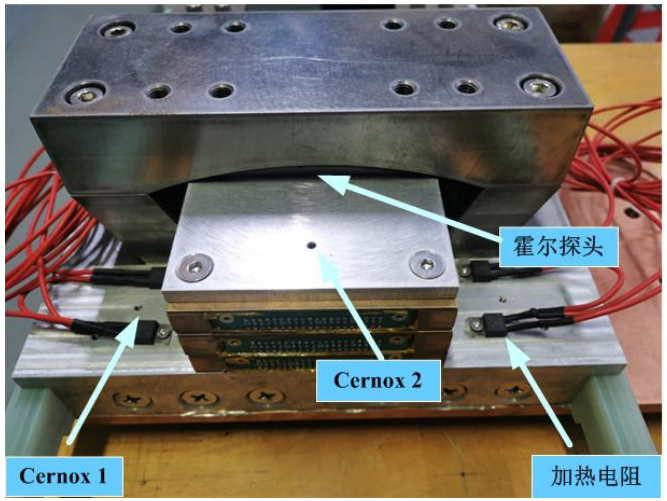


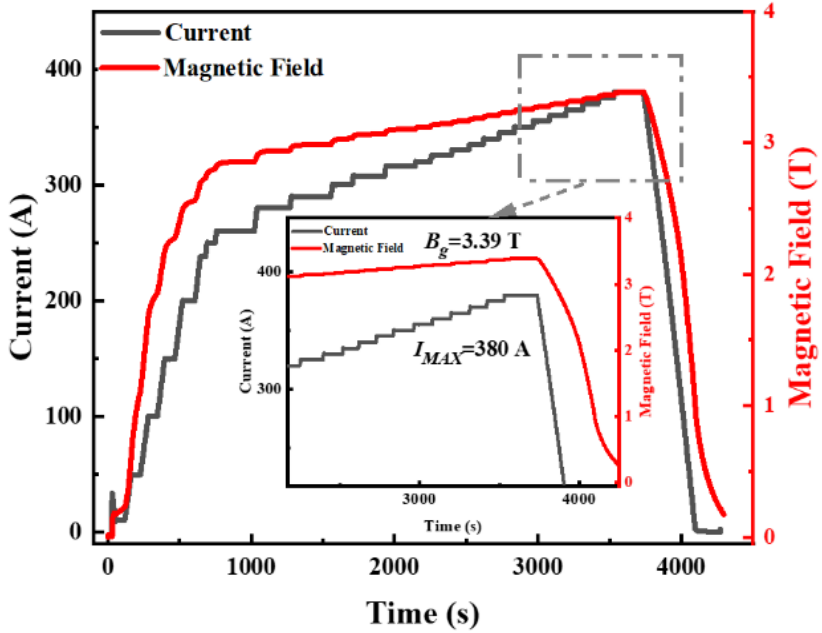
Large–size HTS magnet for 2GeV Accelerator

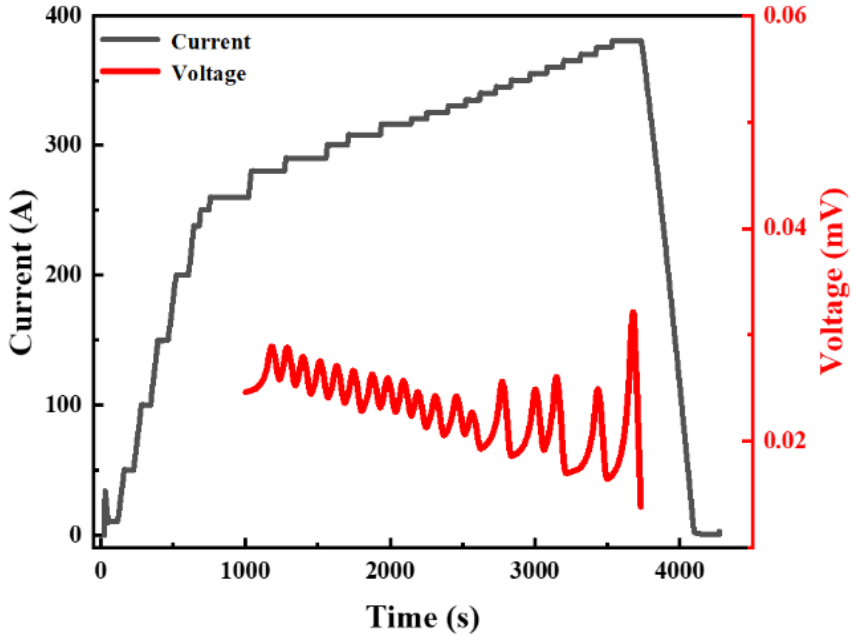


Compact 3T Magnet Design Using MOD REBCO





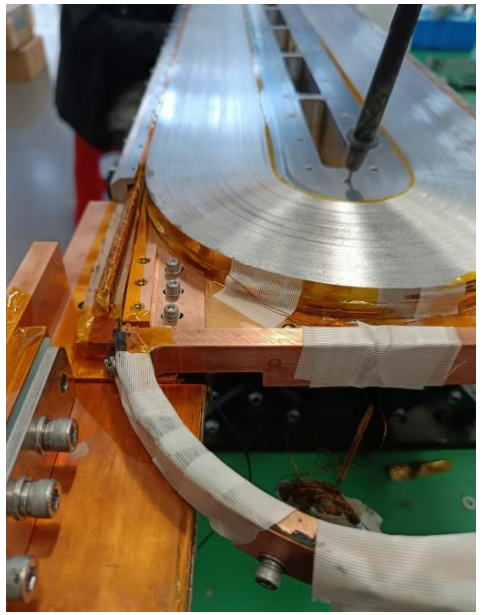


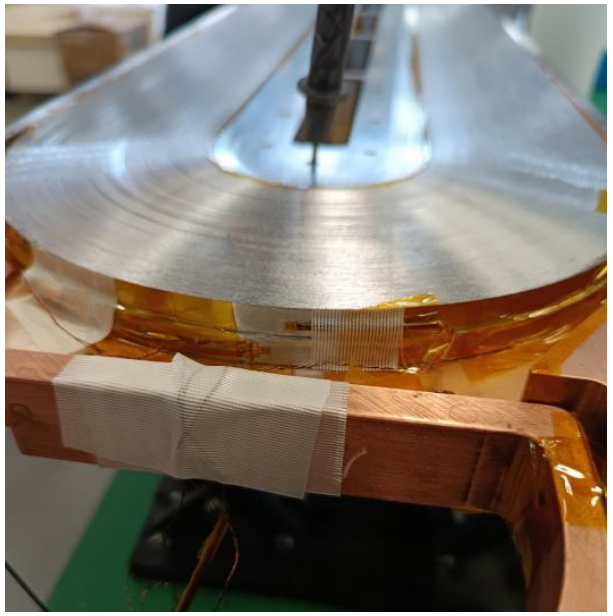


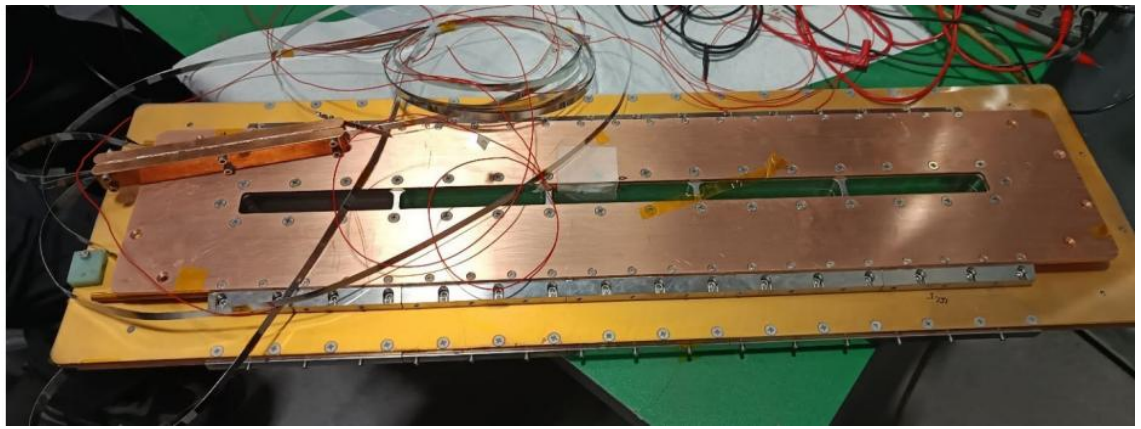
Air Gap (mm)	Excitation Current (A)	Central Magnetic Field(T)
3.5	380	3.39
15	392	3.04

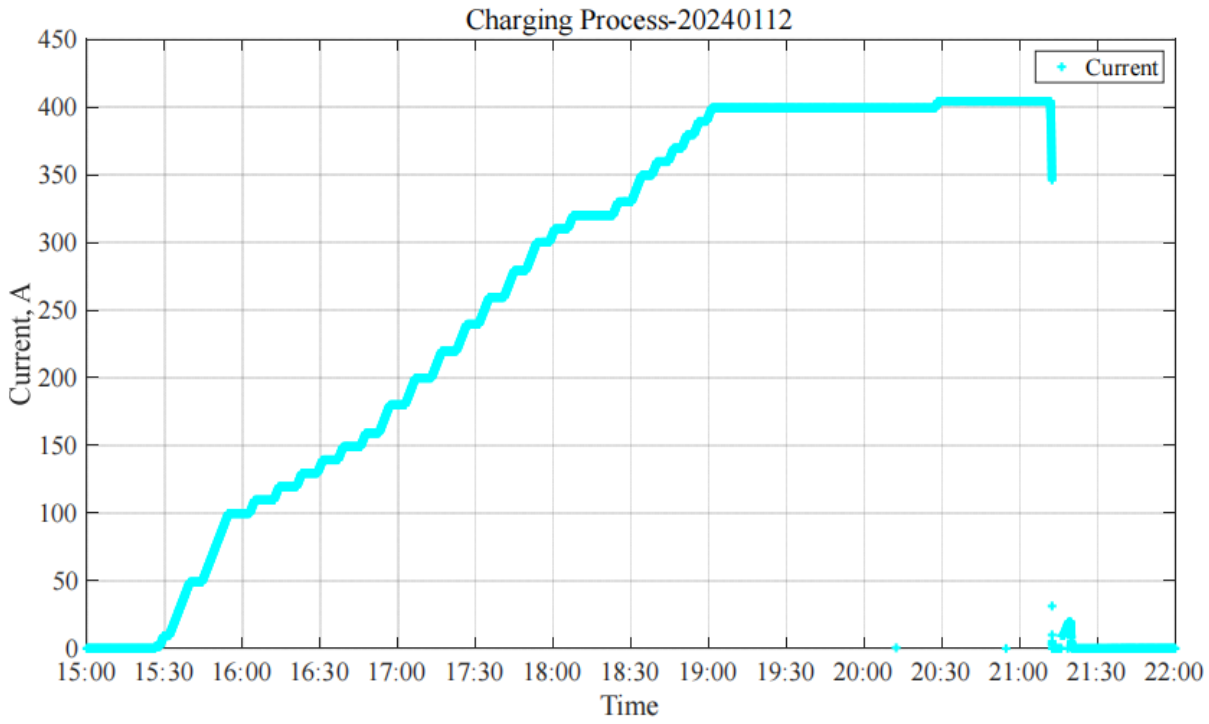
Breakthrough in Central Magnetic Field Performance, Showing Promising Application Prospects.

High-Field, Large-Scale Double-Pancake Coil of MOD Conductor









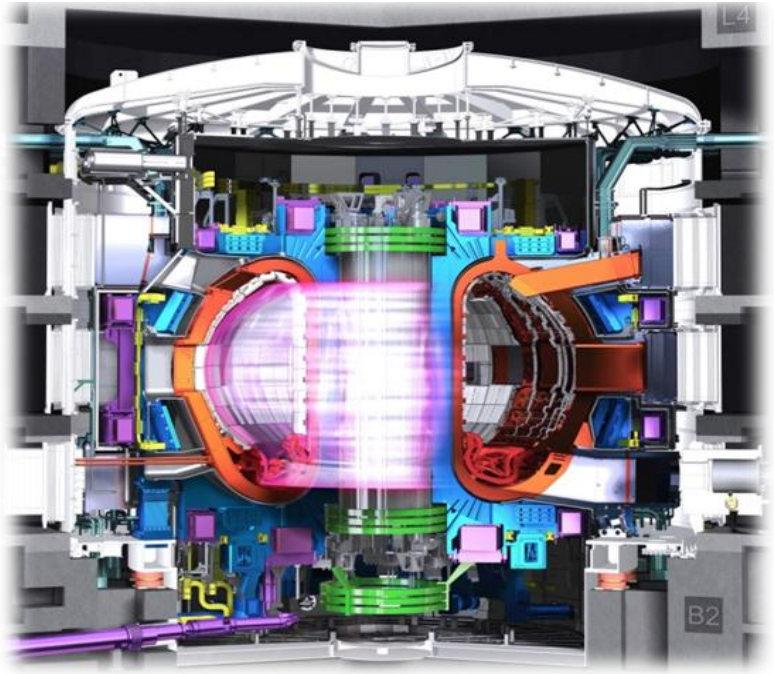
Critical Current Test:30 K, 400 A

(Industrial Partner: Suzhou Bama Superconductive Technology Co., Ltd.)

典型应用案例-核聚变超导磁体

上创超导

牵头国家重点研发计划-
磁约束核聚变能发展研究专项
(2022-2027)
(项目编号: 2022YFE03150100、2022YFE03150200)



项目负责人：**蔡传兵**

为聚变堆CS磁体提供高温超导解决方案

下游应用案例

中国科学院合肥物质科学研究院 等离子体物理研究所

- ✓ 已签订带材供货合同，实现批量供货，
- ✓ 预计装置超导带材需求上万公里

核工业西南物理研究院 Southwestern Institute of Physics

- ✓ 已签订带材采购合同，实现批量供货

能量奇点 ENERGY SINGULARITY　STARTORUS FUSION 星环聚能　中国聚变 CFEC　超磁新能 SUPERMAG ENERGY

- ✓ 带材采购洽谈中

新奥集团 ENN GROUP　翌曦科技 YIXI TECHNOLOGY

- ✓ 已签订带材采购合同，实现批量供货

Outline

1. Introduction of Shanghai Creative superconductor
2. Recent progress of MOD-derived tape thick REBCO layer
3. Tipical applications of HTS tapes supplied by SCSC
4. **Latest Expansion Progress**

产能规划：计划扩产落地7条高温超导带材产线



	2025	2026	2027	2028	2029	2030
现有中试产能	300 公里/年					
I期建成 5条产线		3000 公里/ 年				
II期新增 7条产线				10000 公里/ 年		

本次产能建设规划

- 计划落地12条产线，每条产能600~1000公里/年，**26年达产3000公里/年，28年达产10000公里/年**
- 总投资8.5亿元，一期投资3.5亿元，在上海、合肥、张家港新建5条产线，预计于2026年下半年投入使用；二期总投资5亿元，新增7条产线。

产线建设进度：预计下半年新增超2000km产能

上创超导

安徽基地





- **基地定位**：重点针对合肥及周边核聚变产业需求
- 在建产线2条，单条产能600公里/年
- 已于26年7月投入使用，满产后达1200公里/年

江苏基地





- **基地定位**：重点针对长三角地区可控核聚变及超导电缆需求
- 在建产线2条，单条产能600公里/年
- 预计26年8月投入使用，贡献产能1200公里/年

THANKS

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