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Challenges and advances in thick film REBCO tapes

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Why thick REBCO film?

Benefit of REBCO:

- Best available candidate for high field applications over a wide range of temperature, 77K - 4.2K

Major bottleneck in its commercialization:

- High cost/performance metric
- High manufacturing cost
- Limitation in current carrying capability
- Current commercial production restricted to 1-2 μm films

Probable solution:

- Thick REBCO with high performance and low cost
- Same critical current density (J_c) – higher Engineering current density (J_e) – high critical current
- Reduces amount of superconductor quantity required – light weight compact machines – improves machine efficiency

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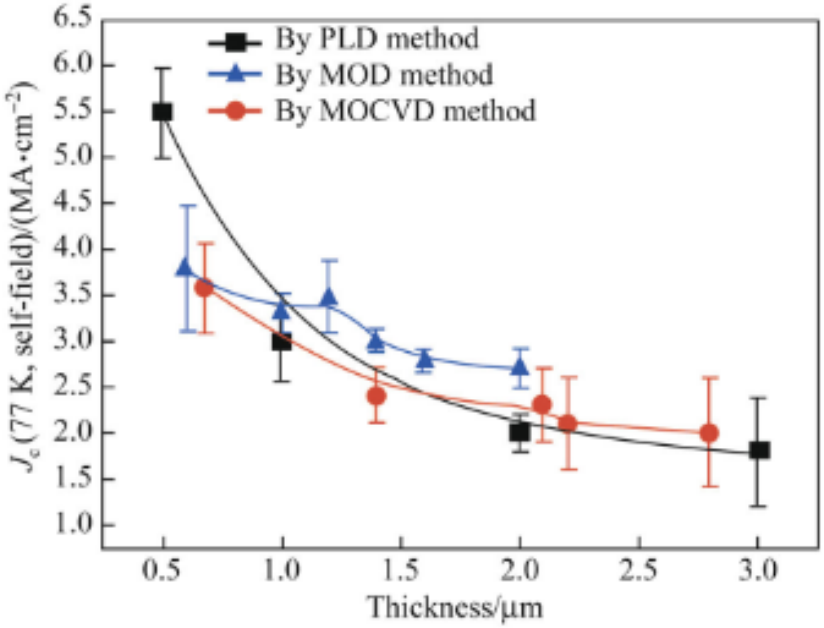
Major challenge: Deterioration of J_c with increasing thickness independent of technique



Lin, Jian-Xin, et al. "A review of thickness-induced evolutions of microstructure and superconducting performance of REBa2Cu3O7− δ coated conductor." *Advances in Manufacturing* 5.2 (2017): 165-176.

Reasons for deterioration :

- Degradation of texture quality - Deadlayer formation
- Formation of a-axis oriented grains
- Residual stress
- Increase in surface roughness

Tackling thick films J_c deterioration issue needed out of the box approach in processing techniques and its optimization

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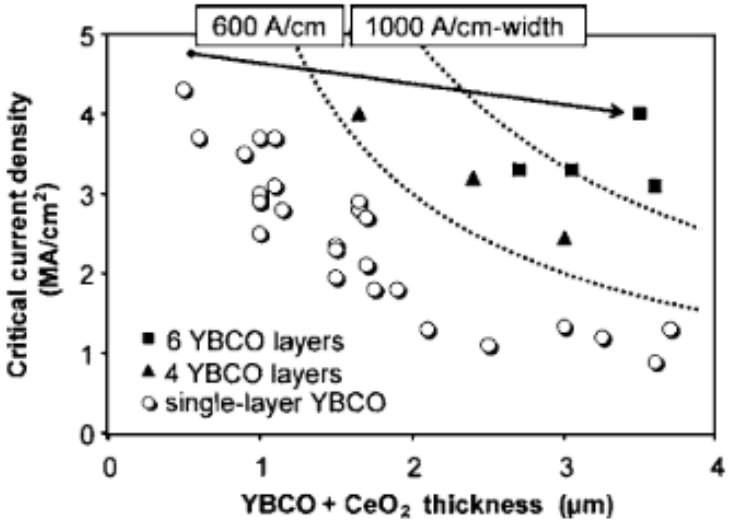
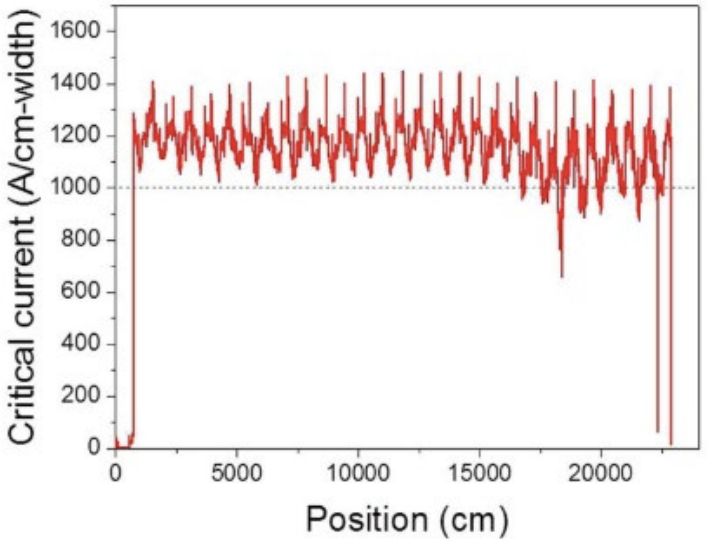
Major advances in Thick REBCO films: Self-field J_c improvement



Multilayer approach:

Foltyn, S. R., et al. "Overcoming the barrier to 1000 A/cm width superconducting coatings." *Applied Physics Letters*87.16 (2005): 162505.



Kim, Ho-Sup, et al. "Ultra-high performance, high-temperature superconducting wires via cost-effective, scalable, co-evaporation process." *Scientific reports* 4 (2014): 4744.

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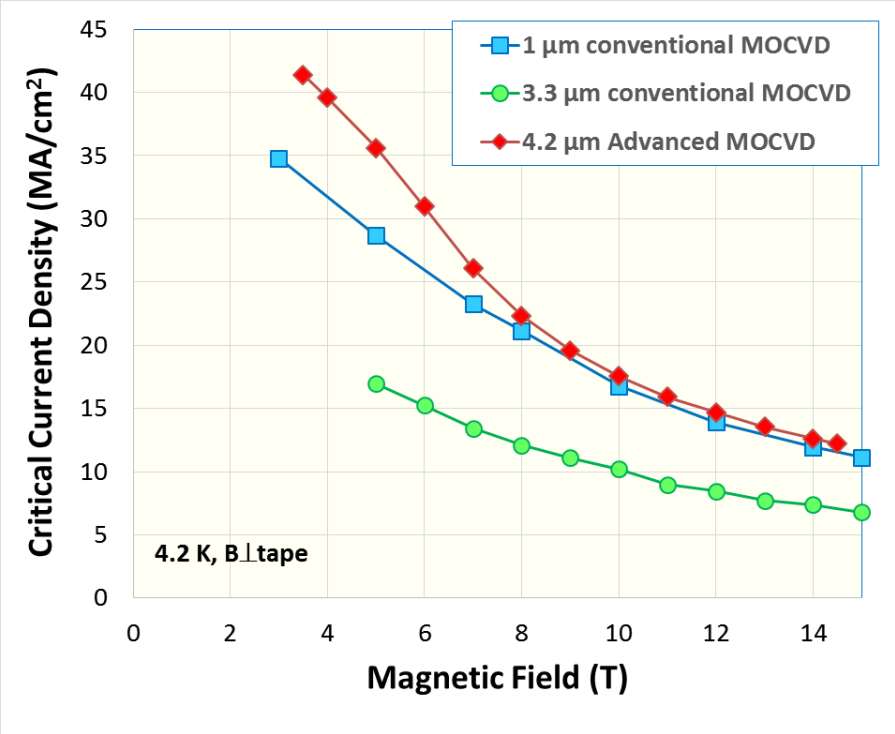
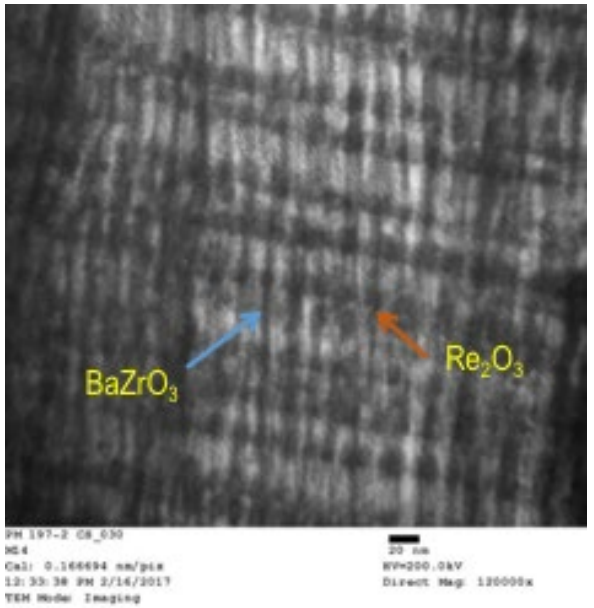
Major advances in thick REBCO films: In-field J_c improvement





Majkic, Goran, et al. "Over 15 MA/cm 2 of critical current density in 4.8 µm thick, Zr-doped (Gd, Y) Ba 2 Cu 3 O x superconductor at 30 K, 3T." *Scientific reports* 8.1 (2018): 6982.

J_c of 4.2 µm thick film by Advanced MOCVD comparable to 1 µm thick films

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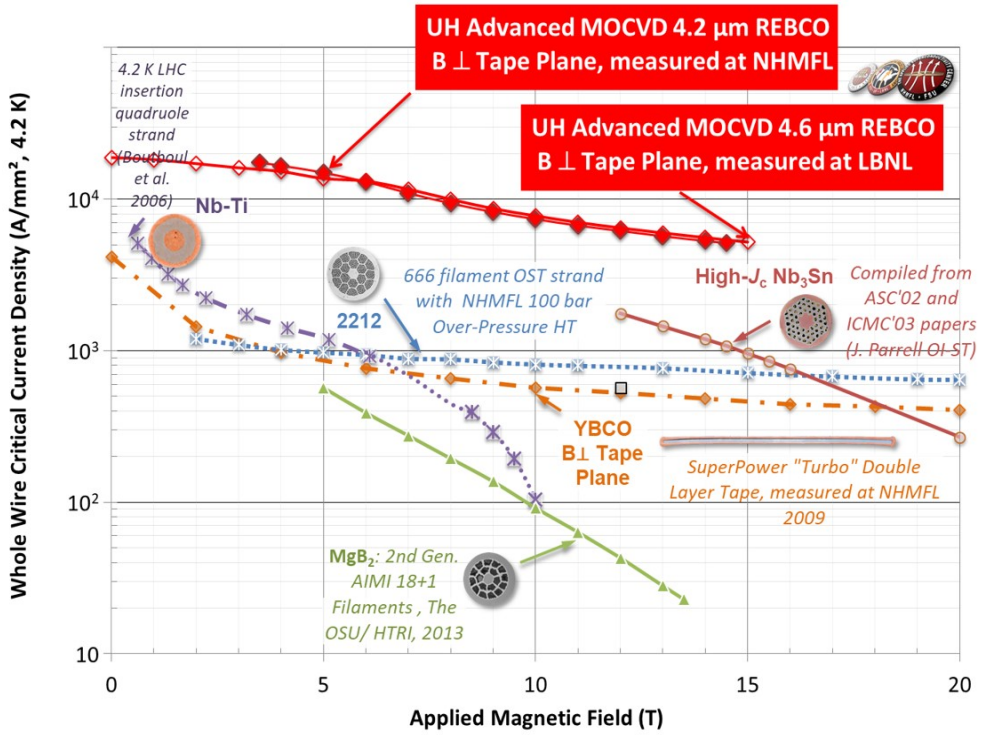
Major advances in Thick REBCO films: In-field J_c improvement



Majkic, Goran, et al. "Engineering current density over 5 kA mm− 2 at 4.2 K, 14 T in thick film REBCO tapes." *Superconductor Science and Technology* 31.10 (2018): 10LT01.

J_e of 4+ µm REBCO 5X Nb_3Sn @ 14 T

High performance, long length, thick REBCO film tapes has a potential to contribute towards a better, brighter and greener future

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Thank You

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