Texture Development in 2-3 μm Thick YBCO Films Synthesized by BaF_2 and MOD Processes on Metal RABiTS™

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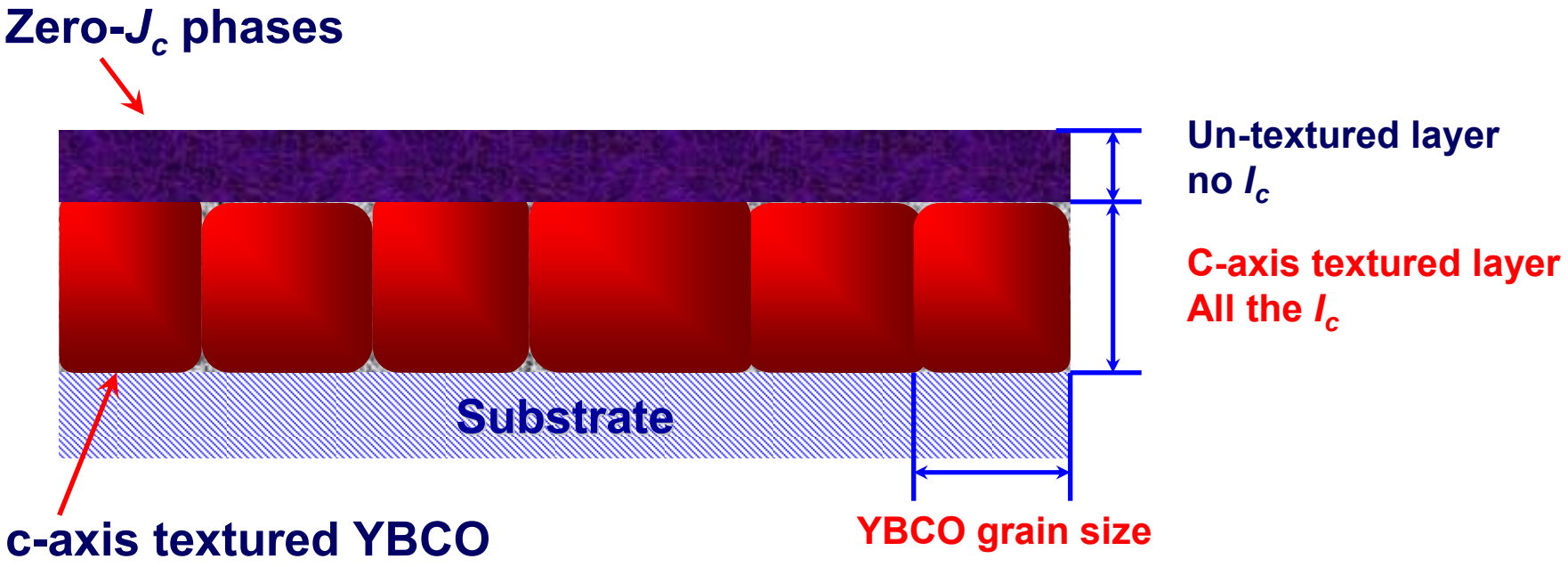
Outline

- Introduction
- Diagnostics of the texture
- J_c relation to the growth:
  - Quantity factor
  - Quality factor
- Conclusion

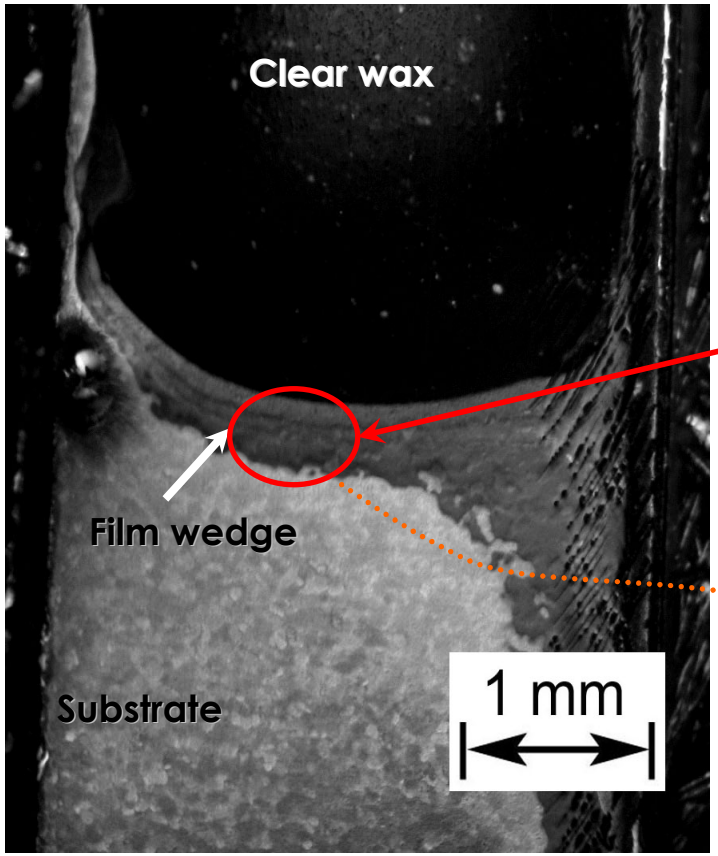
Introduction: how the growth is related to J_c

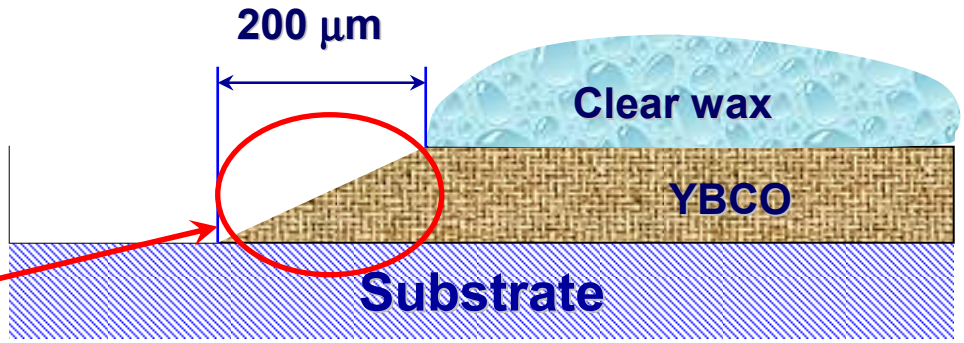
Model of the ex-situ YBCO conversion

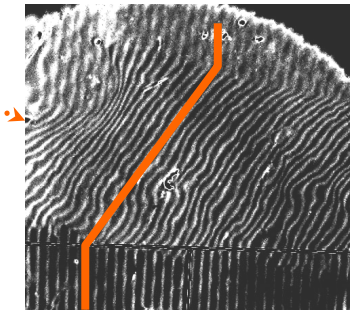


- Two goals of the growth optimization:
  - Suppress growth of zero-J_c phases
  - Maximize crystalline quality of the c-axis textured YBCO

Local structure diagnostics: low-angle polishing







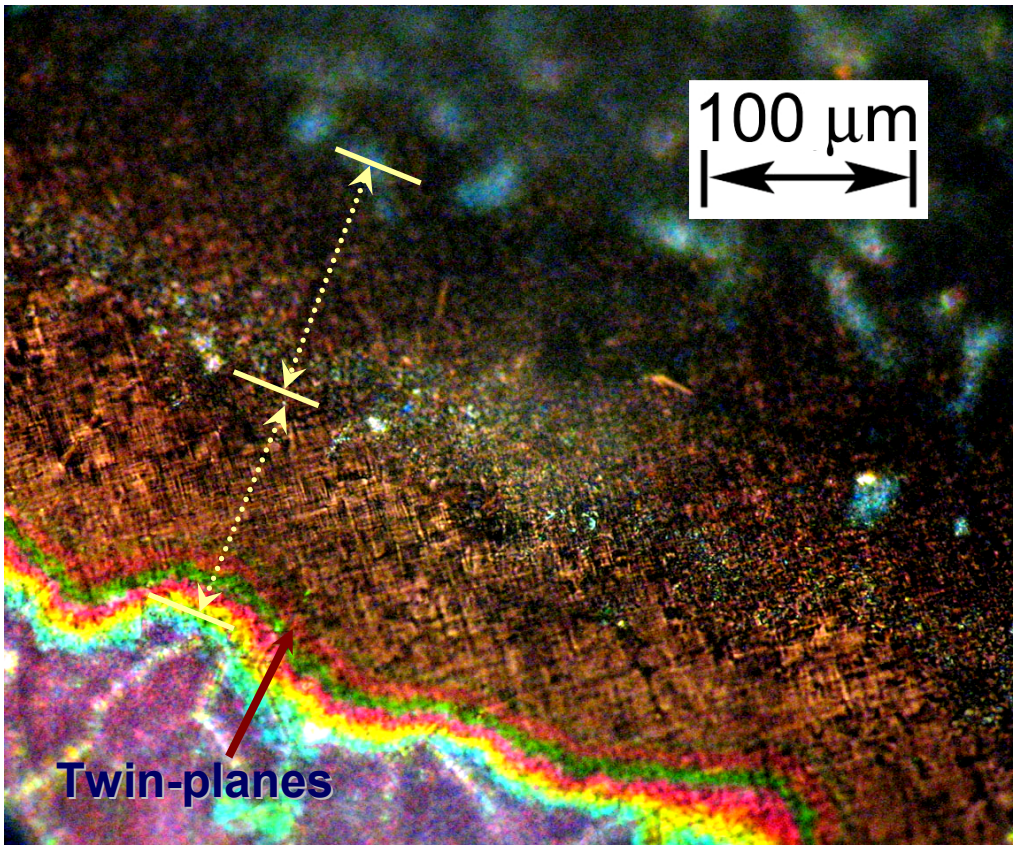
Interferometry: Linear thickness profile

➢ **Low-angle polishing gives a full picture of the film morphology in 10 minutes.**

Quantity factor: thickness of c-axis oriented layer

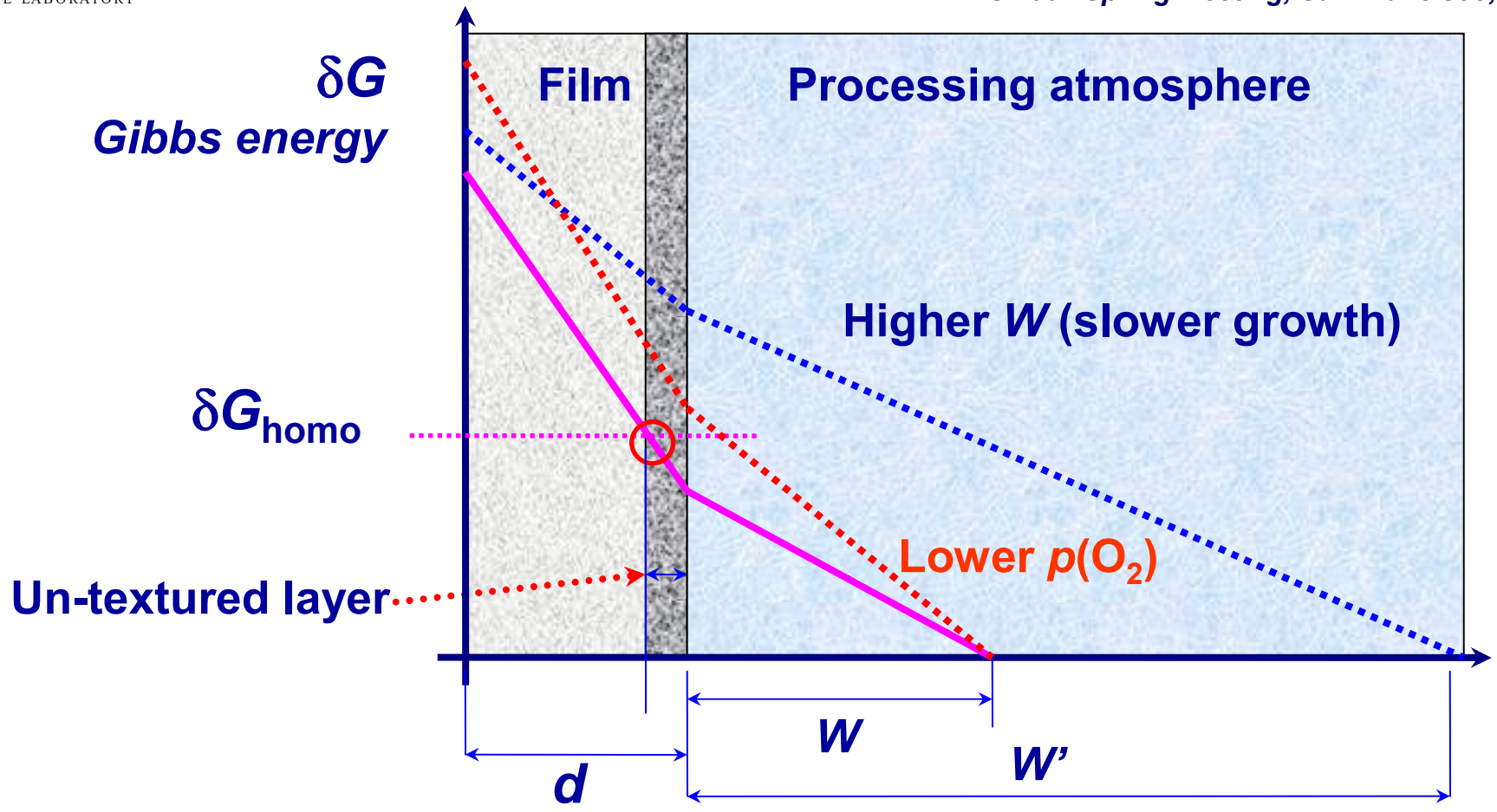
Un-textured layer

C-axis textured layer



- **Typical texture defect: un-textured pre-surface layer.**

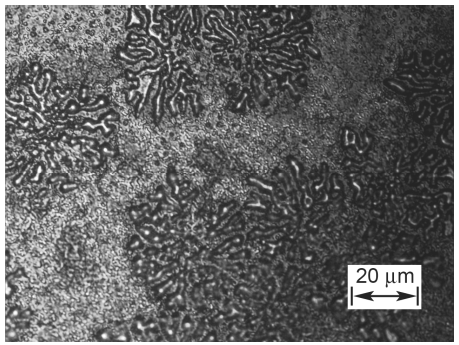
Thermodynamic analysis: role of p(HF) gradients

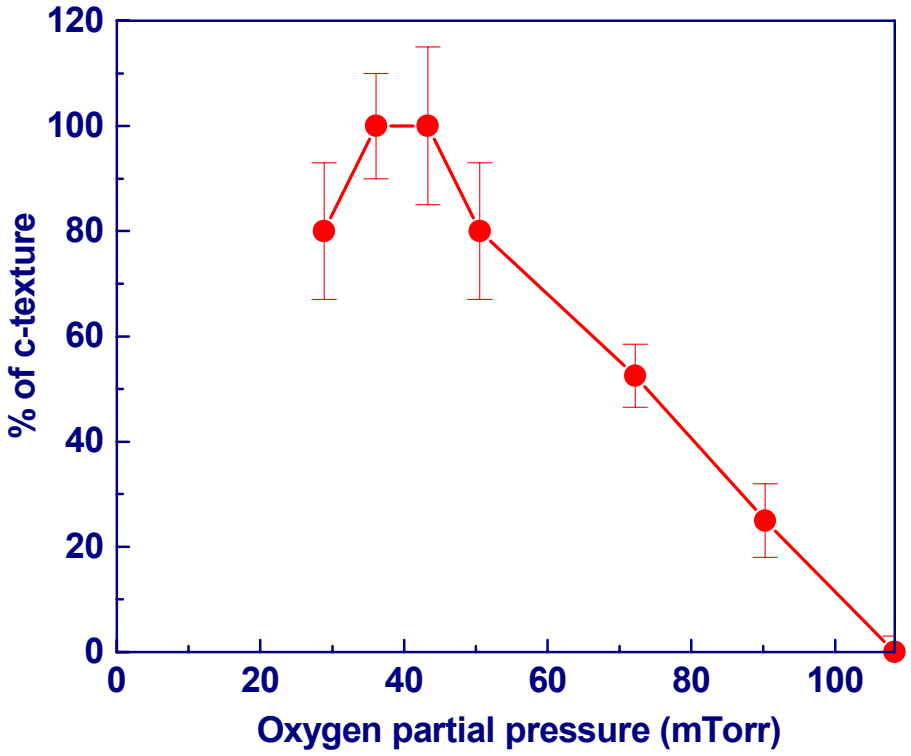


- We can reduce $p(O_2)$ or/and increase *W* to suppress homogeneous nucleation.

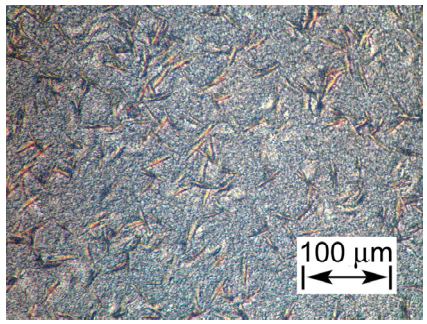
Quantity factor: maximize effective cross-section

Low $p(O_2)$: Ba-Cu-O phases





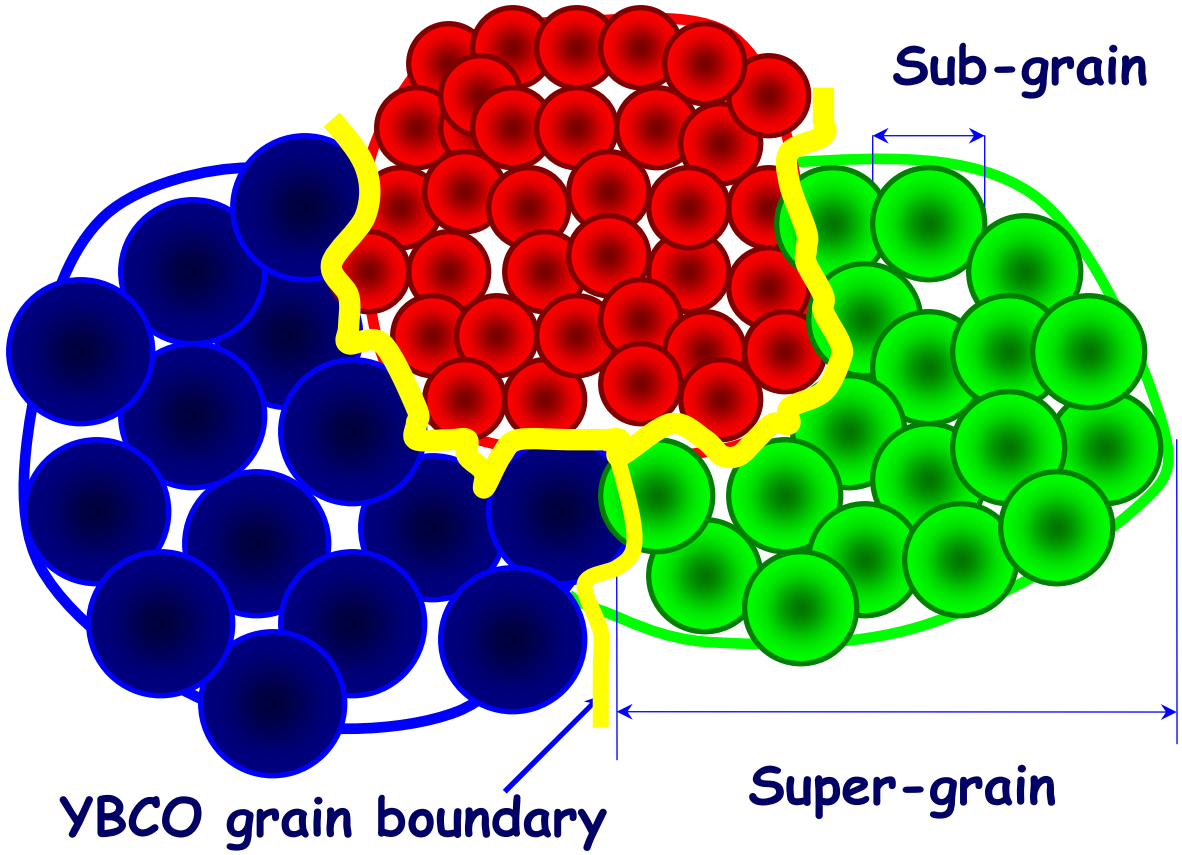
High $p(O_2)$: Random YBCO



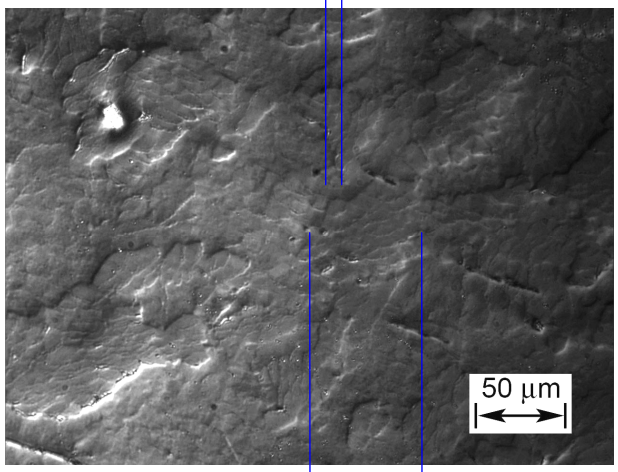
- **At optimum $p(O_2)$ c-axis oriented YBCO occupies 100% of the film cross-section.**

Quality: what makes perfect YBCO layer?

Complete YBCO layer



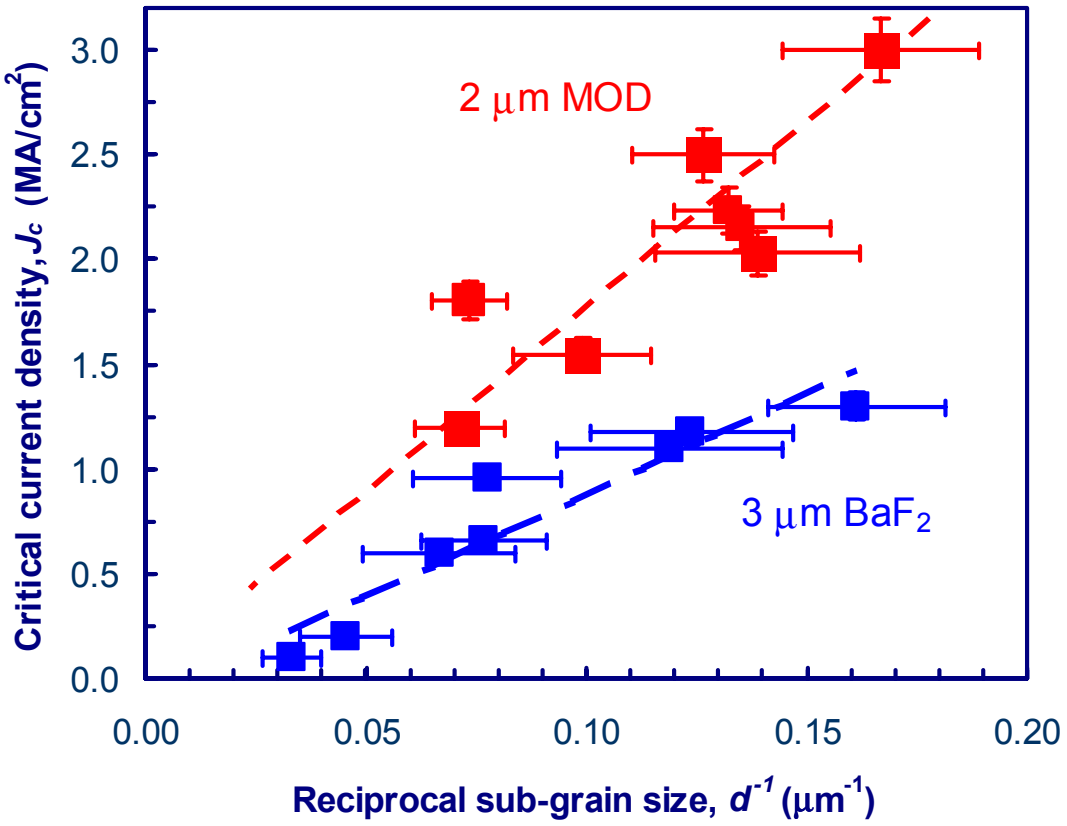
Sub-grain ≈ 10 μm



Super-grain ≈ 50 μm

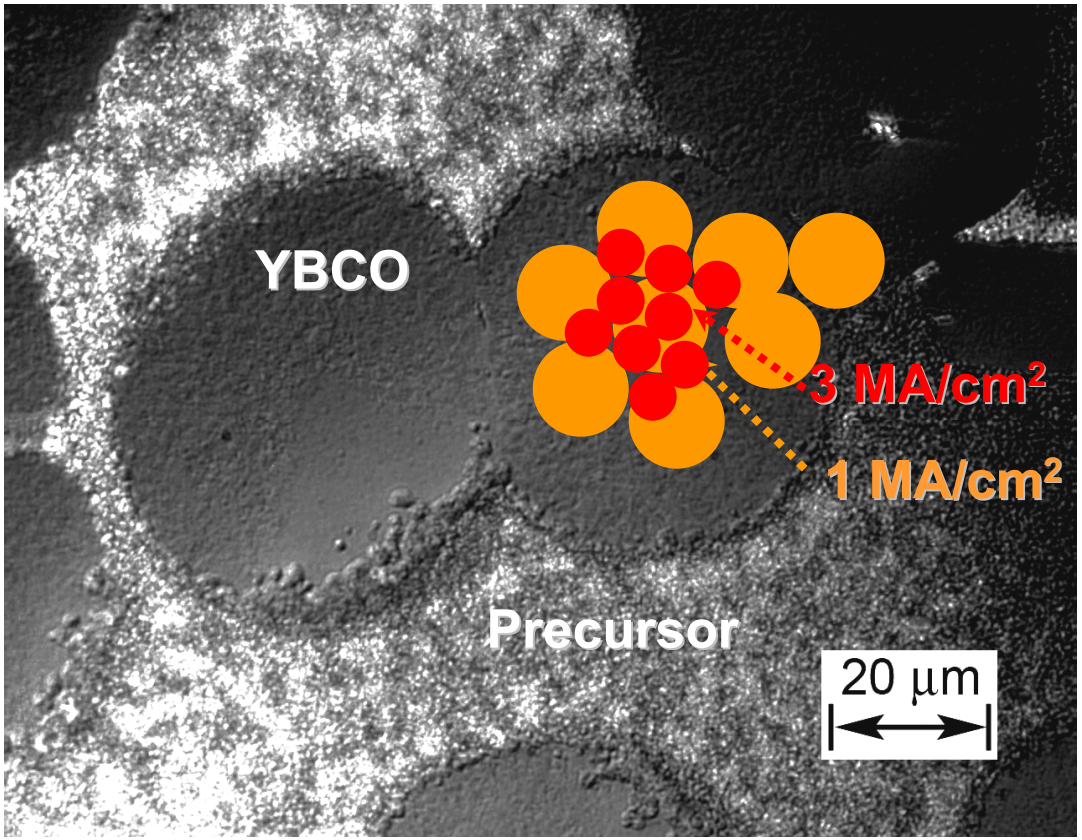
- Small sub-grains make good YBCO layer.

Sub-grain size effect: 2 μm MOD vs. 3 μm BaF_2



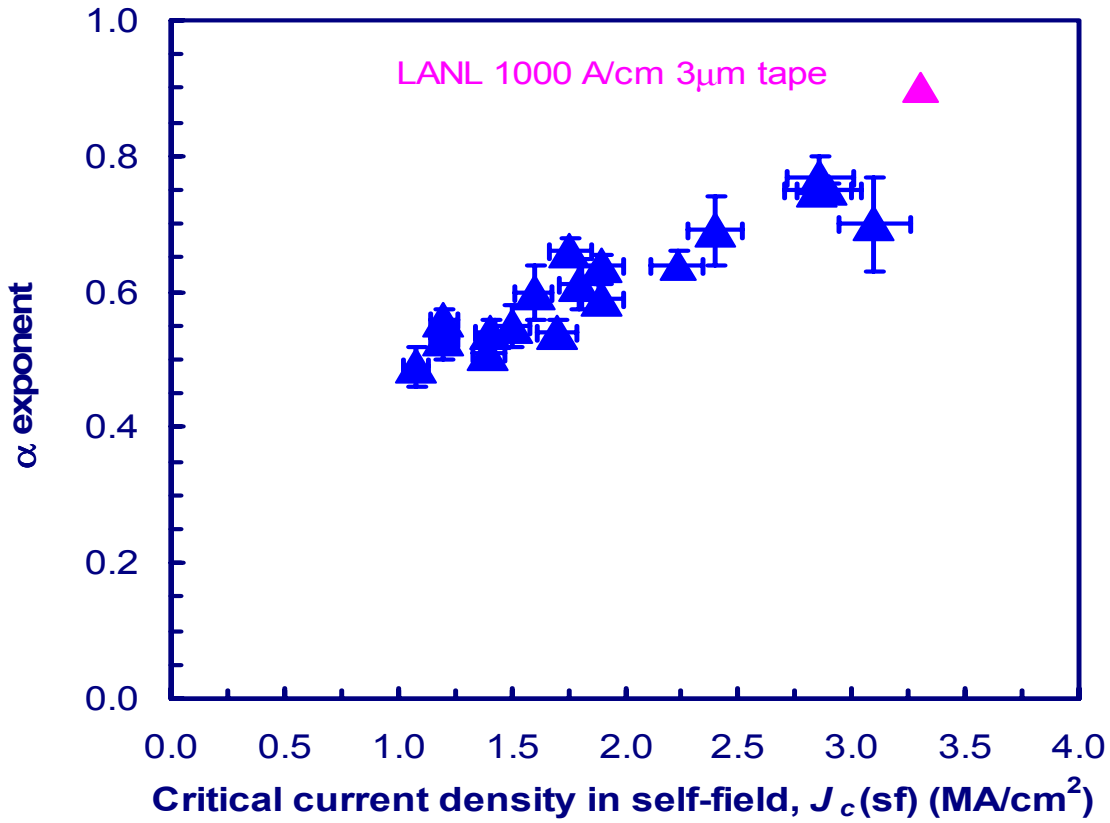
- J_c is inversely proportional to the sub-grain size!

Why small grains make good material? *or* Why large grains make bad material?



- Structure degrades when the nuclei expand laterally.

α vs. J_c in 2 μm MOD films



- **Is weaker high field pinning is the price for high self-field J_c?**

Conclusion

- To achieve >3 MA/cm^2 we need 100% texture and <10 μm grains
- The quantity factors:
  - Homogeneously nucleated YBCO
  - Epitaxial random YBCO
  - Other zero-J_c phases
- The quality factor: sub-grain size