

Imaging Domain Structures In Strongly Correlated Oxide Crystals

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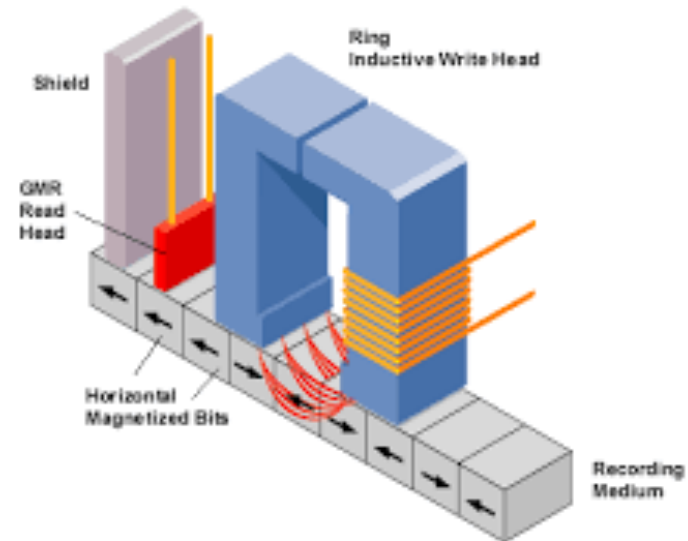
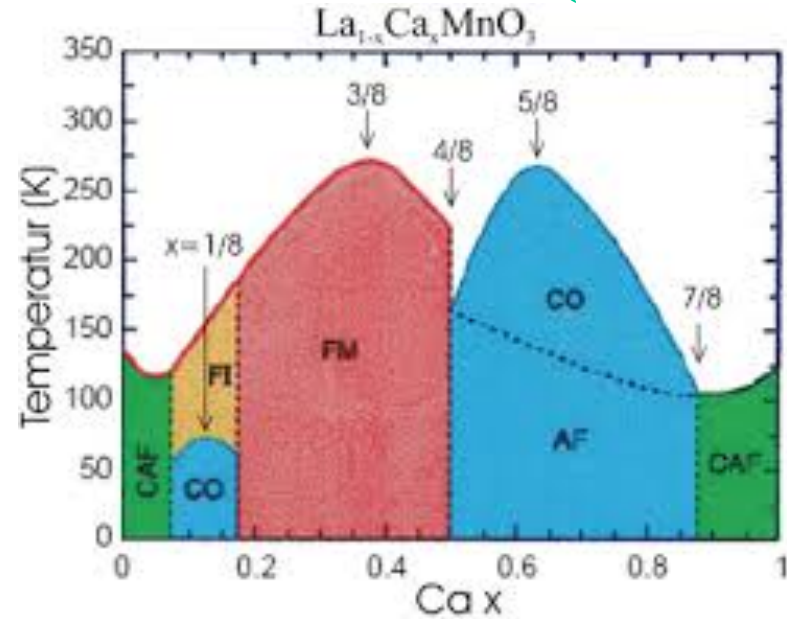
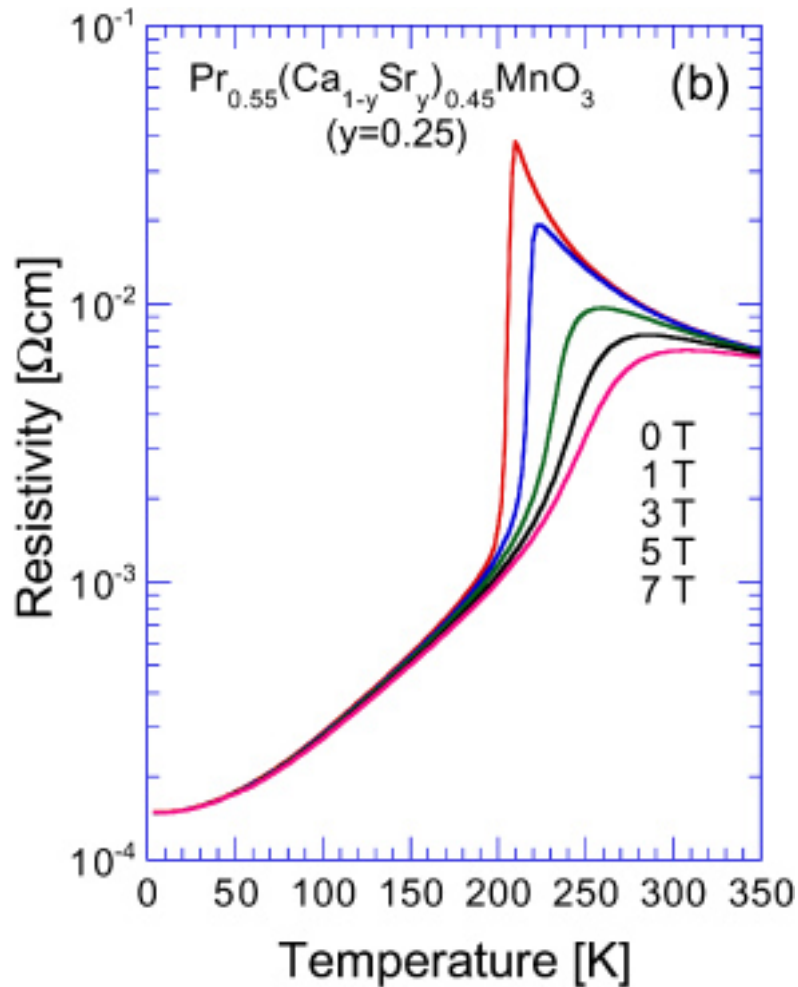
Brookhaven National Lab

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XTOP, Bari, Italy

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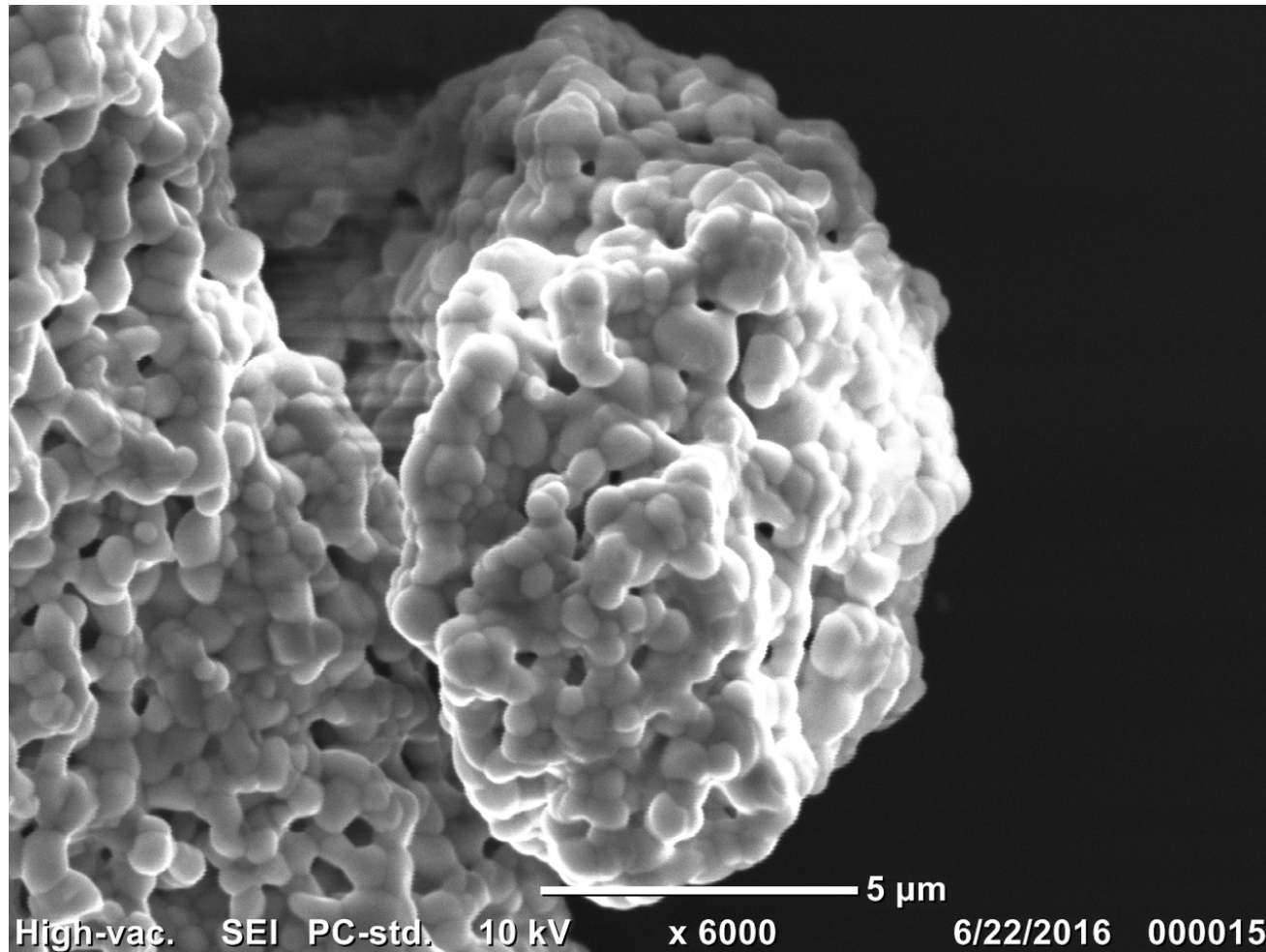
Colossal Magnetoresistance (CMR)



I. K. Robinson,

$\text{La}_{0.5}\text{Ca}_{0.5}\text{MnO}_3$ (LCMO) nanocrystals

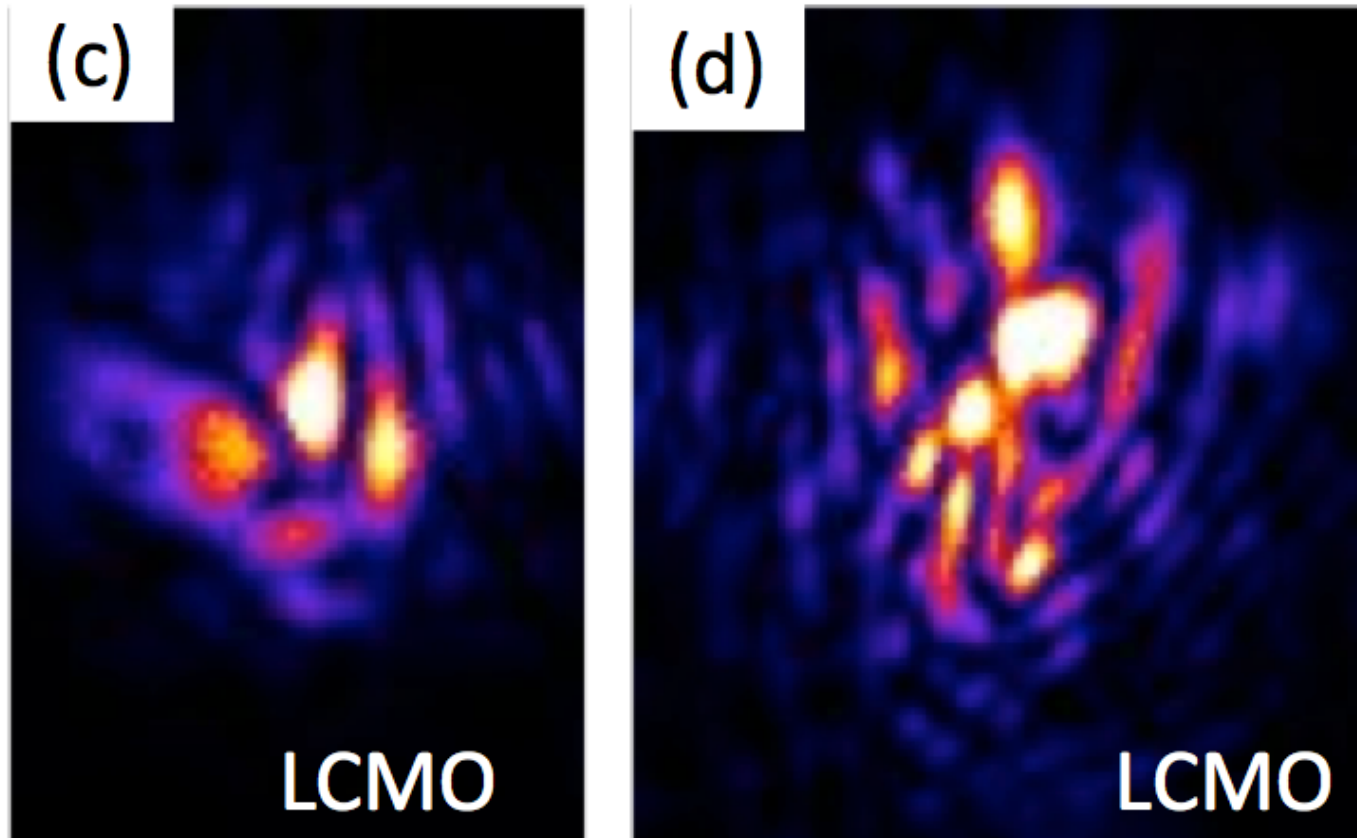
SEM by Xiaojing Huang



I. K. Robinson, XTOP 2018

BCDI from $\text{La}_{0.5}\text{Ca}_{0.5}\text{MnO}_3$

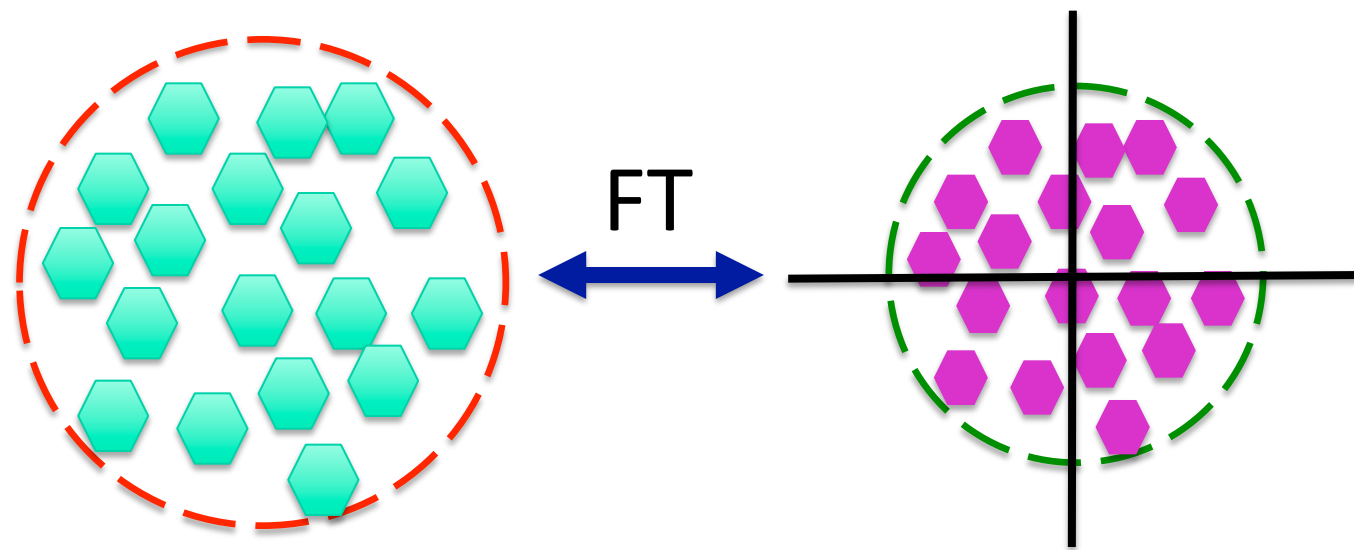
LCMO-500, Ian McNulty and Jon Logan, 34-ID-C Argonne



Domain structures give speckled diffraction

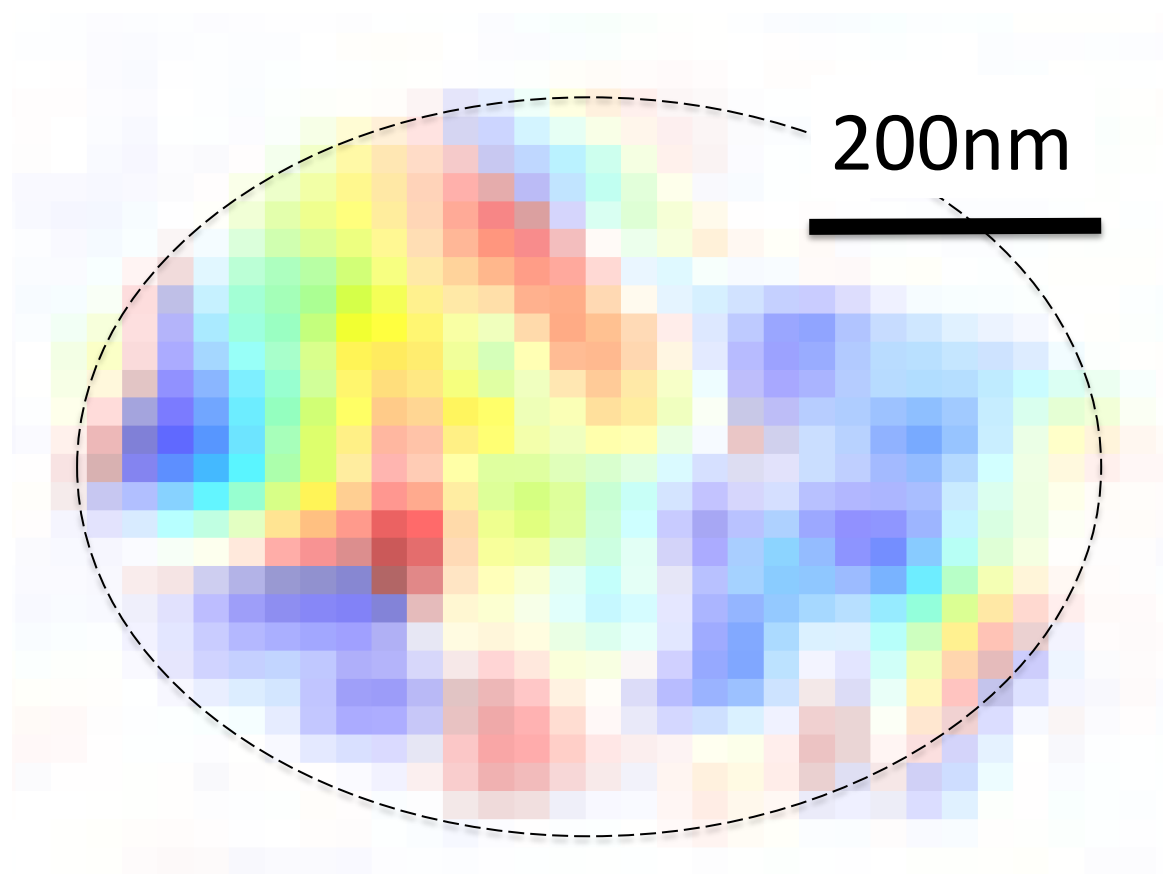
Real Space

Reciprocal Space



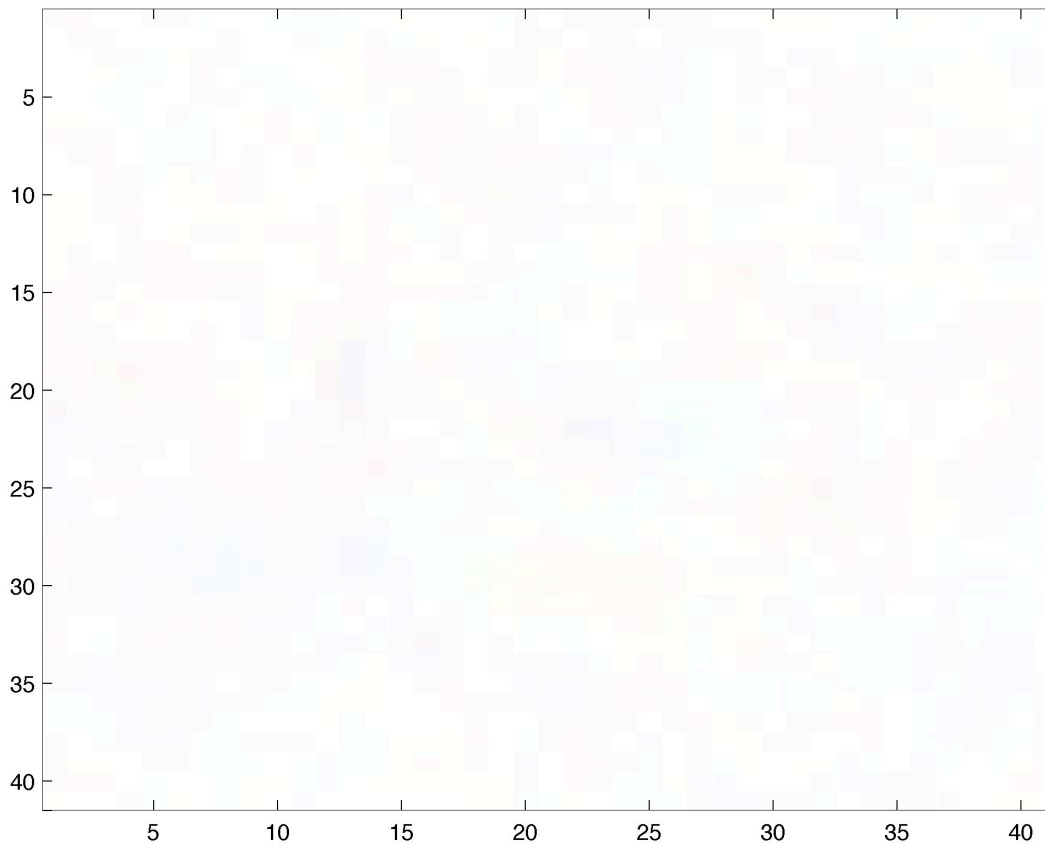
BCDI from $\text{La}_{0.5}\text{Ca}_{0.5}\text{MnO}_3$

Ian McNulty and Jon Logan, 34-ID-C Argonne

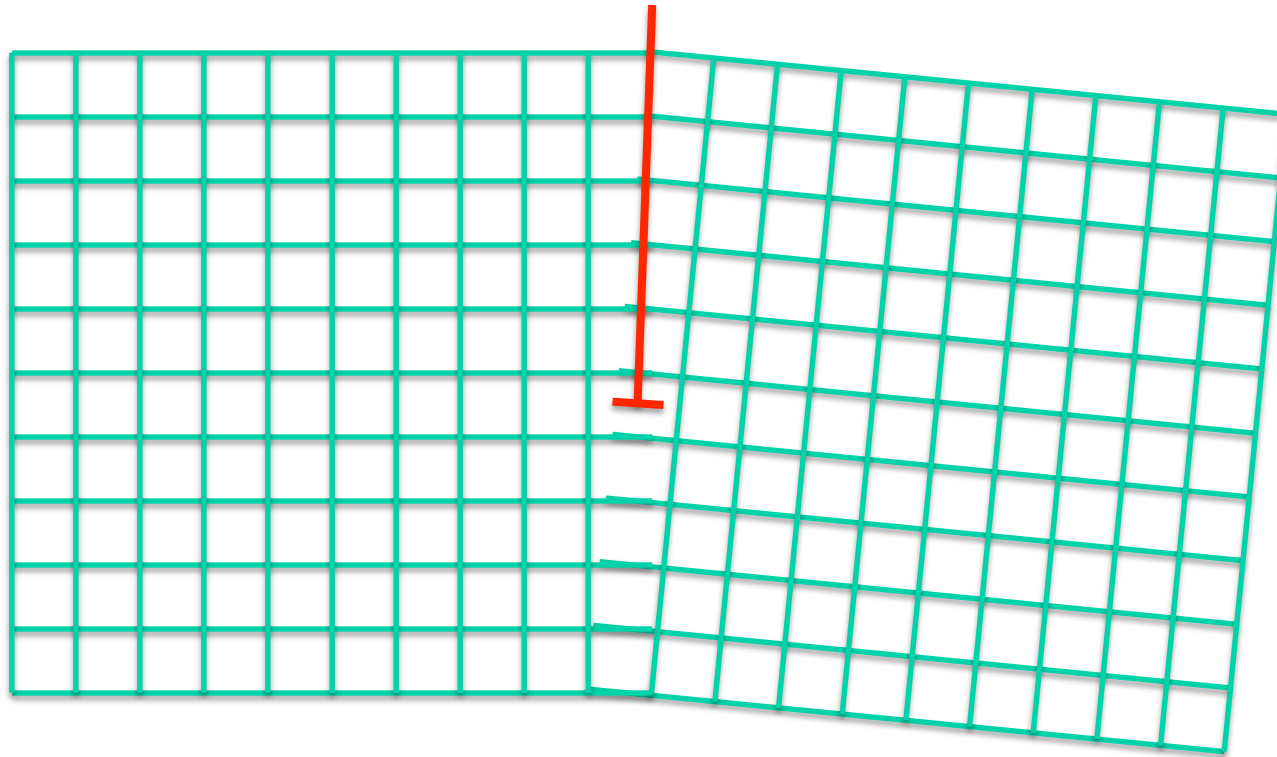


BCDI from $\text{La}_{0.5}\text{Ca}_{0.5}\text{MnO}_3$

LCMO-500, Ian McNulty and Jon Logan, 34-ID-C Argonne

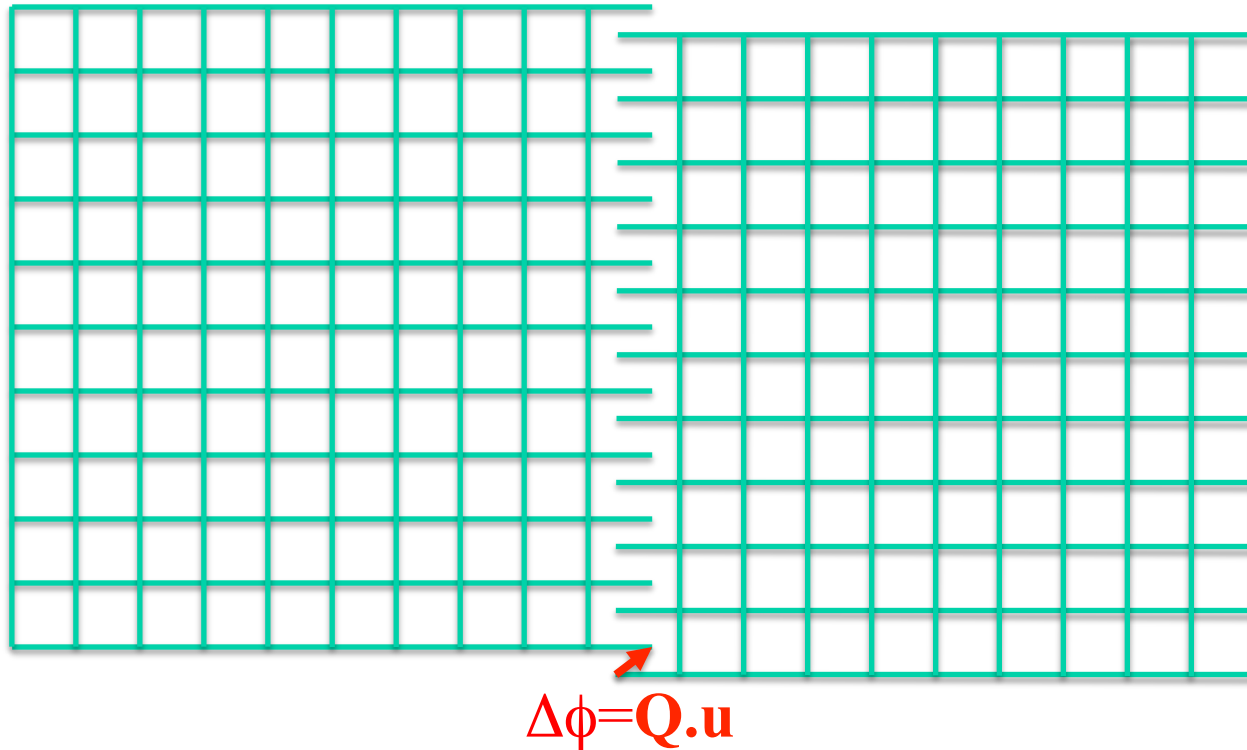


Low-angle grain boundary



- Energy proportional to number of dislocations
- Energy proportional to angle (small angle limit)
- Contributes to “mosaic spread” of crystal

Zero-angle grain boundary

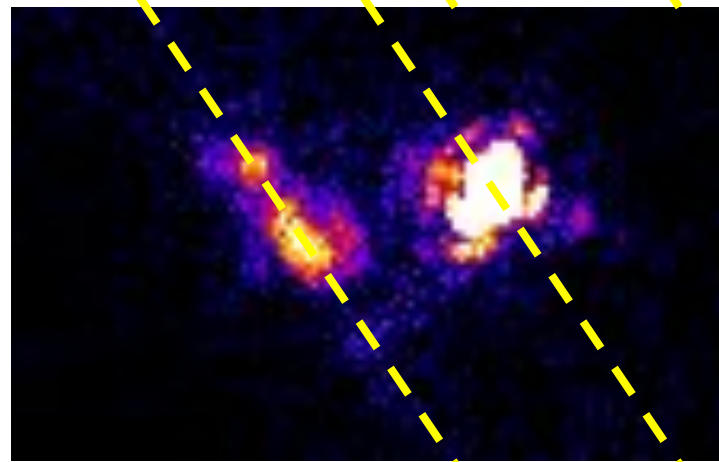
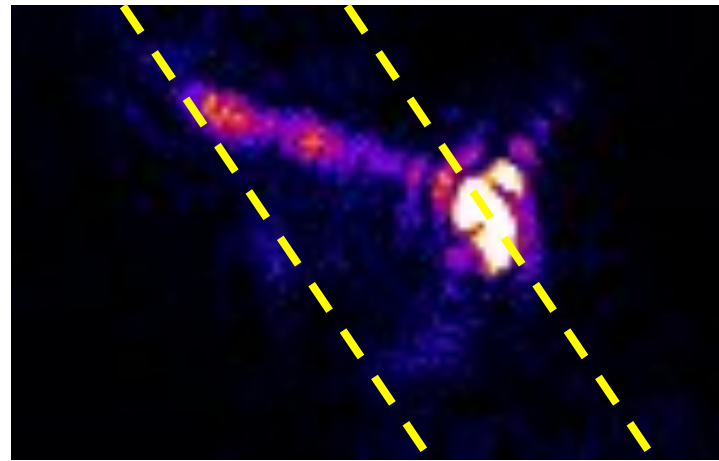


- Each domain has a Phase, relative to a reference lattice
- Phase depends on measurement vector \mathbf{Q}
- Phase boundaries contribute to crystal “mosaic”

BaTiO₃ bicrystal imaged by BCDI



BCDI from Barium Titanate (BaTiO_3)



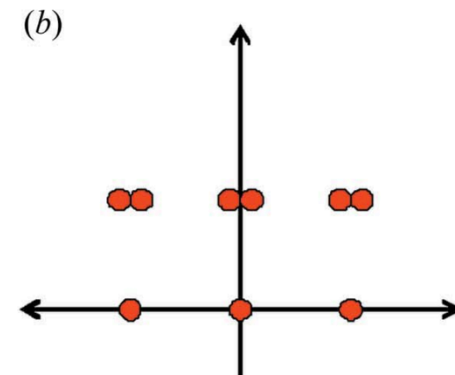
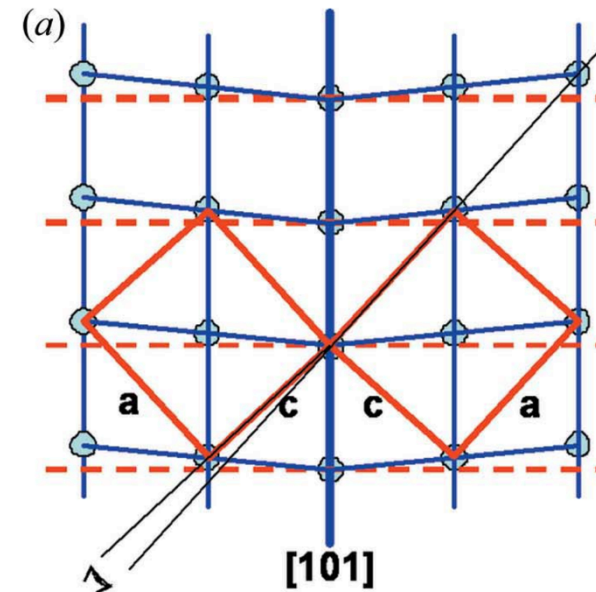
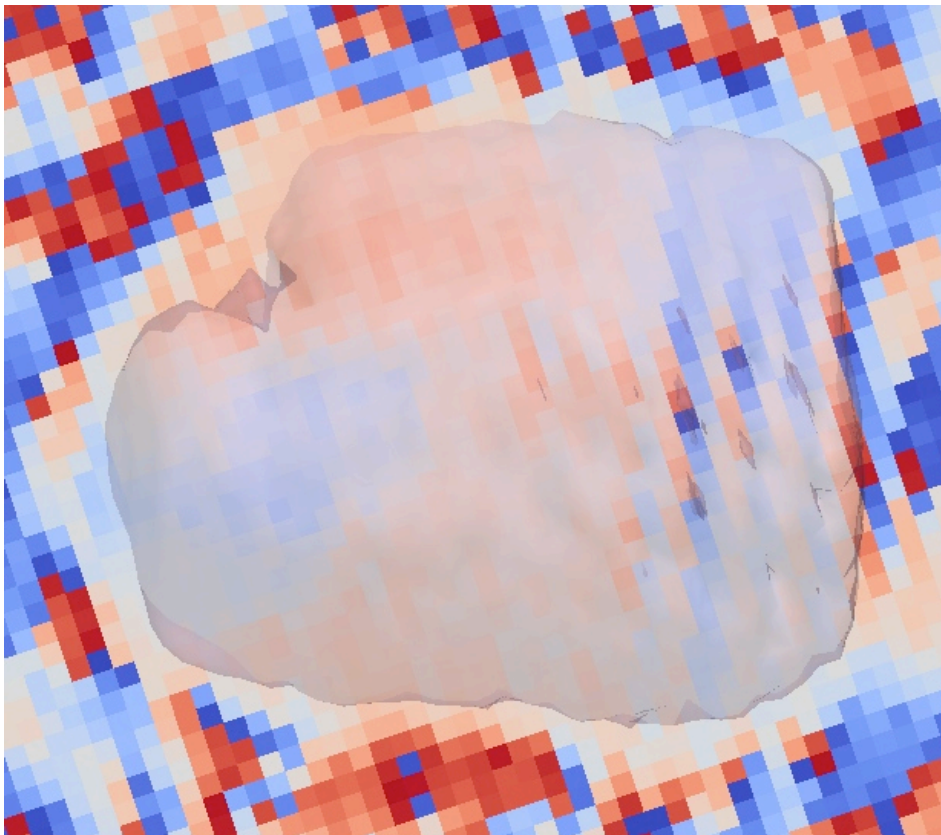
Tetragonal
splitting

(101) (110)

BCDI from Barium Titanate (BTO)

3D reconstruction #312 shows merohedral twinning

M. A. G. Aranda et al, JSR 17 751 (2010)

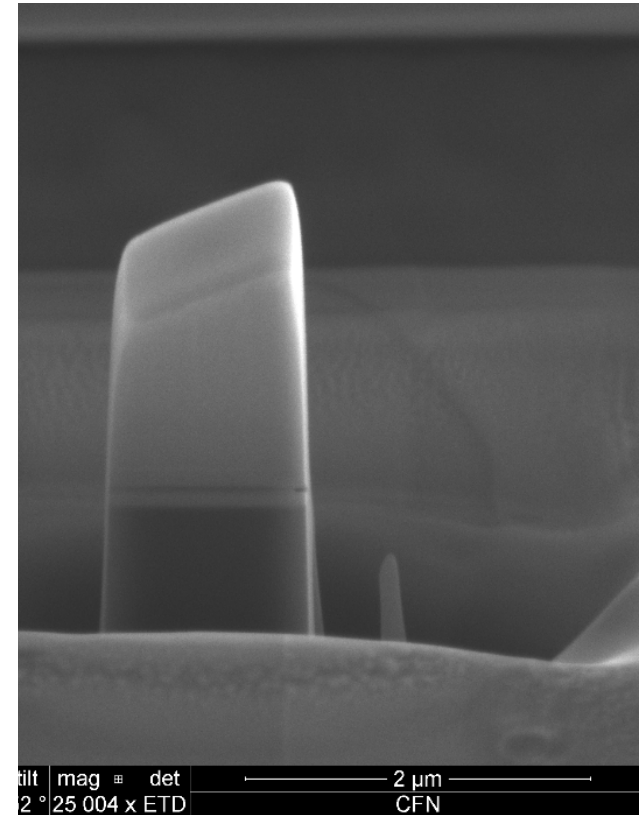
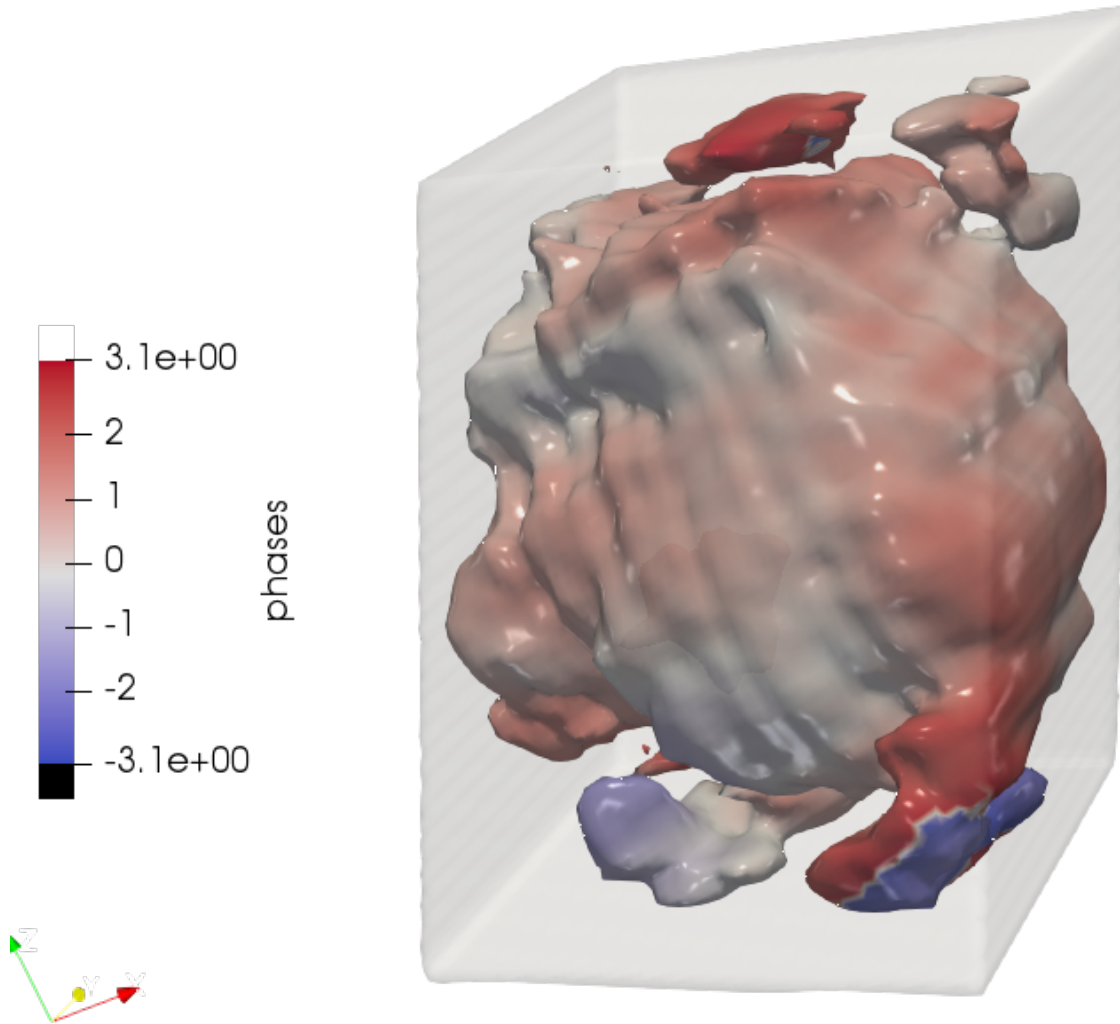


Twinned quartz crystals



FIB sample at 273 K, (103) peak

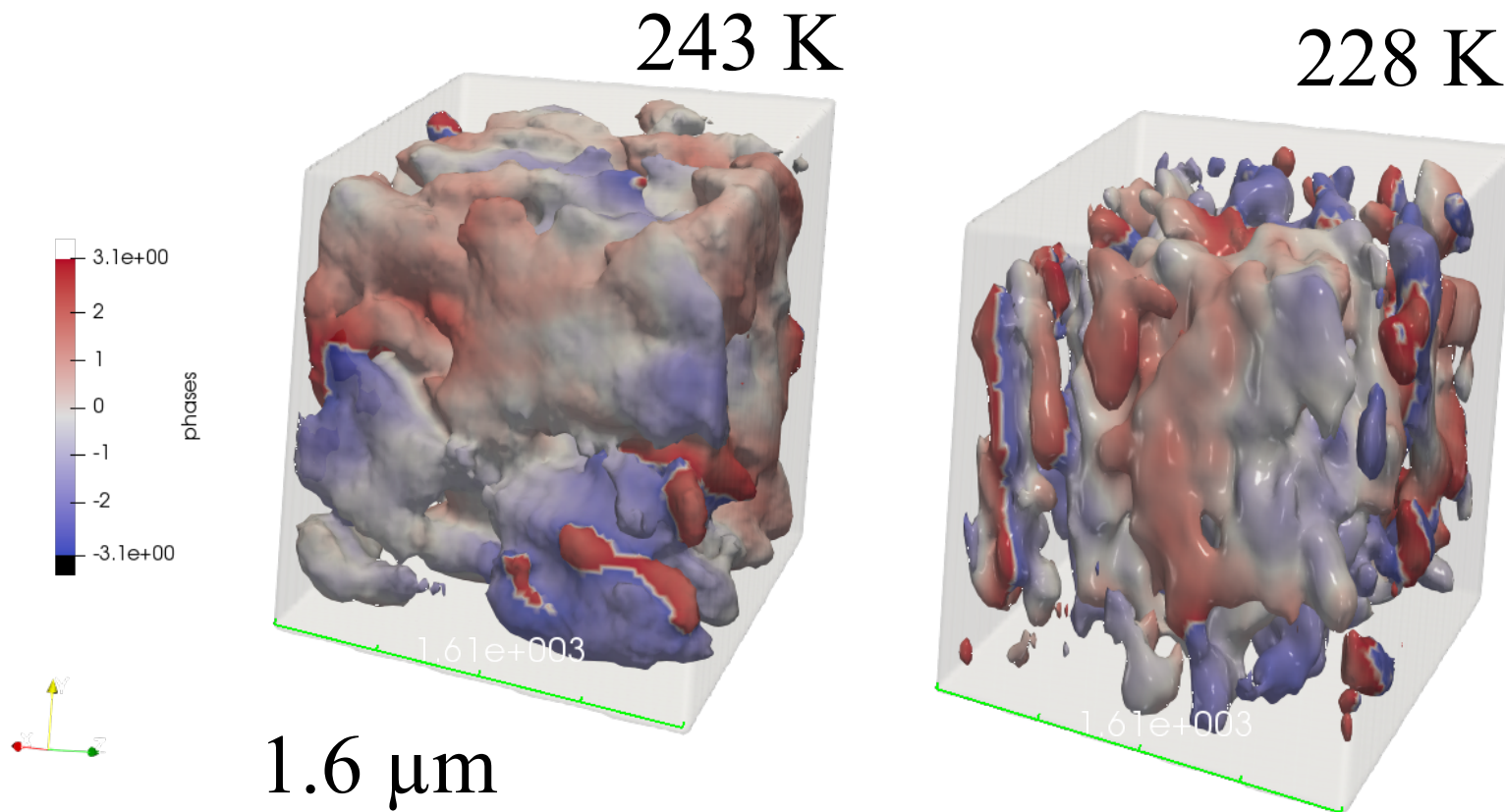
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HTT to LTO transition of $\text{La}_{2-x}\text{Ba}_x\text{CuO}_4$

Tadesse Assefa, Yue Cao

(114) Bragg peak



Conclusions

- Bragg Coherent Diffraction Imaging
- Phase Domain Structures
- Phase domains in $\text{La}_{0.5}\text{Ca}_{0.5}\text{MnO}_3$
- Twinning in BaTiO_3
- Phase transition in $\text{La}_{1.875}\text{Ba}_{0.125}\text{CuO}_4$

TEM of PLD films of LaCaMnO_3

O. I. Lebedev, G. Van Tendeloo, S. Amelinckx, B. Leibold and H.-U. Habermeier, PRB **58** 8065 (1998)

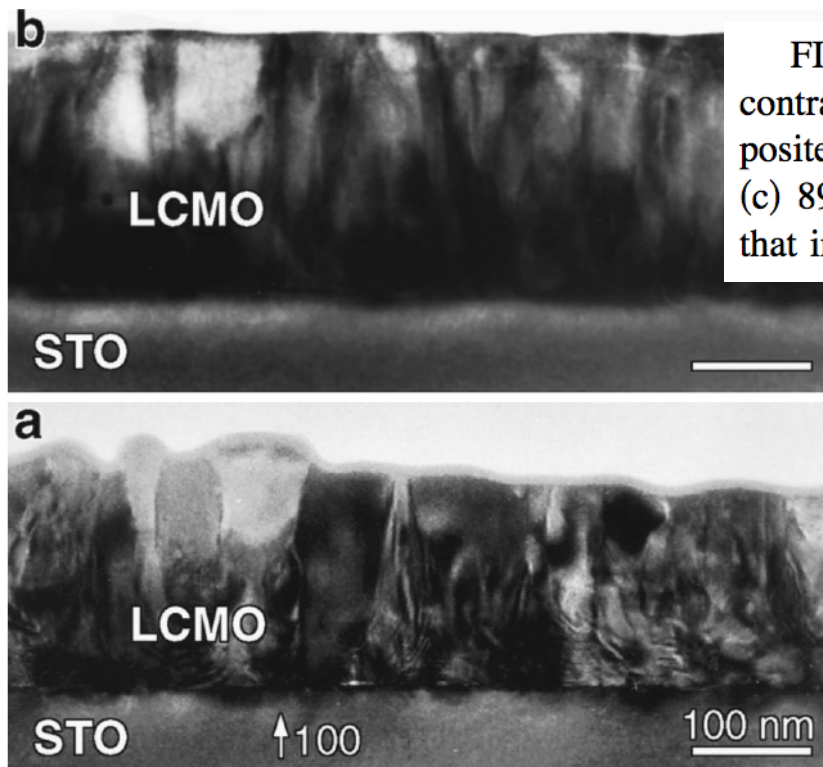


FIG. 1. Low magnification multibeam bright field diffraction contrast image of the columnar texture of $(\text{La}, \text{Ca})\text{MnO}_3$ film deposited at different substrate temperatures: (a) 530 °C, (b) 720 °C, (c) 890 °C. The substrate is STO limited by a cube plane. Note that in (c) a perfectly epitaxial transition layer has been formed.

