Institut des Nanotechnologies de Lyon UMR 5270

Sensitive RHEED signature of Ti-excess enabling enhanced cationic composition control during the molecular beam epitaxy of SrTiO3 based solid solutions

Masoumeh Razaghi, Marc d'Esperonnat, Claude Botella, Sébastien Cueff, Romain Bachelet and Guillaume Saint-Girons

Masoumeh R. P. G. et al., *CrystEngComm*, *23*(11), 2269-2275, (2021)

EPIDOX Flash Presentation – 19/11/2021

cnrs

ÉCOLE CENTRALE LYON

INSA

Lyon 1

CPE LYON

UNIVERSITÉ DE LYON

Quaternary Complexes

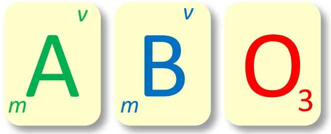
Ternary functional oxides : ABO_3
Properties : piezoelectricity, ferroelectricity,…

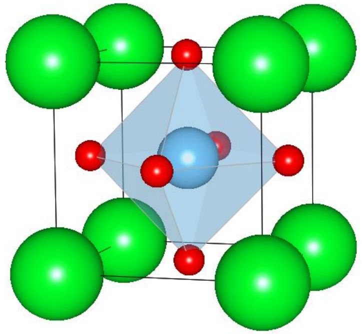
Quaternary complexes :
-La-STO : n-type, tunable properties by doping
(Bouras, M. et al., ACS photonics, 6(7), 1755-1762. (2019))

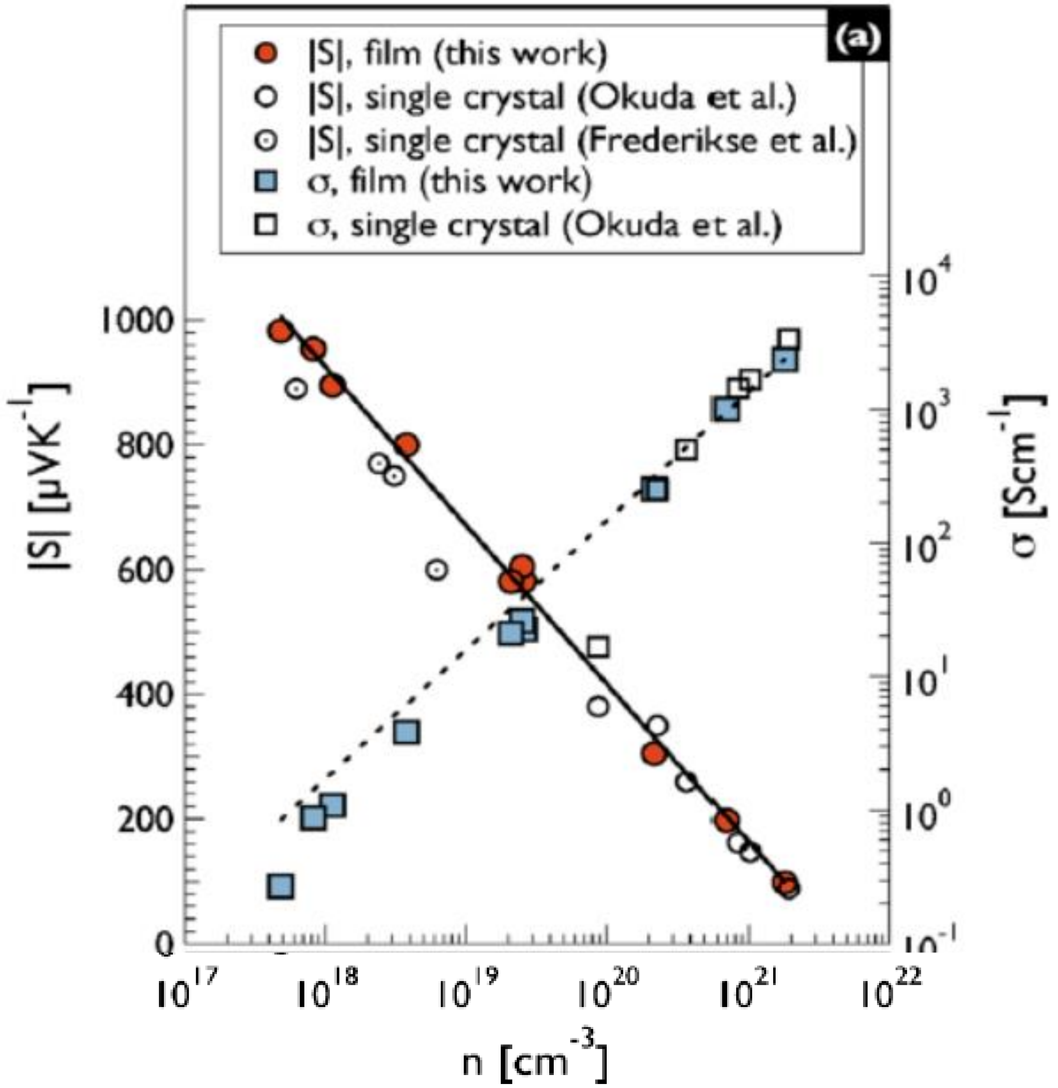
These properties depend on **composition**, which must be **accurately controlled.**

*(C.N.R. Rao, J. Gopalakrishnan et al., Indian J. Chem. Sect. A **23A**, 265 (1984).)*

*(D.M. Smyth, Annu. Rev. Mater. Sci. **15**, 329 (1985).)*



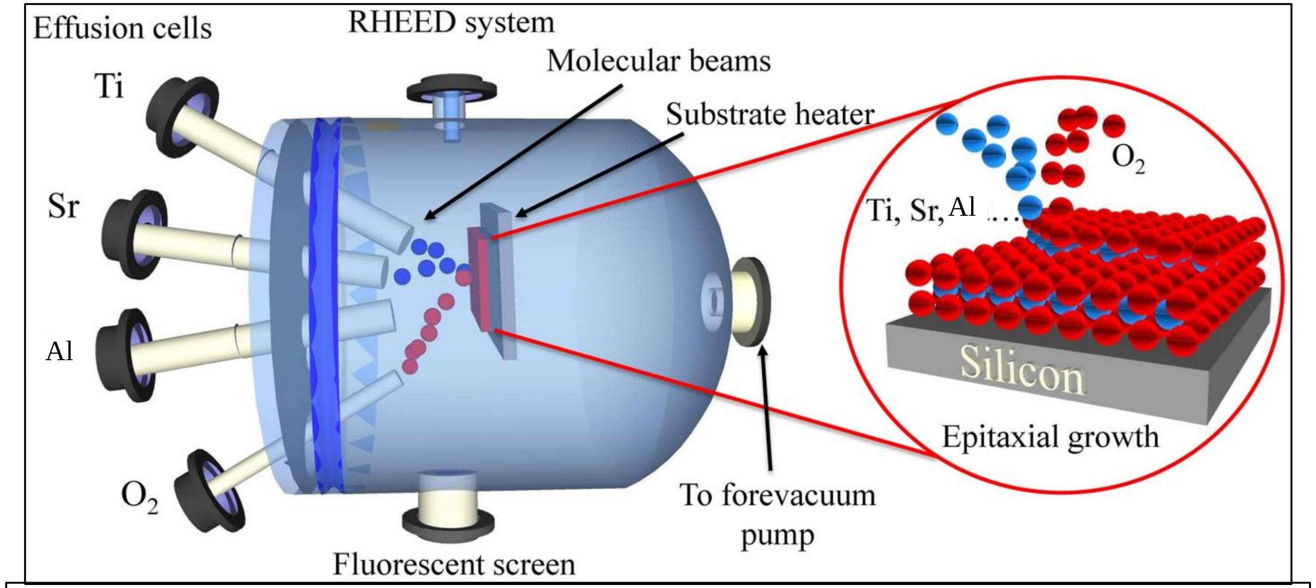




B . Jalan *et al.*, Appl. Phys. Lett. (2010)

Oxide Molecular Beam Epitaxy

MBE: Molecular Beam Epitaxy



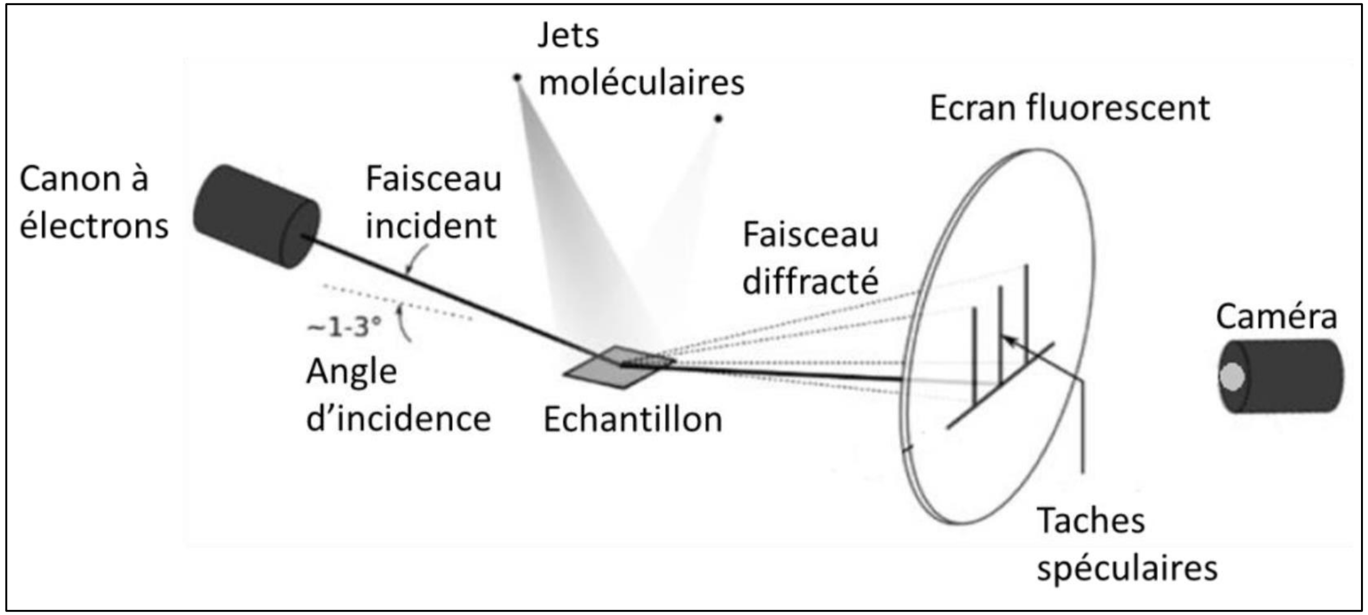
Source drift (*from oxidation*) **makes this control difficult**

Molecular beam epitaxy (MBE) is particularly well suited to control perovskite oxide composition and physical properties thanks to elemental sources.

(D.G. Schlom et al., J. Am. Ceram. Soc. ***91****, 2429, (2008))*

RHEED

Reflective High Energy Electron Diffraction

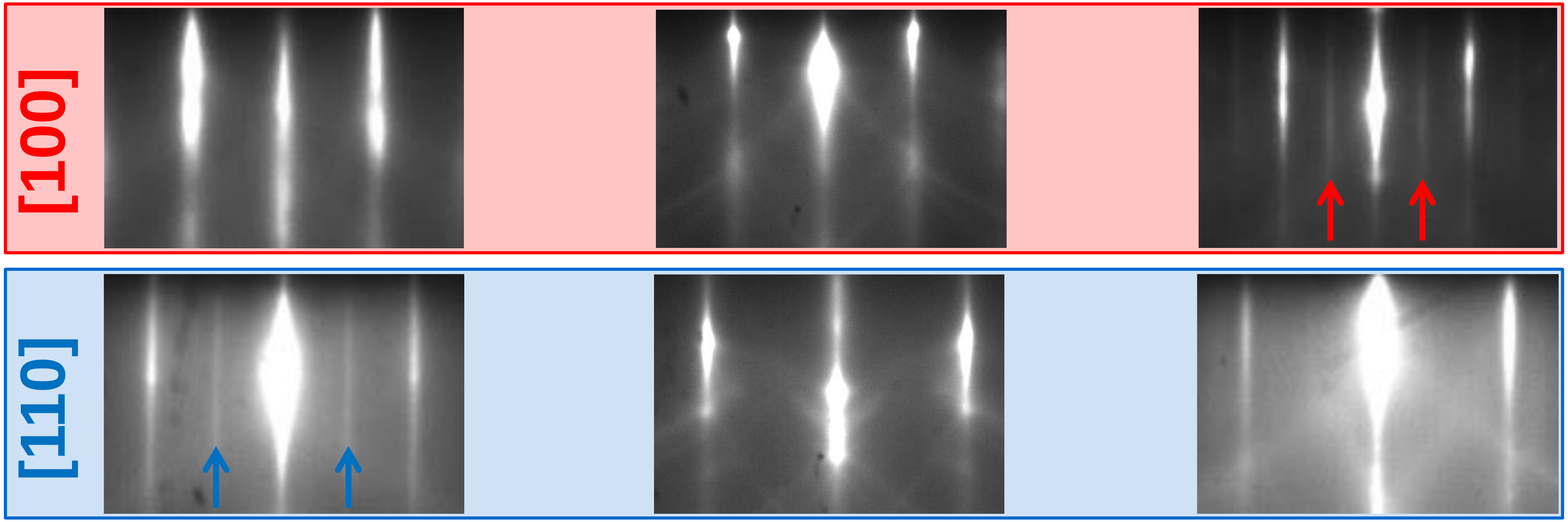


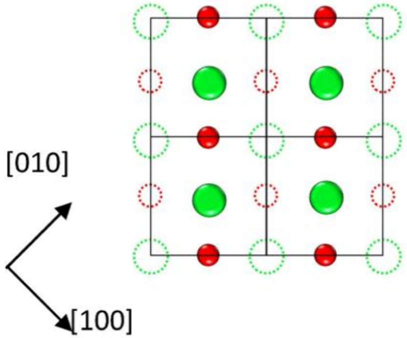
Molecular beam epitaxy (MBE) is particularly well suited to control perovskite oxide composition and physical properties thanks to elemental sources.

(D.G. Schlom et al., J. Am. Ceram. Soc. ***91****, 2429, (2008))*

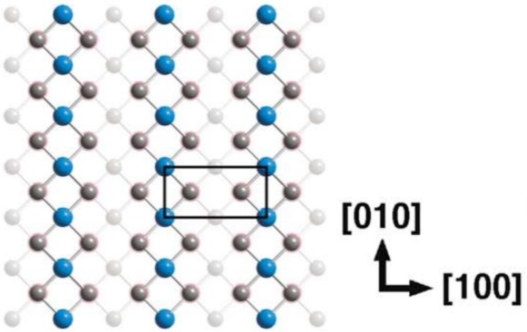
In-situ RHEED monitoring : previous method

Sr-rich **Stoichiometric** **Ti-rich**





Masoumeh R. P. G. et al.,
CrystEngComm, *23*(11), 2269-2275, (2021)

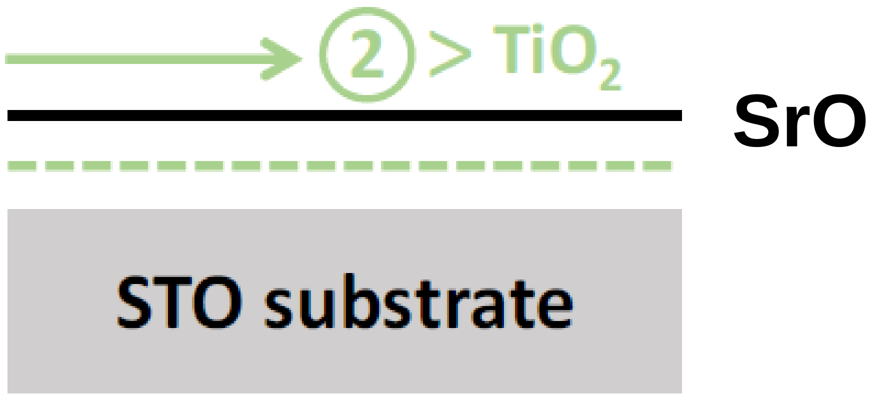


S. Ogawa et al., Phys. Rev. B 96, 085303 (2017).

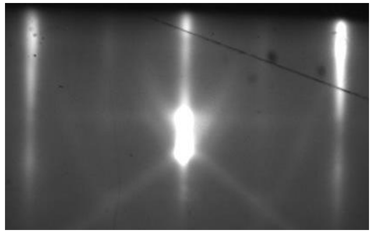
Z. Yu, et al., Thin Solid Films (2004).

M.R. Castell, Surface Science, 505 (2002)

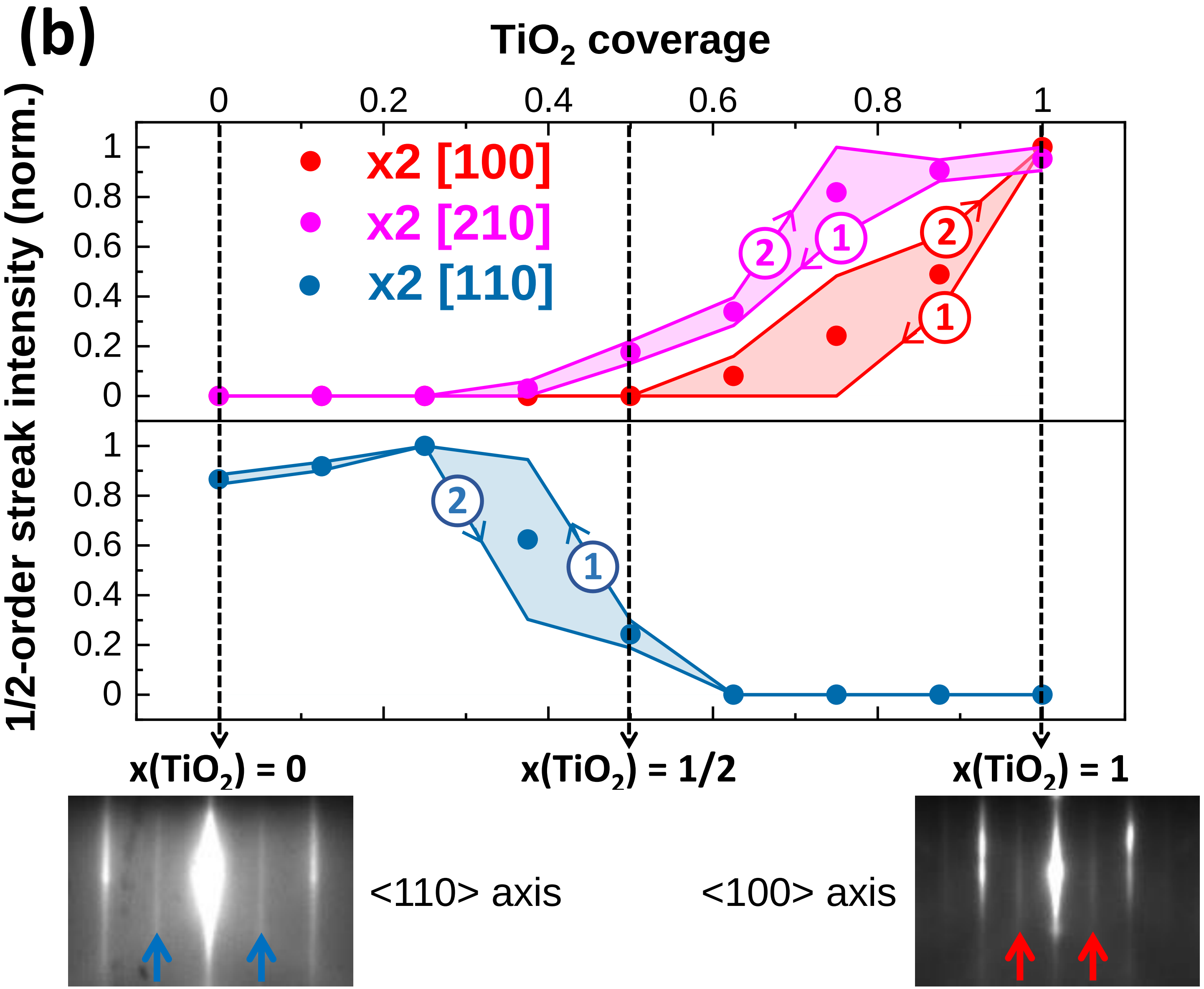
In-situ RHEED monitoring : 210 reconstruction (monolayer)



x2 along <210> for low Ti excess ➔

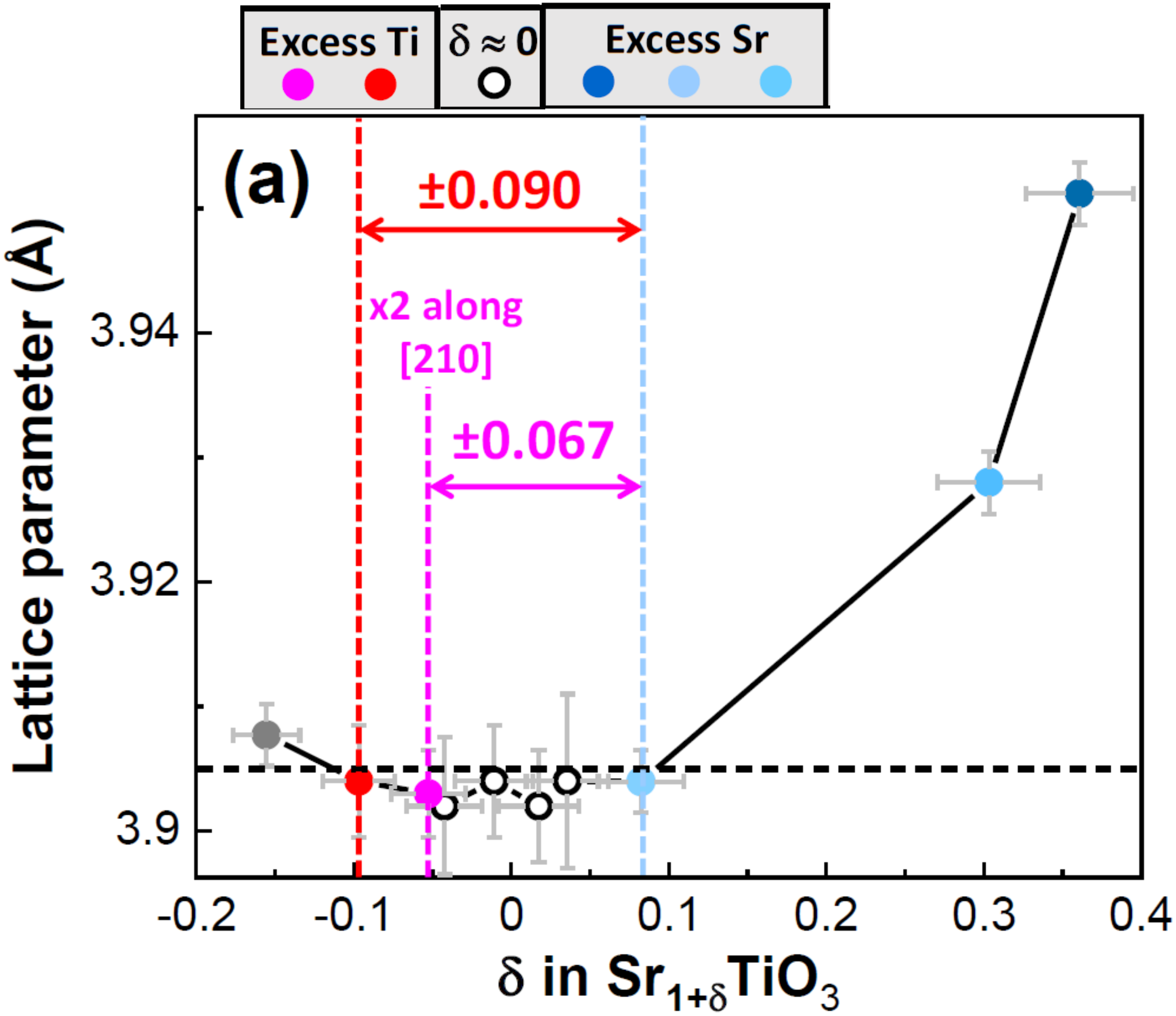


<210> axis



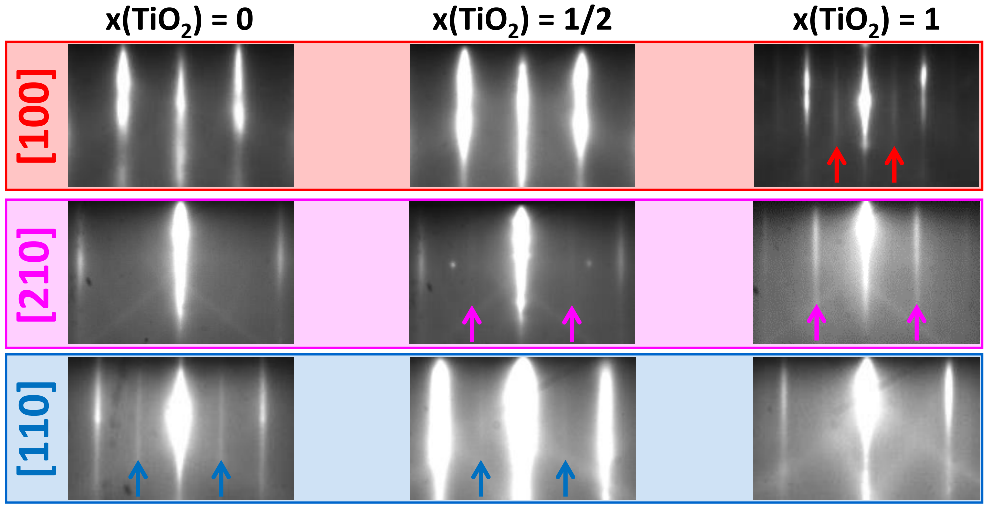
Masoumeh R. P. G. et al., *CrystEngComm*, *23*(11), 2269-2275, (2021)

Application to the growth of STO and accuracy quantification



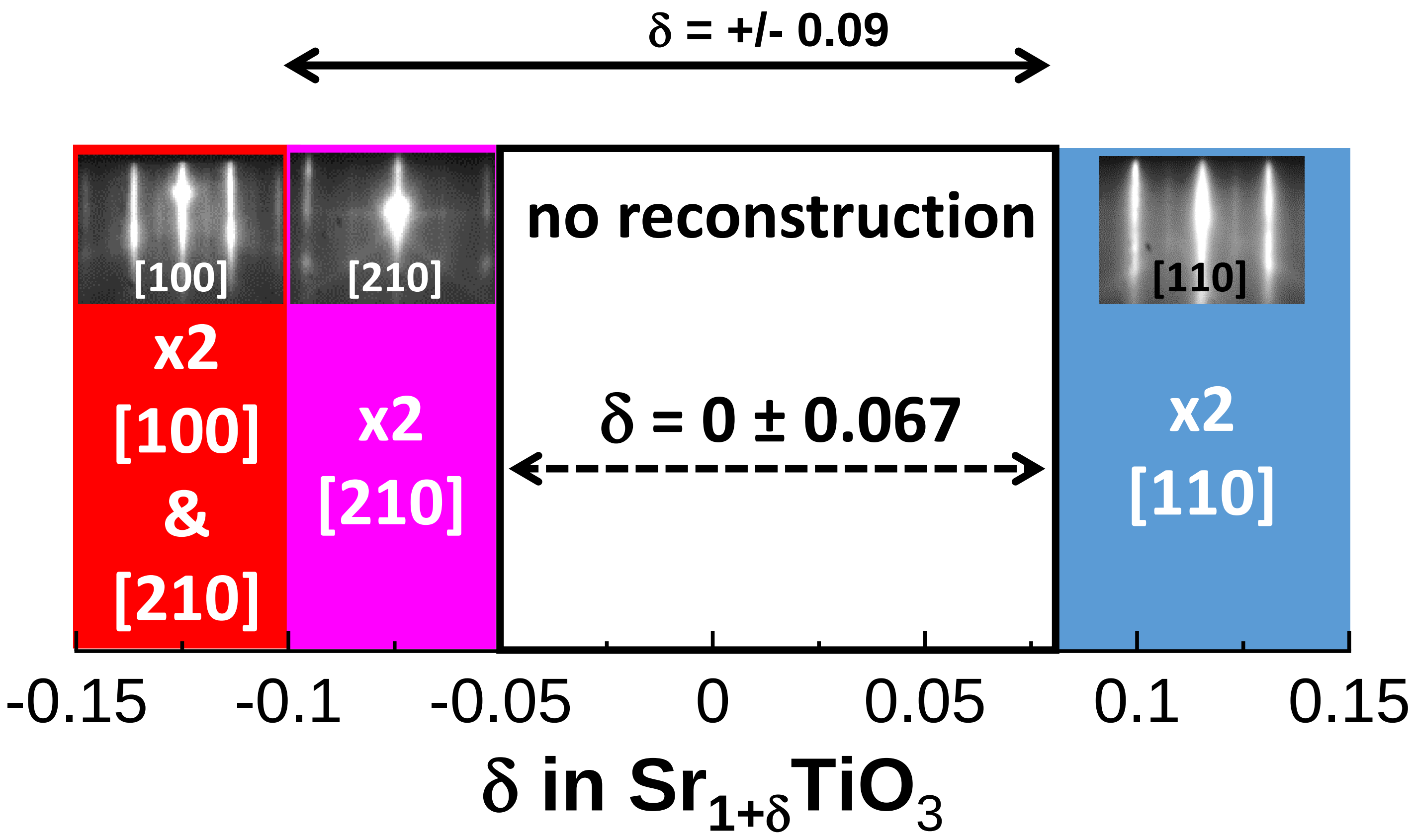
STO codeposition by MBE

Monitoring <210> azimuth allows improving accuracy



Masoumeh R. P. G. et al., *CrystEngComm*, *23*(11), 2269-2275, (2021)

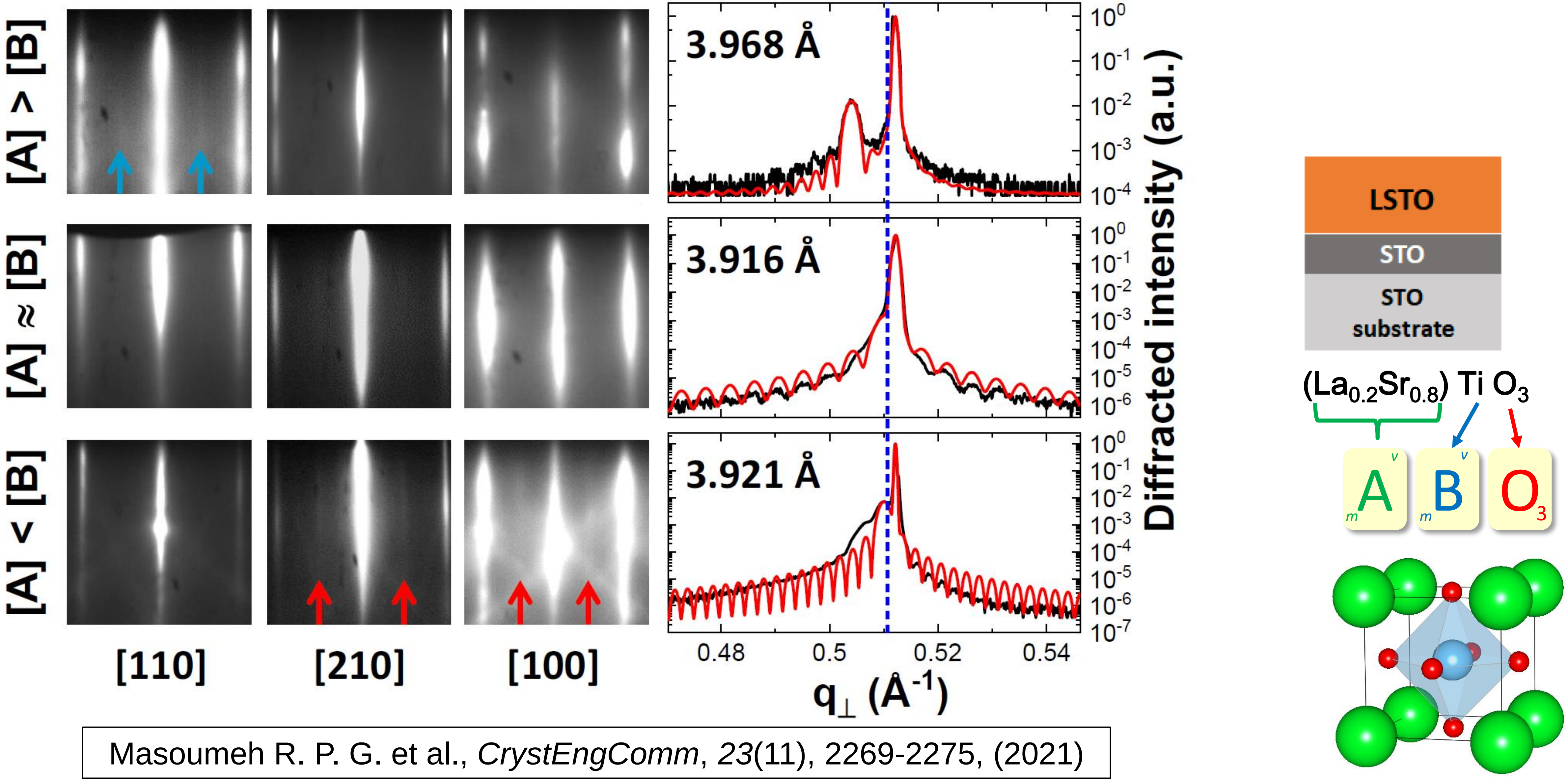
Application to the growth of STO and accuracy quantification



Quantification of the accuracy of the new method compared with the previous method

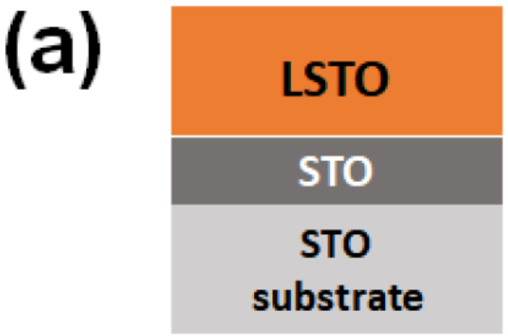
Masoumeh R. P. G. et al., *CrystEngComm*, *23*(11), 2269-2275, (2021)

Application to the growth of La-STO



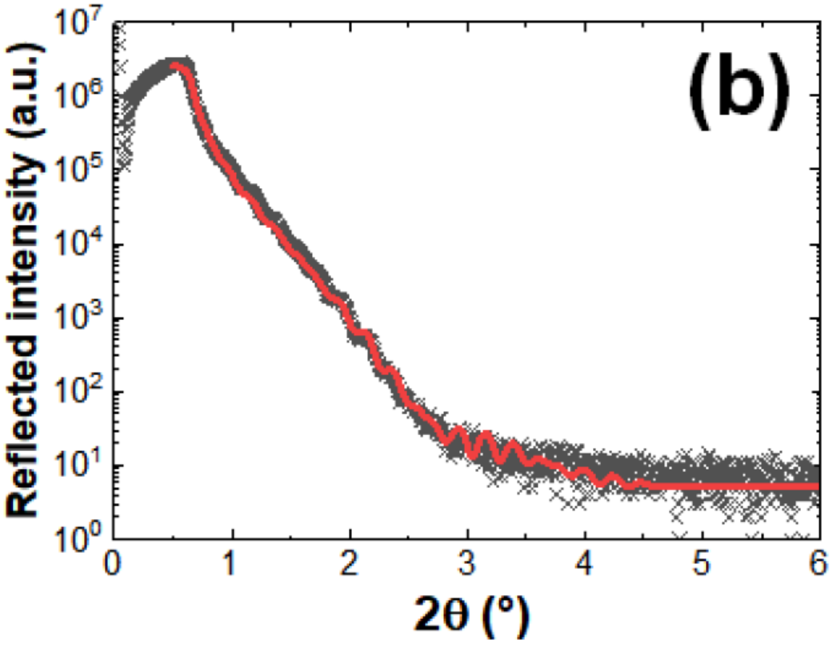
Masoumeh R. P. G. et al., *CrystEngComm*, *23*(11), 2269-2275, (2021)

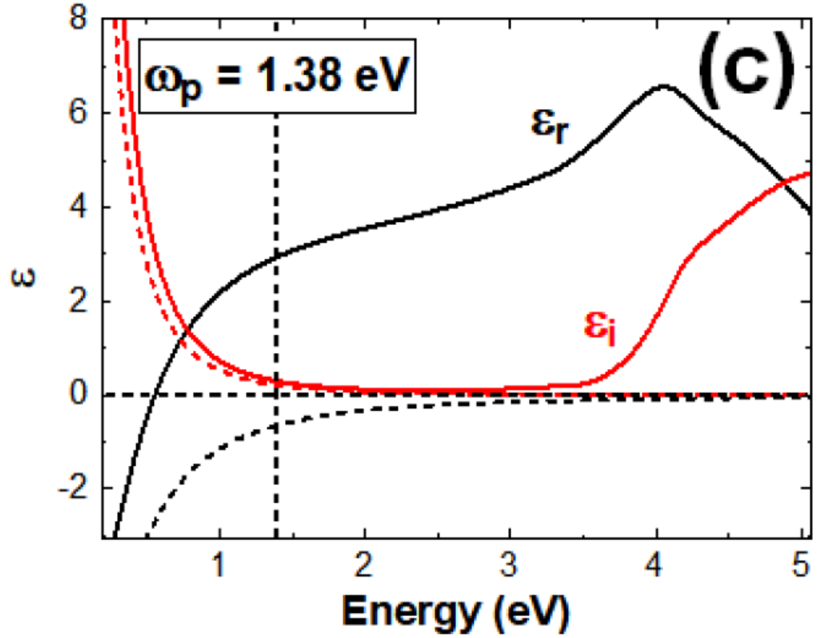
Application to the growth of La-STO



	STO	LSTO
Thickness (nm)	8.2 *(10)*	29.6 *(30)*
% La	--	18.2 *(20)*

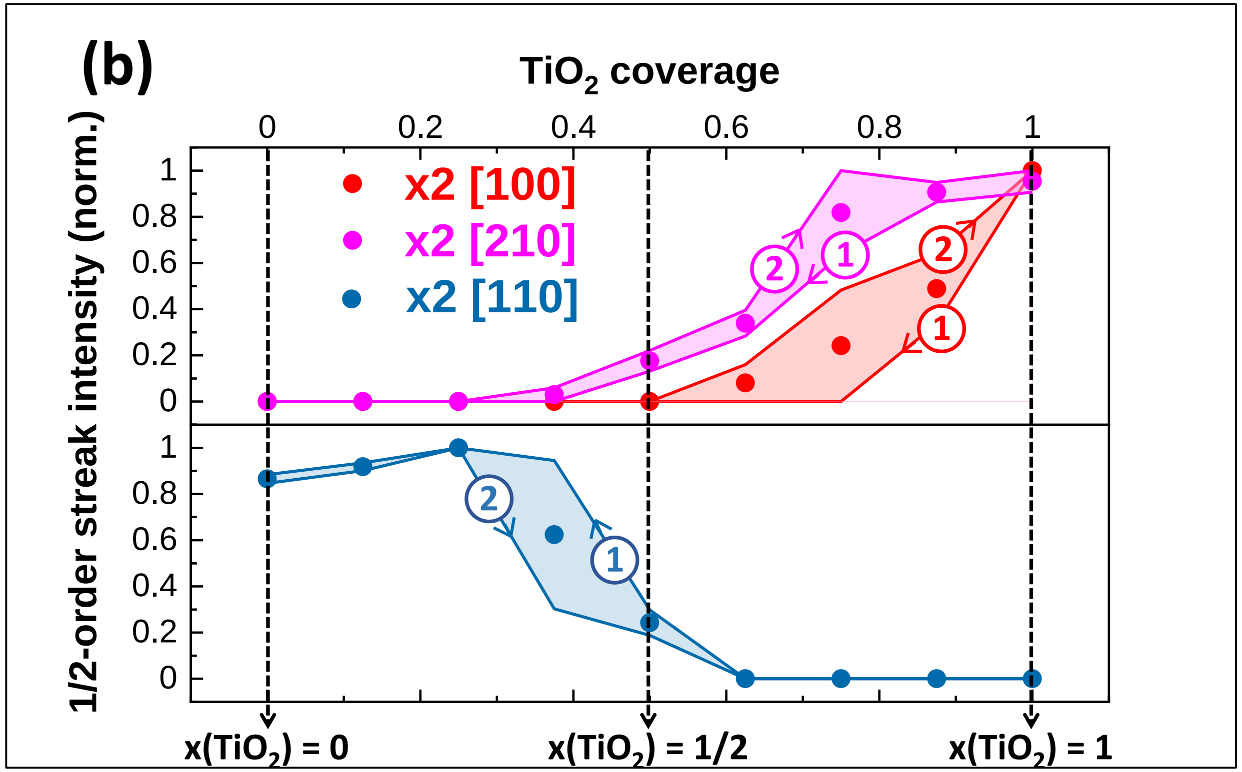
Very close to the targeted values

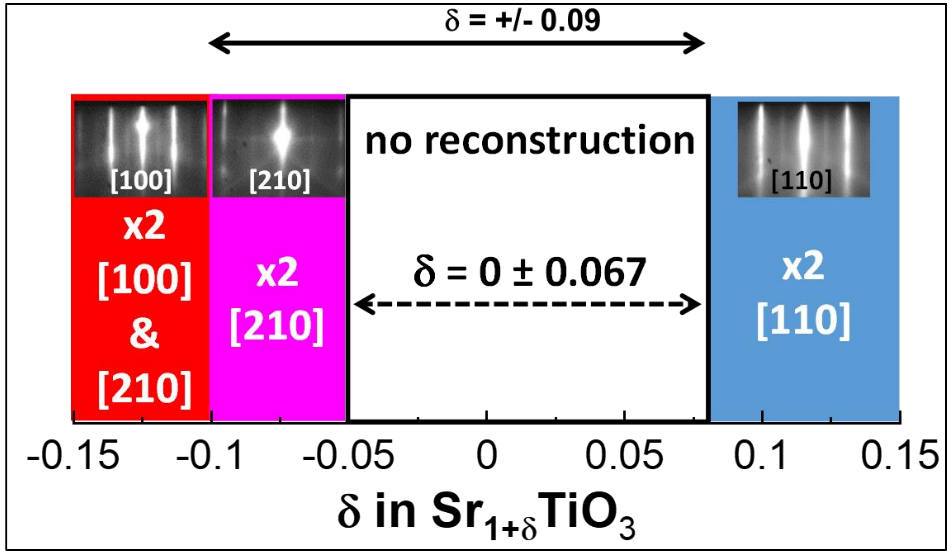




Masoumeh R. P. G. et al., *CrystEngComm*, *23*(11), 2269-2275, (2021)

Results Summary





	STO	LSTO
Thickness (nm)	8.2 *(10)*	29.6 *(30)*
% La	--	18.2 *(20)*

I) Evaluation of the Precision of the previous method
II) Improvement of the precision with the new method
III) Application of this new method to Quaternary Oxides

Masoumeh R. P. G. et al., *CrystEngComm*, *23*(11), 2269-2275, (2021)

Acknowledgements

iLM INSTITUT LUMIÈRE MATIÈRE

cnrs

IPCMS

CETHIL UMR 5008

inl Institut des Nanotechnologies de Lyon UMR 5270

ÉCOLE CENTRALE LYON

INSA

UCB Lyon 1

CPE LYON

UNIVERSITÉ DE LYON