Deposition and X-RAY Characterization of Oxide Thin Films for Green Energy Application

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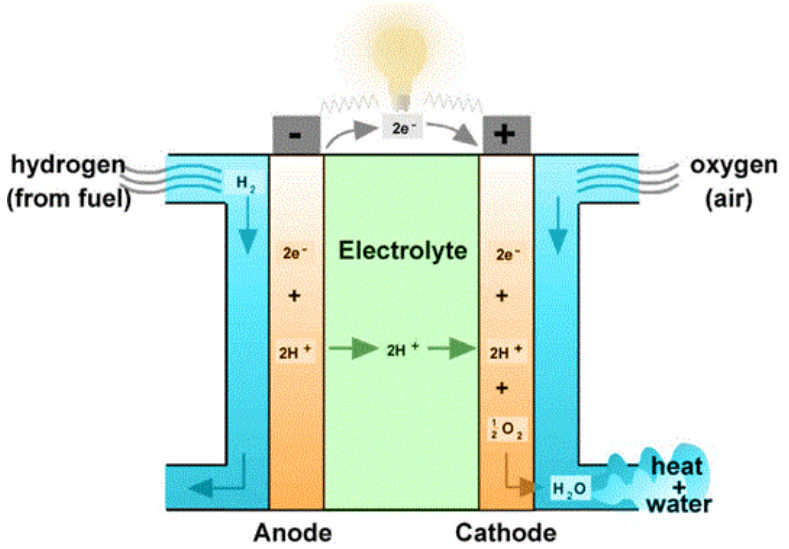
Fuel Cells

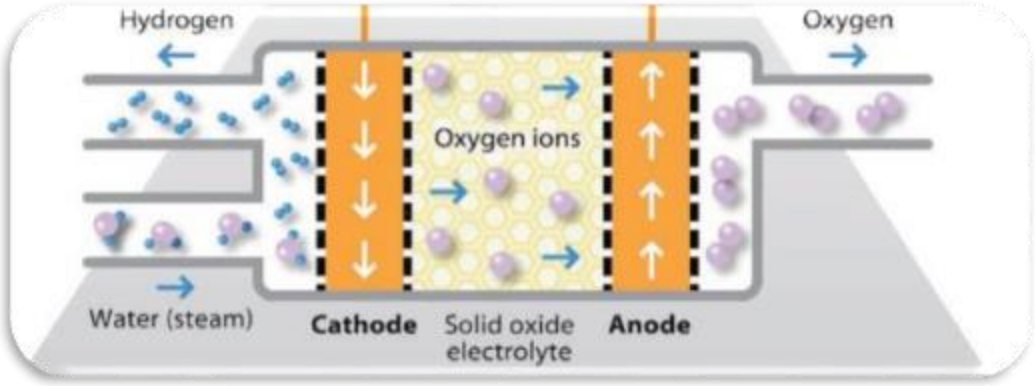
- Energy conversion with a lower-to-zero emission
- Higher efficiency, exceeding 60%

SOFCs	SOECs
Hydrogen+Oxygen reaction	Electrolysis reaction
Byproducts in the form of Water and Heat	Pure Hydrogen and Oxygen production
Electricity production	Electricity storage

Solid Oxide Fuel Cell



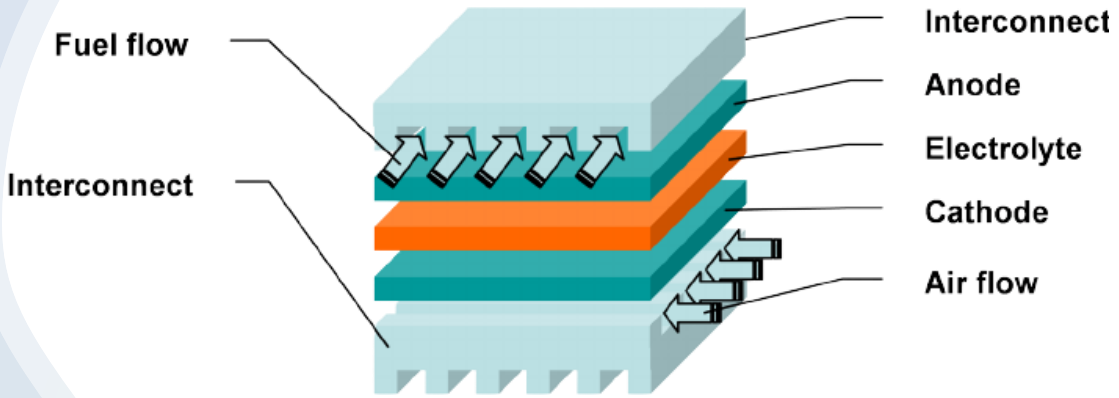
Solid Oxide Electrolysis Cell



Micro-SOFCs

- State-of-the-art Micro-SOFC
- Nanometric thickness
- Operating temperature decrease without performance decrease
- Usable as portable power generators

Micro-SOFC Schematic View



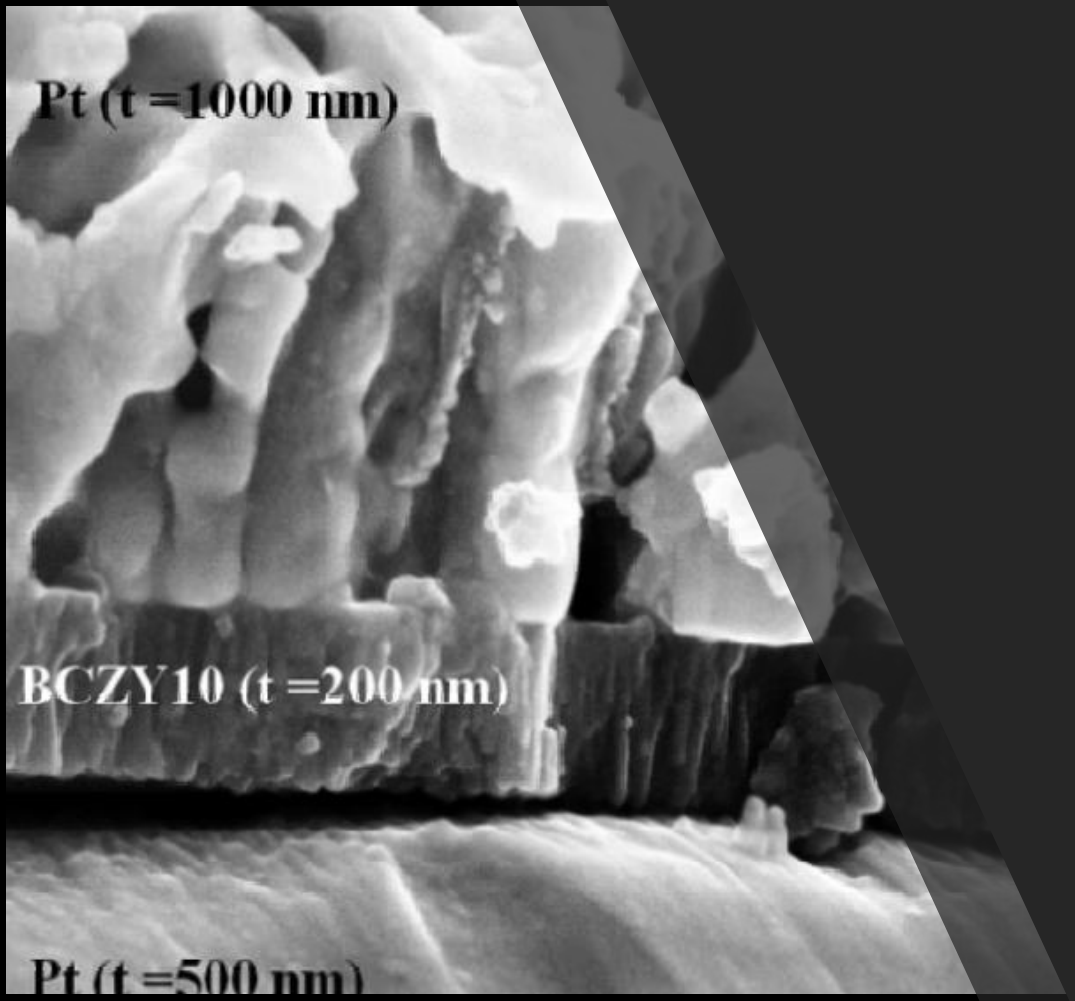


Image of the cross section taken from a FE-SEM micrograph

Materials Used

Complex Oxides

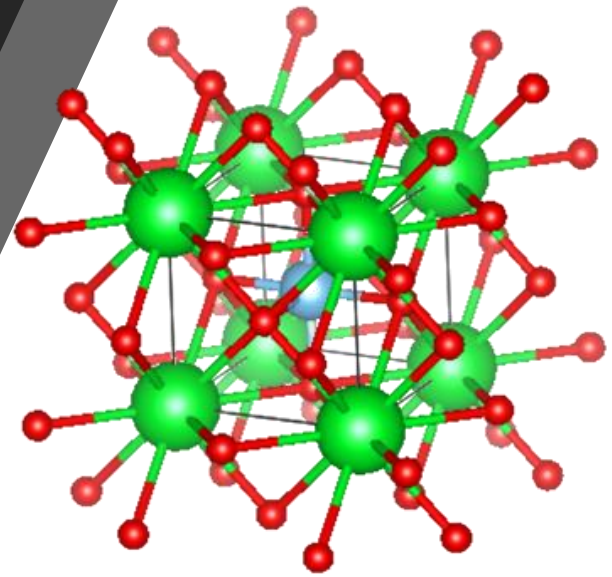
- Compounds containing Oxygen and at least 2 other elements
- Wide variety of magnetic and electronic properties
- Used as electrolytes, anodes and cathodes of the fuel cells

Deposition process:

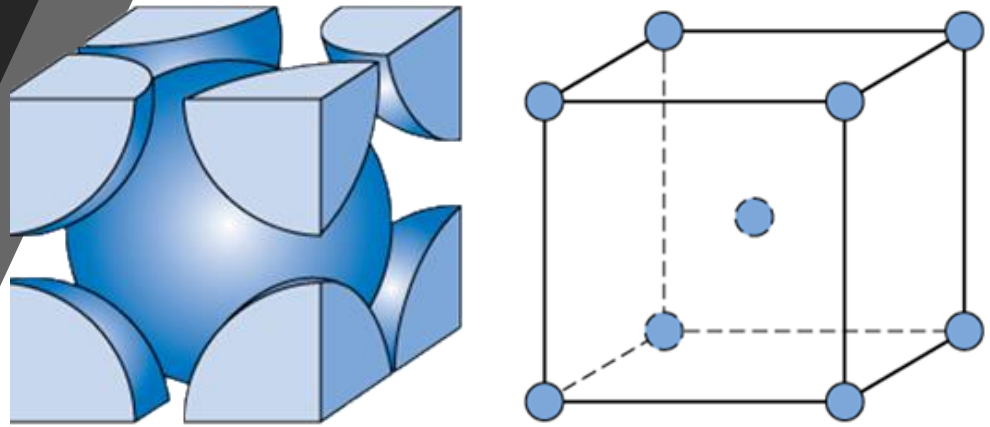
Strontium Titanate → Strontium Aluminate → Samarium Doped Ceria

Strontium Titanate (STO)

- Foundation substrate for the process
- Induces epitaxial growth of film (SDC)
- Perovskyte Oxide
- Body Centered Cubic (BCC)



STO Structure

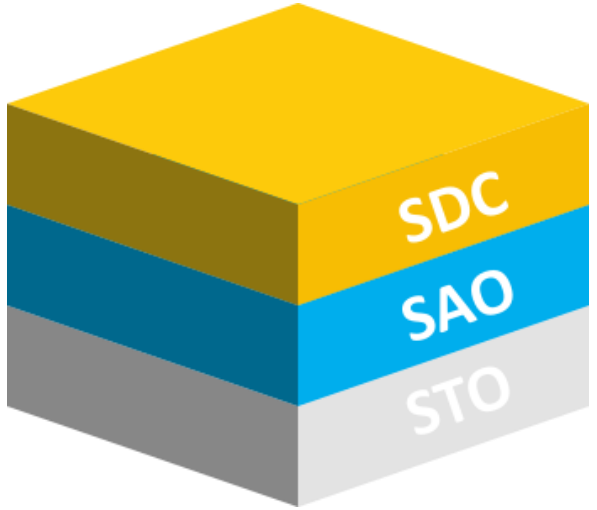


BCC Structure

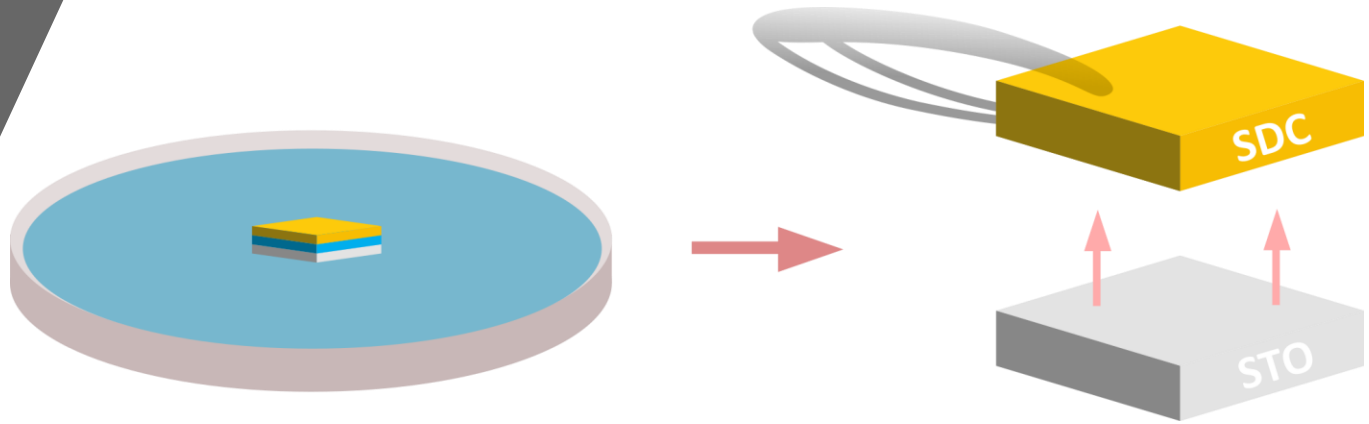
Strontium Aluminate (SAO)

- Deposited onto STO before final deposition
- Sacrificial Salt Layer
- Improves film deposition
- Allows final film detachment

Schematic view of the 3 layers



Final detachment

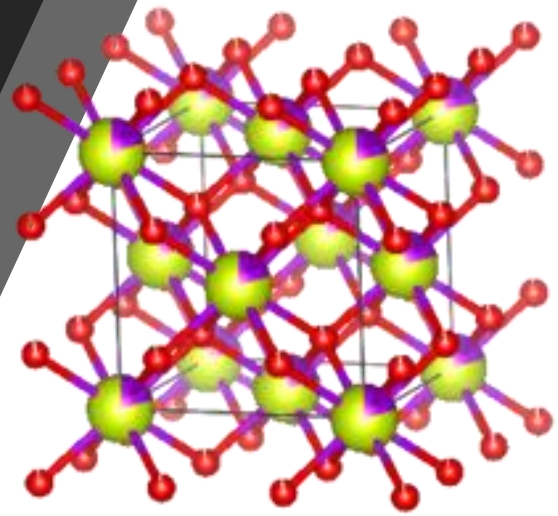


Samarium Doped Ceria (SDC)

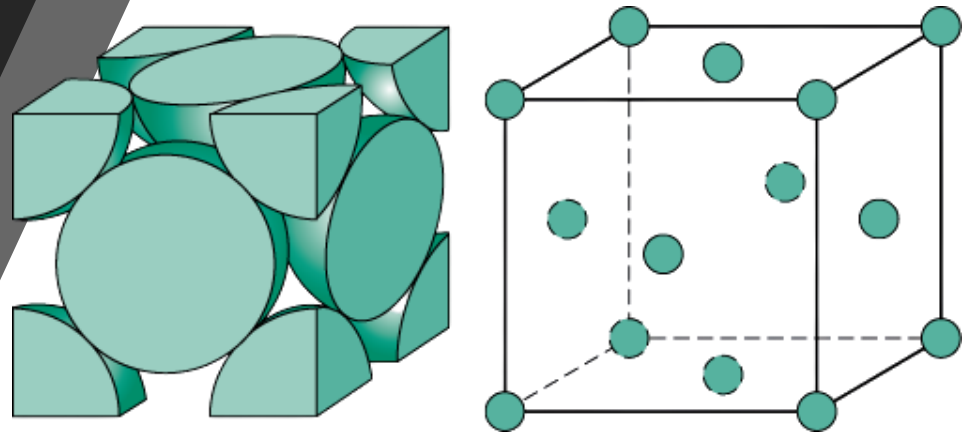
- Final thin film deposition
- Samarium doping grants higher ionic conductivity
- Fluorite
- Face Centered Cubic (FCC)

Why Samarium Doped Ceria?

- Catalytic properites/ Ionic conductivity
- Carbon-deposition suppression (Similar reaction of water-splitting)



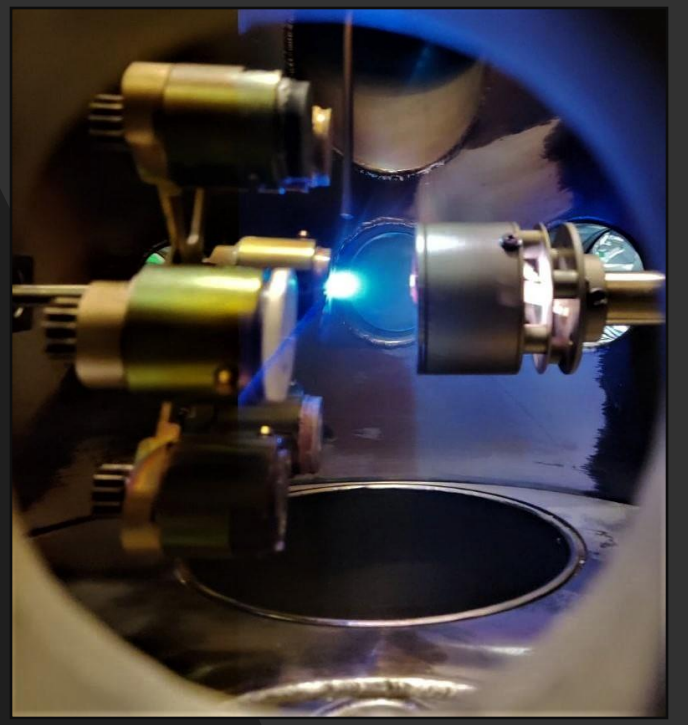
SDC Structure



FCC Structure

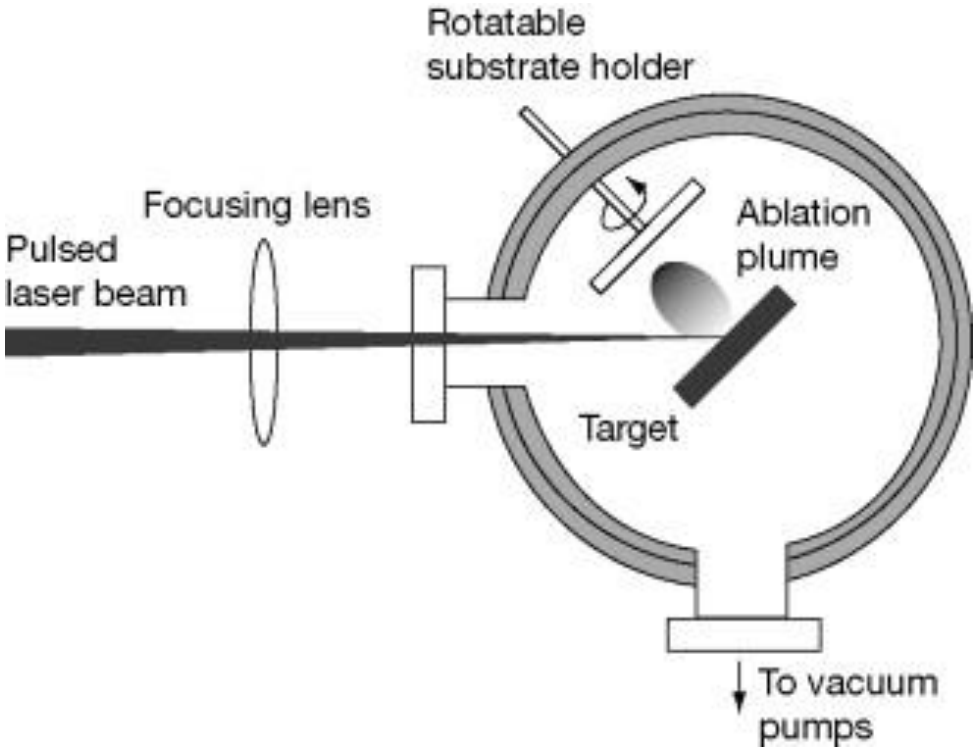
Pulsed Laser Deposition

- Physical Vapor Deposition
- High power laser used to vaporize target of the interested material
- Plasma plume



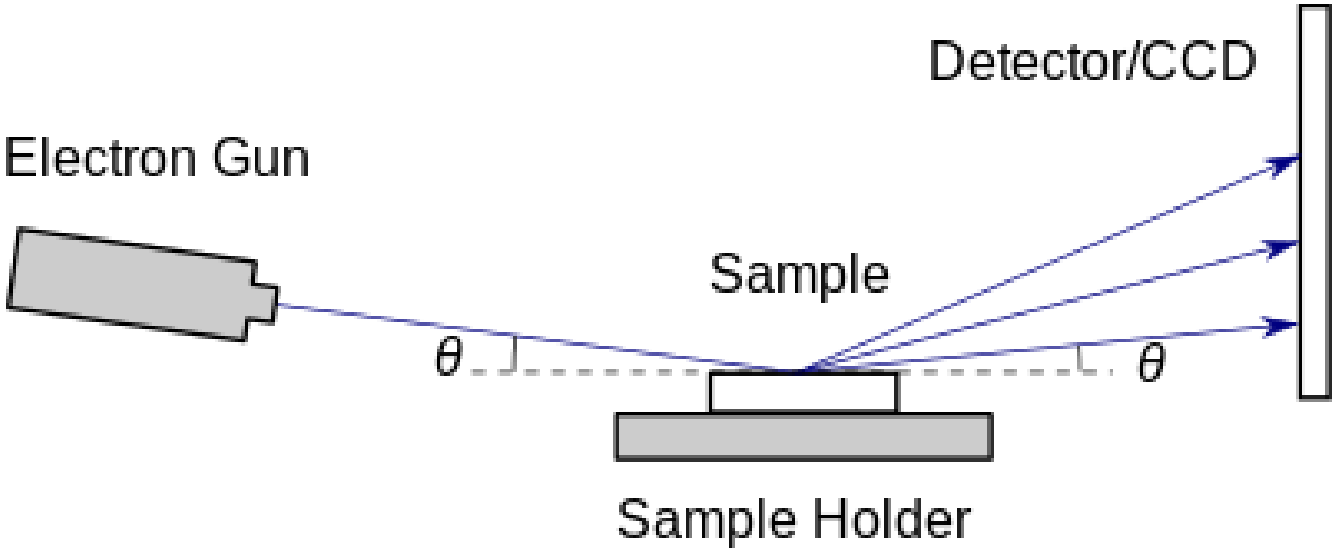
Interior of one of the vacuum chambers at the PLD lab.

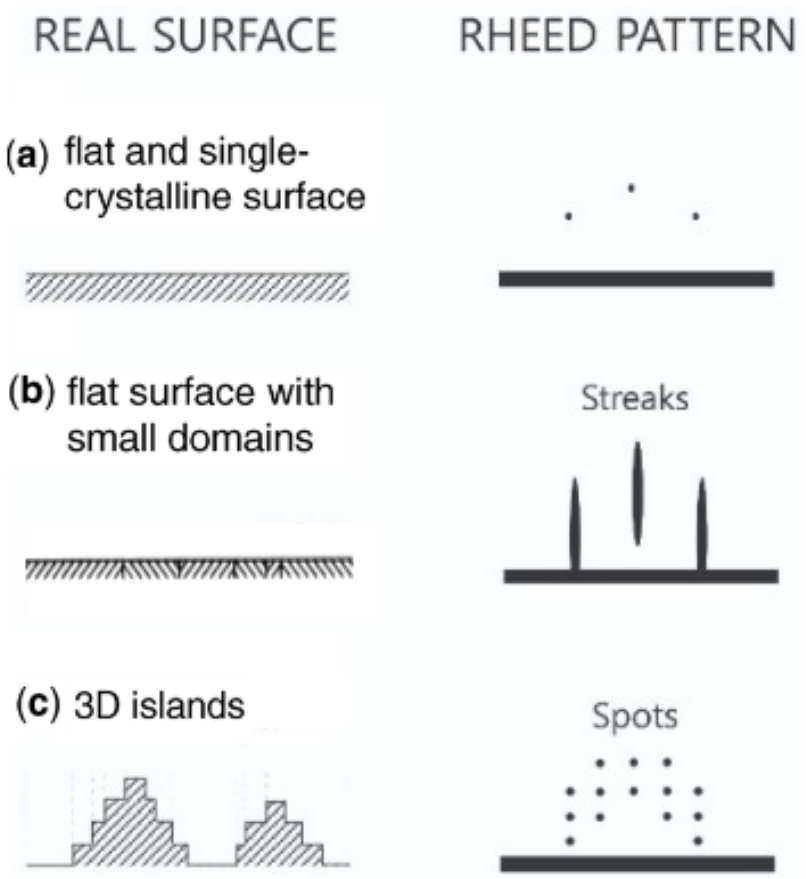
Schematic representation



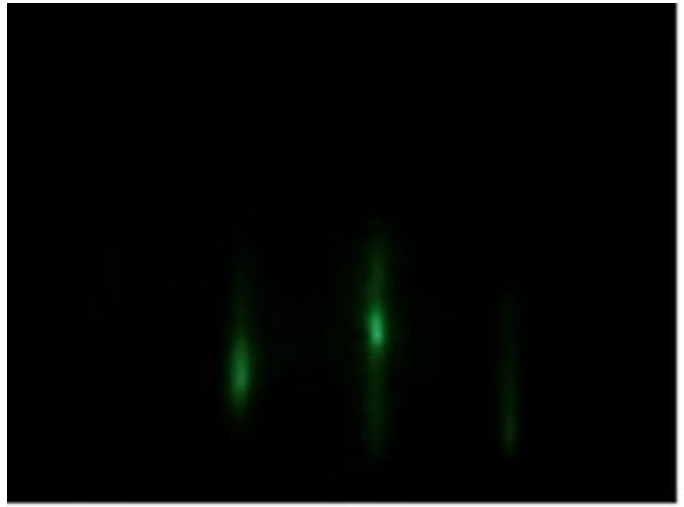
Reflection High Energy Electron Diffraction (RHEED)

- Pattern provides various kind of informations
- Practicality: Surface Structure
- Electron interference according to atoms position

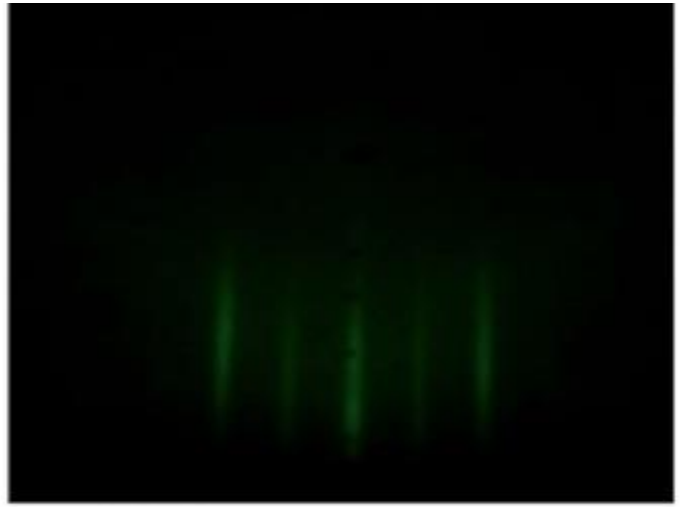




Picture representing the 4 different patterns created by the diffracted electrons

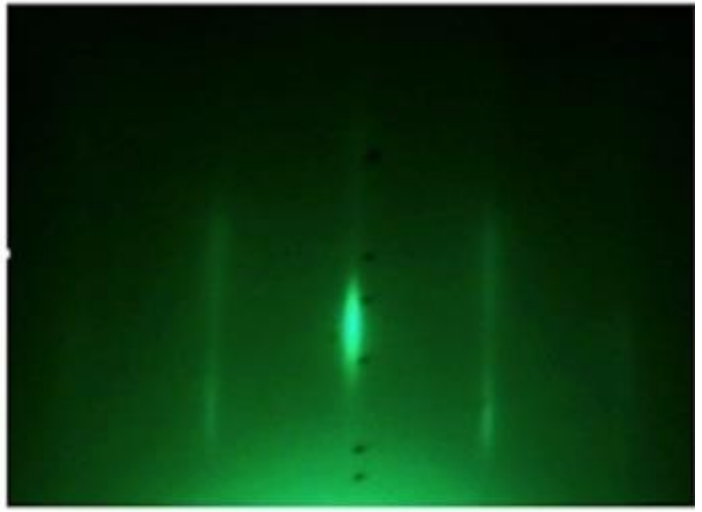


a) STO: substrate before film deposition



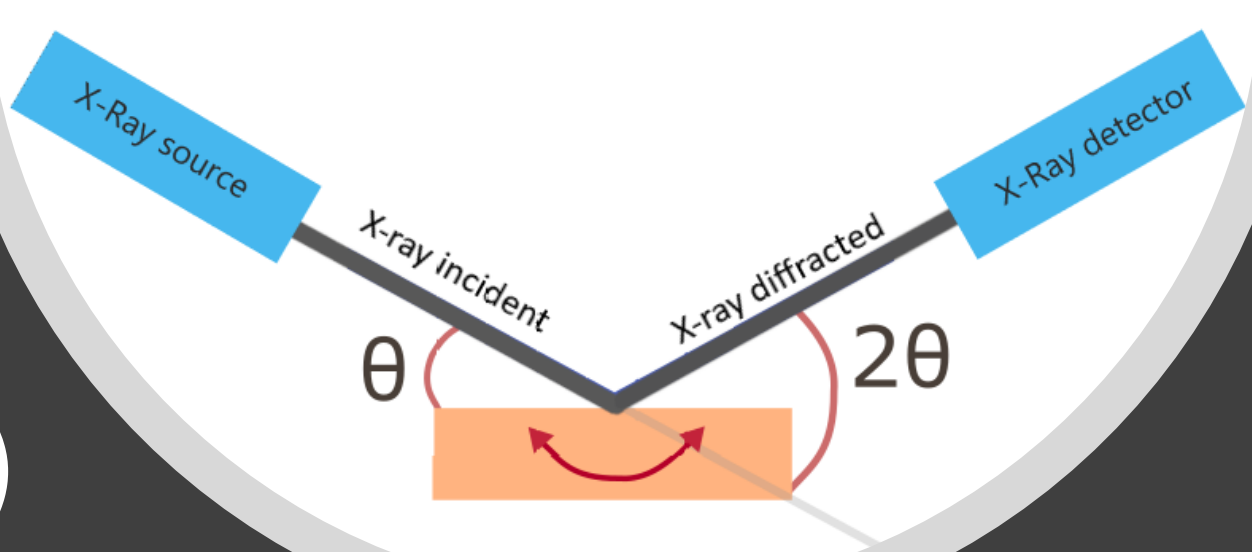
b) SAO: sacrificial layer pattern

c) SDC: not yet uniform film pattern

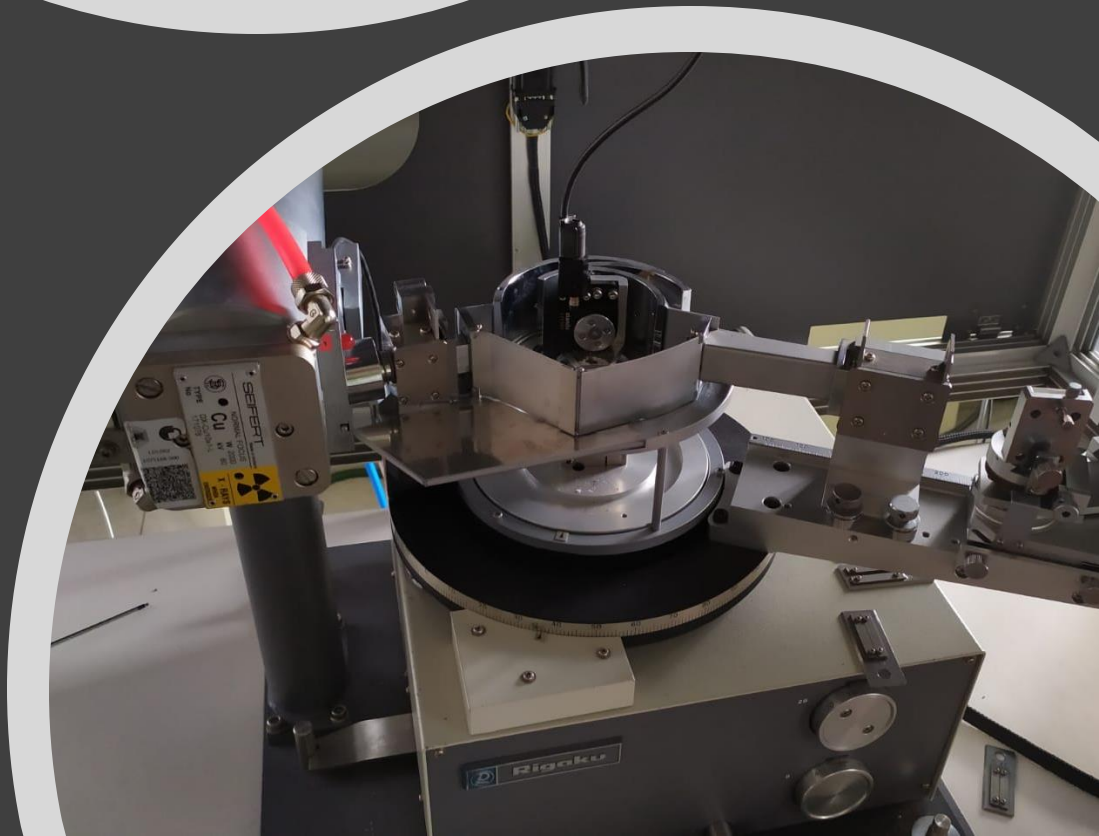


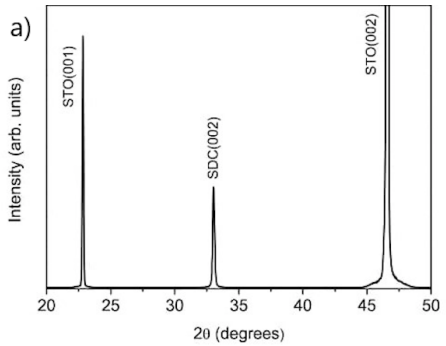
d) SDC: uniform film pattern

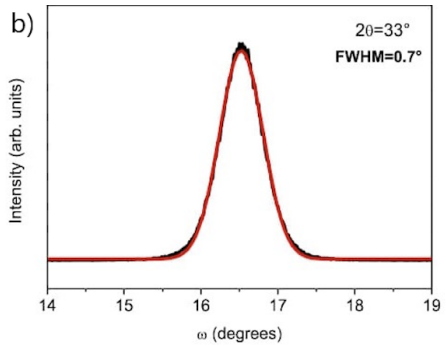
X-Ray diffraction (XRD)

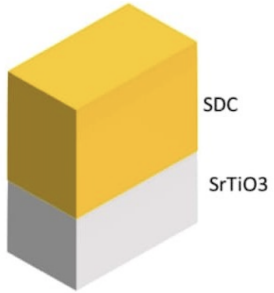


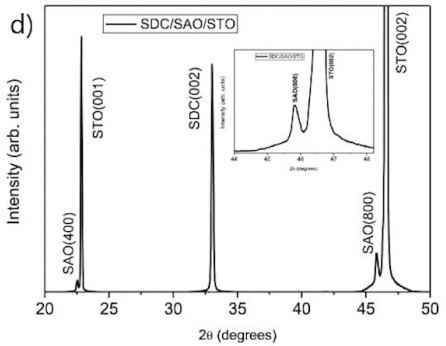
- Technique and process
- Experimental analysis
- Rocking Curve
- Conclusions

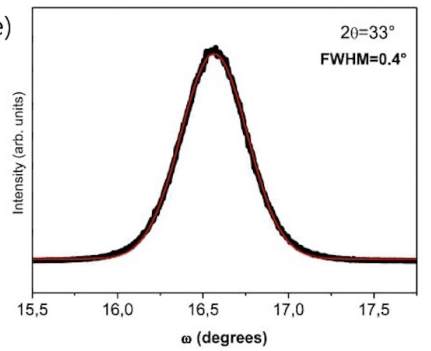


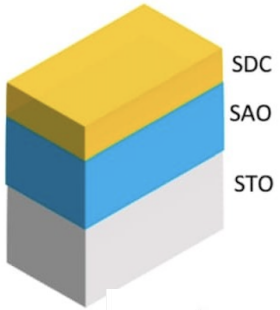






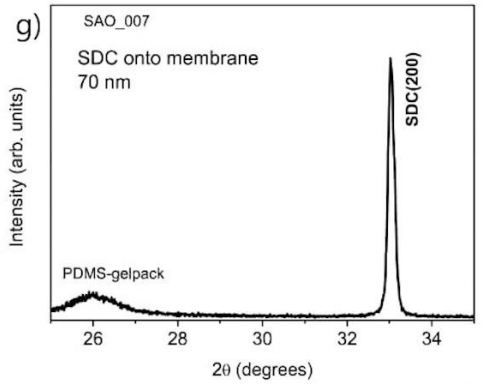


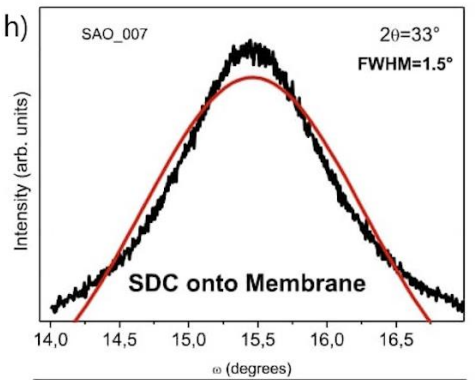


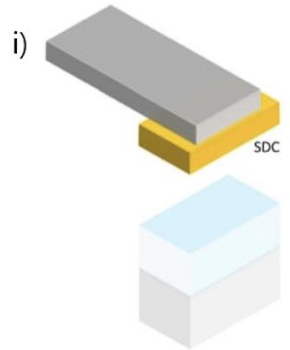


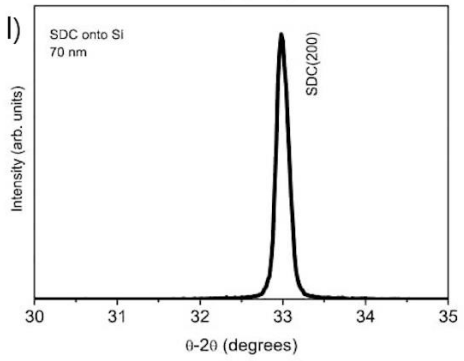
Plots and graphical representation of respectively SDC on STO and SDC on SAO

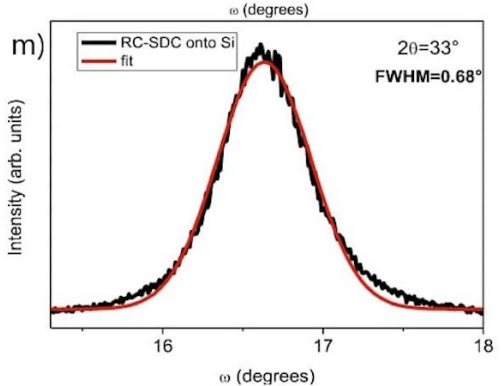
Plots and graphical representation of respectively SDC detached with a gelpack and SDC on Si

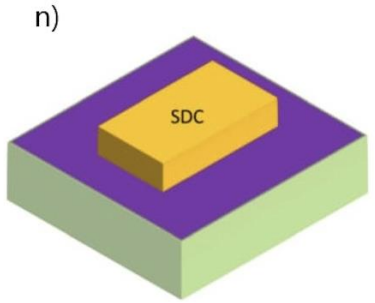













Thanks!