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Perovskite Oxides: Unlocking opto-electronic potential using abundant elements and low temperature synthesis

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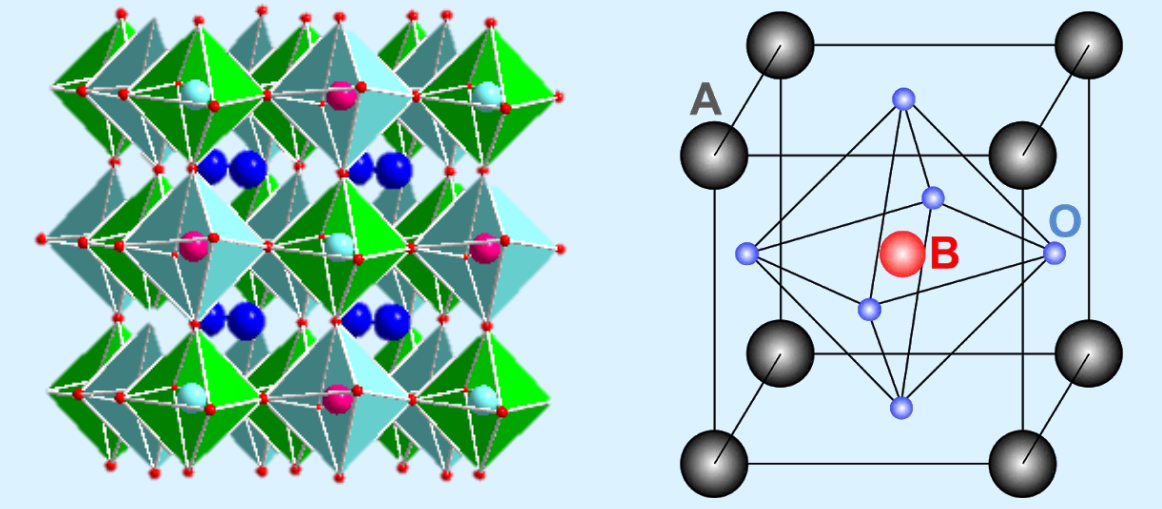
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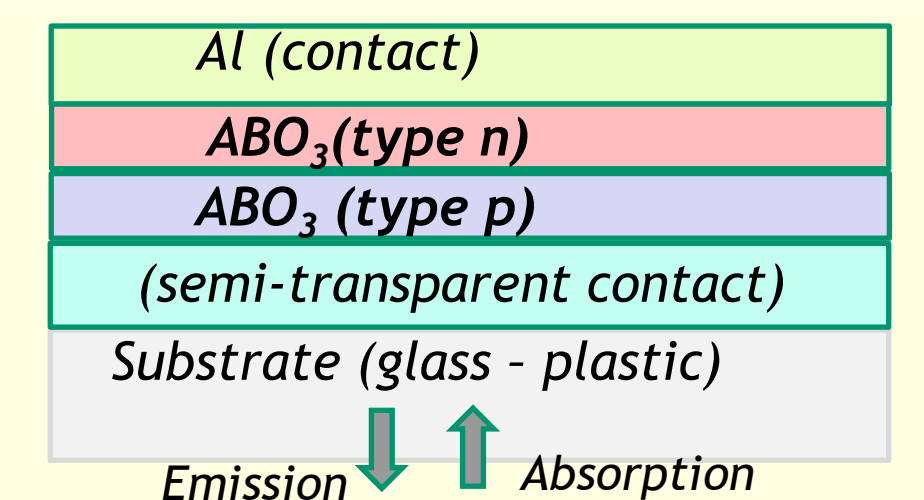
Background

- Perovskite named after the Russian mineralogist L. A. Perovski, their simple and flexible structure : ABO_3 fits to be doped with elements from all the periodic table
- The Perovskite film has a crystalline structure. Many different materials are being developed and gradually adopted for high-performance perovskite solar cells (Rapid increase in efficiency ; from 3,8% in 2009 to 25% in 2020 and 30% in 2022)
- Low production cost and simple and scalable manufacturing



Abstract

The objective of this work is the realization of an opto-electronic component (pn junction) based on doped metal oxide semiconductors ($SrSnO_3:Sb@SrSnO_3:Al$) synthesized in an eco-environmental framework of sustainable development. The project goes from the low cost, simple and scalable synthesis of the materials (e.g., sol-gel process), to their application as light absorbers or barrier layers in highly efficient solar cells. Other applications are also possible (e.g., LEDs).

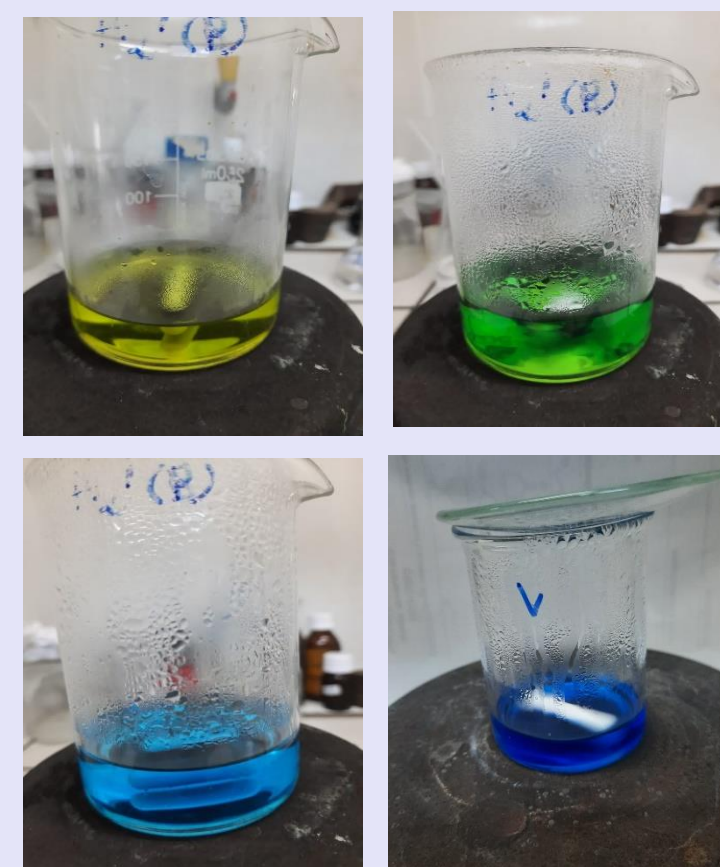


Experimental

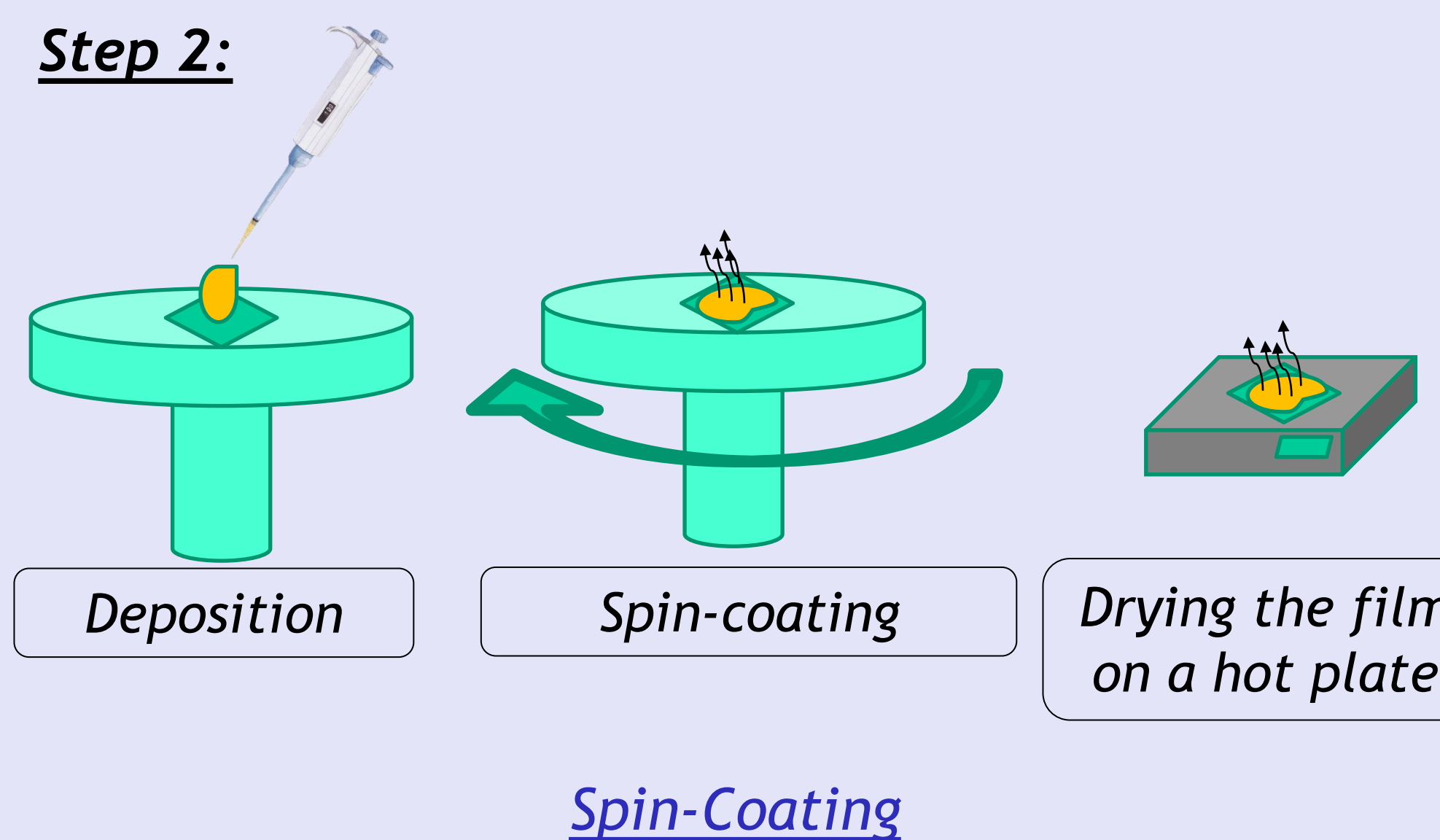
First method: Chemical solution deposition (CSD)

Step 1: Synthesis process

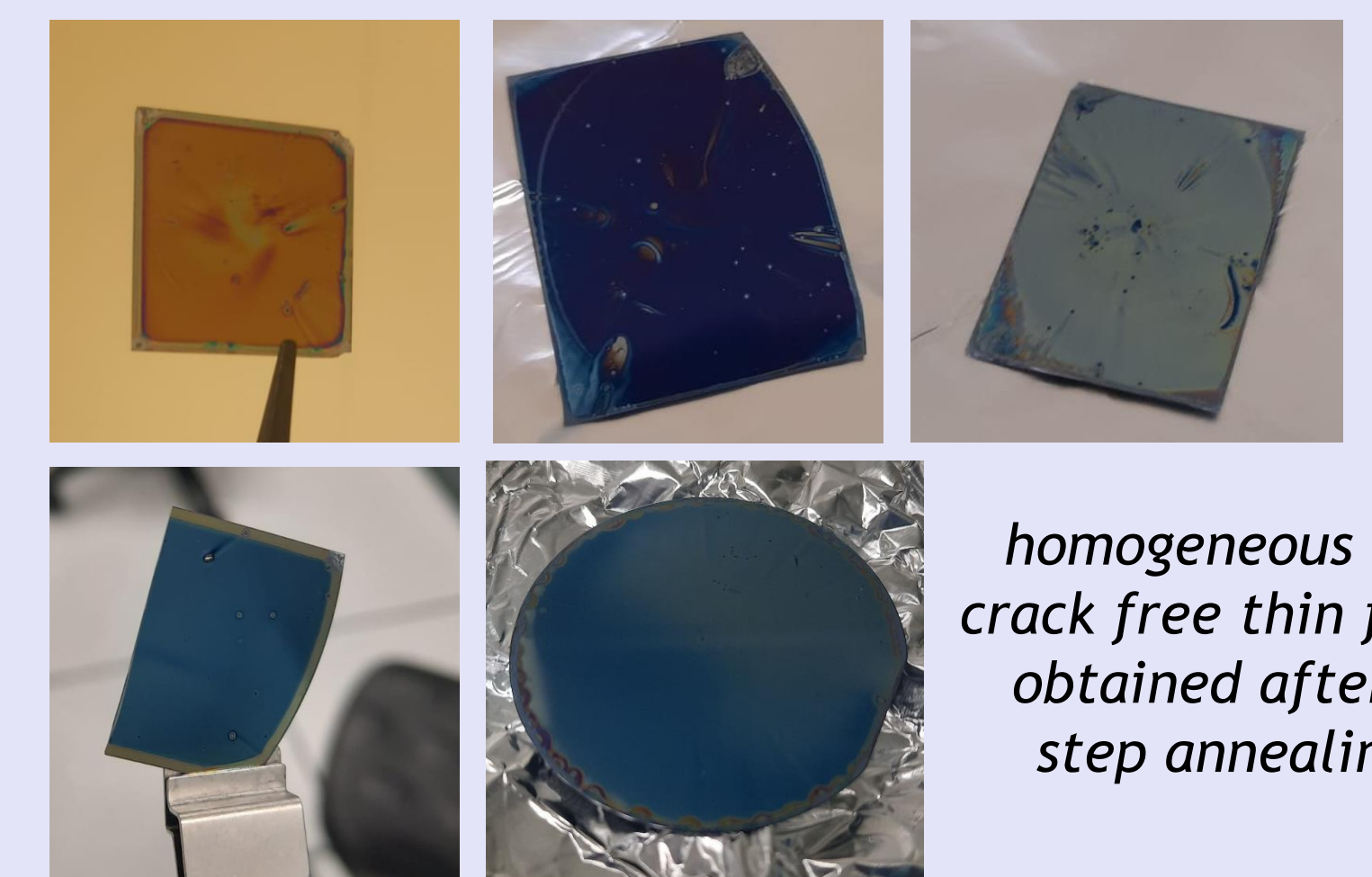
This method consists in chelating metallic cations with citric acid in an aqueous solution. Then these metal citrates polymerize with ethylene glycol by increasing the temperature.



Step 2:



Step 3: Annealing



Second method: Physical Vapor Deposition

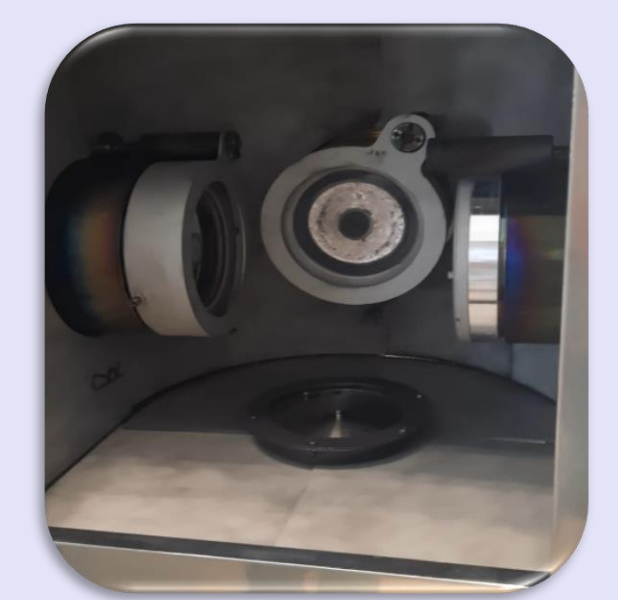


Step 1: Preparing the powder with sol gel synthesis method

Step 2: Pressing the powder on a target using a hydrolic press



Step 3: Physical vapor deposition



PVD chamber

Characterisation

XRD measurement (CSD)

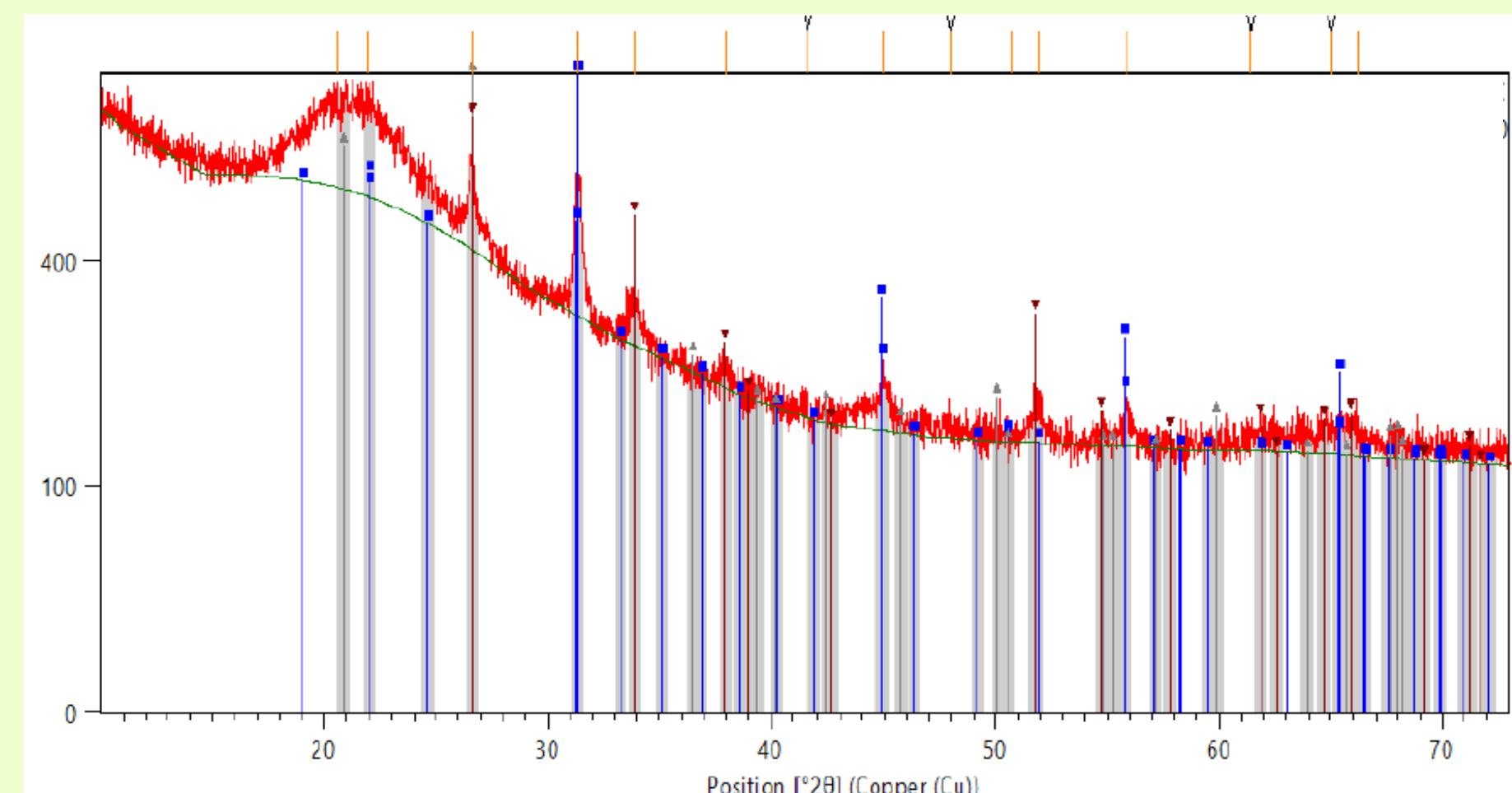
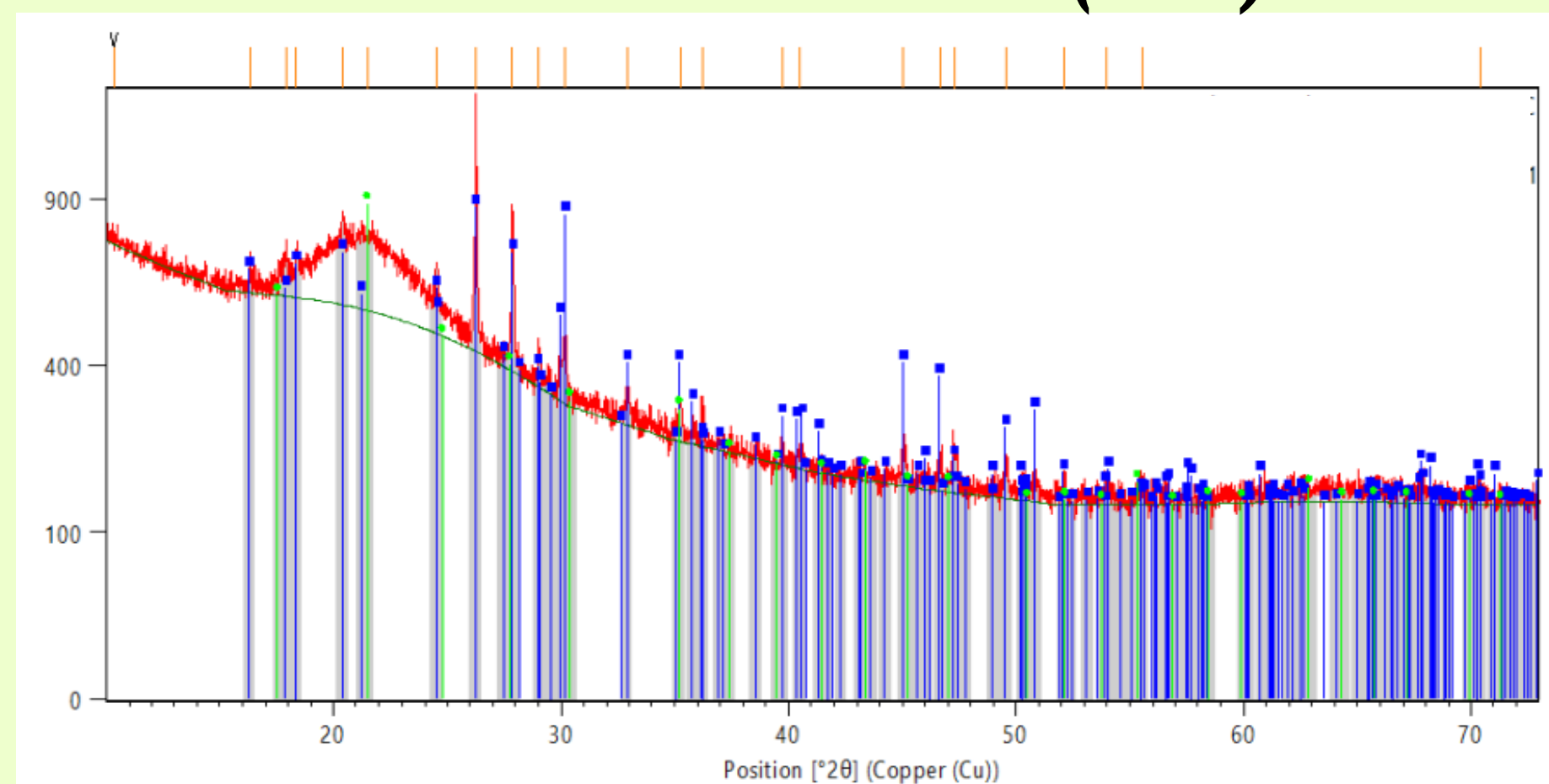


Figure: XRD diffractograms plotted on highscore to verify the crystallinity and the chemical composition of CSD prepared samples.

SEM Analysis

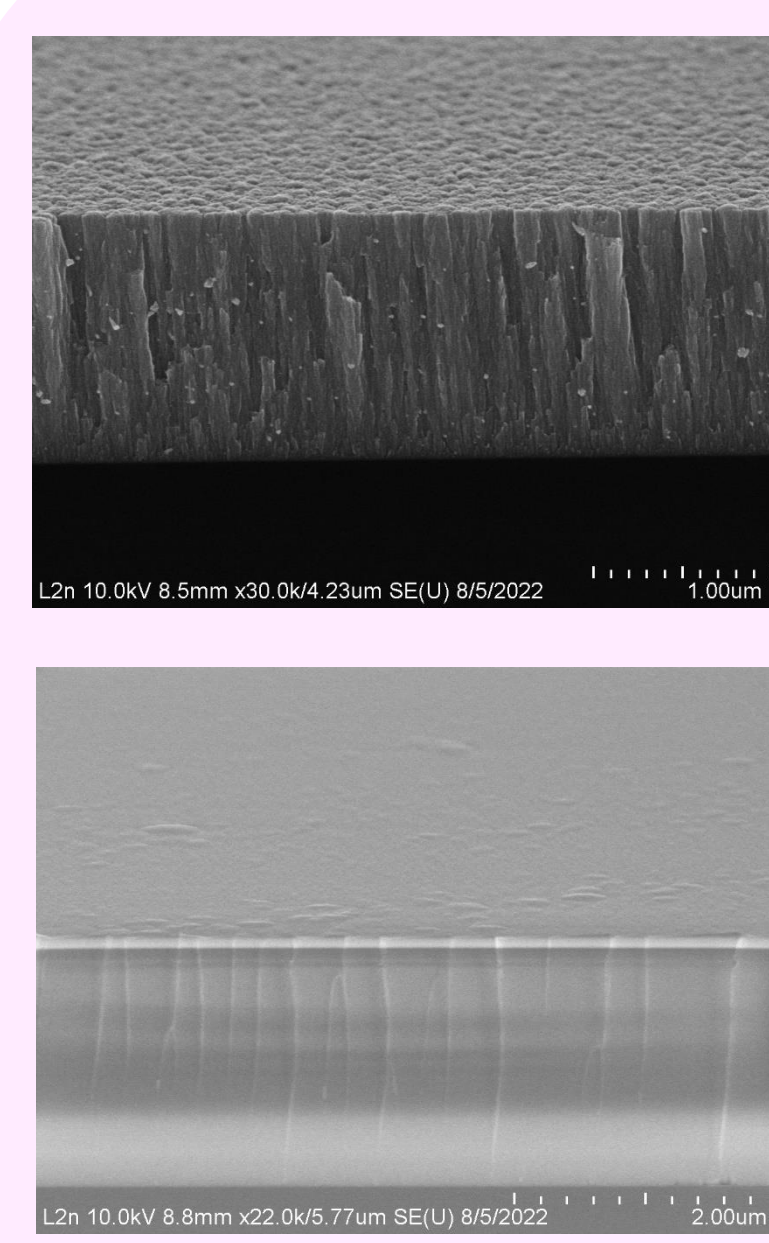


Figure: SEM images for PVD prepared samples

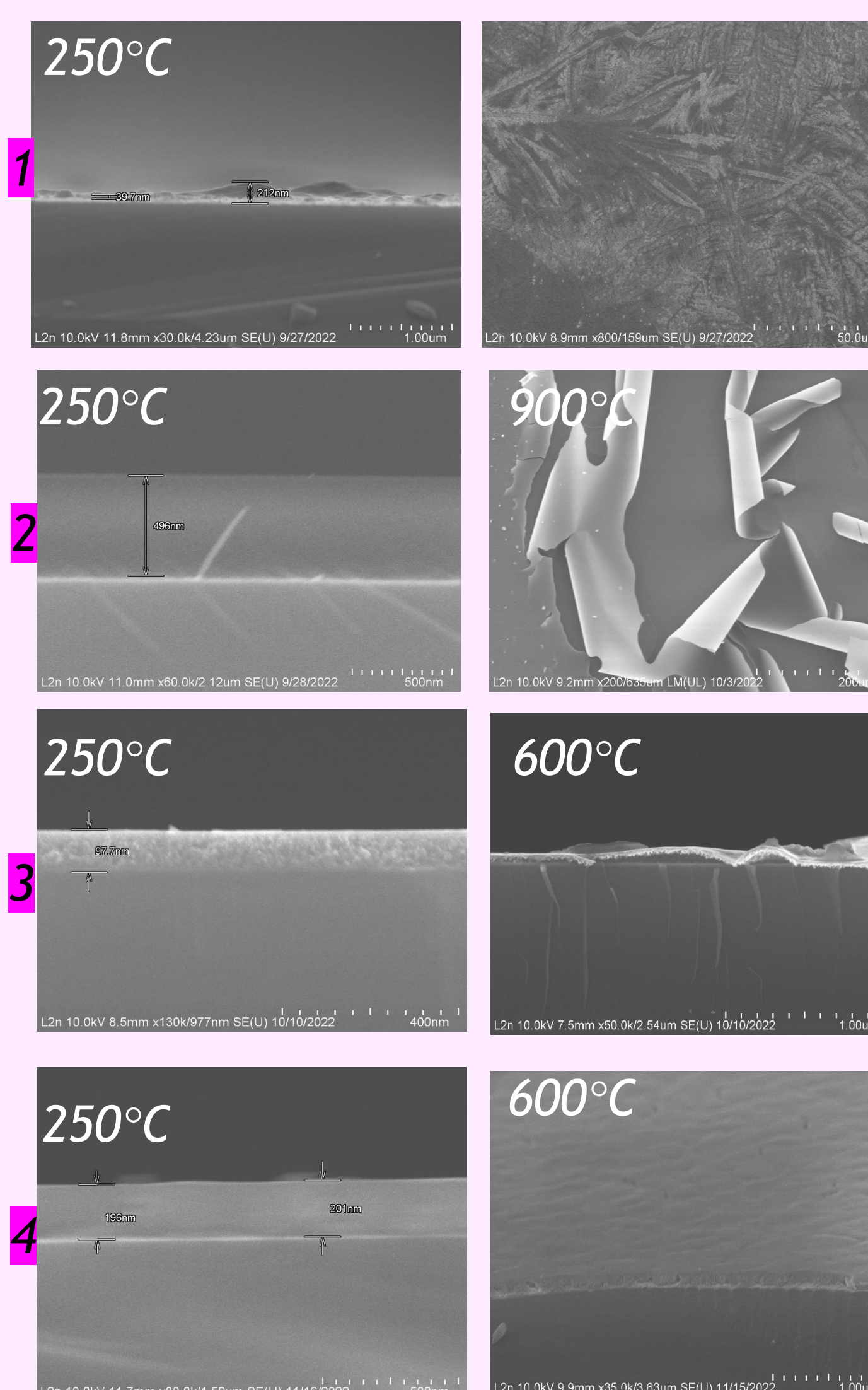


Figure: SEM images for CSD samples prepared in different conditions

Reflectance measurements

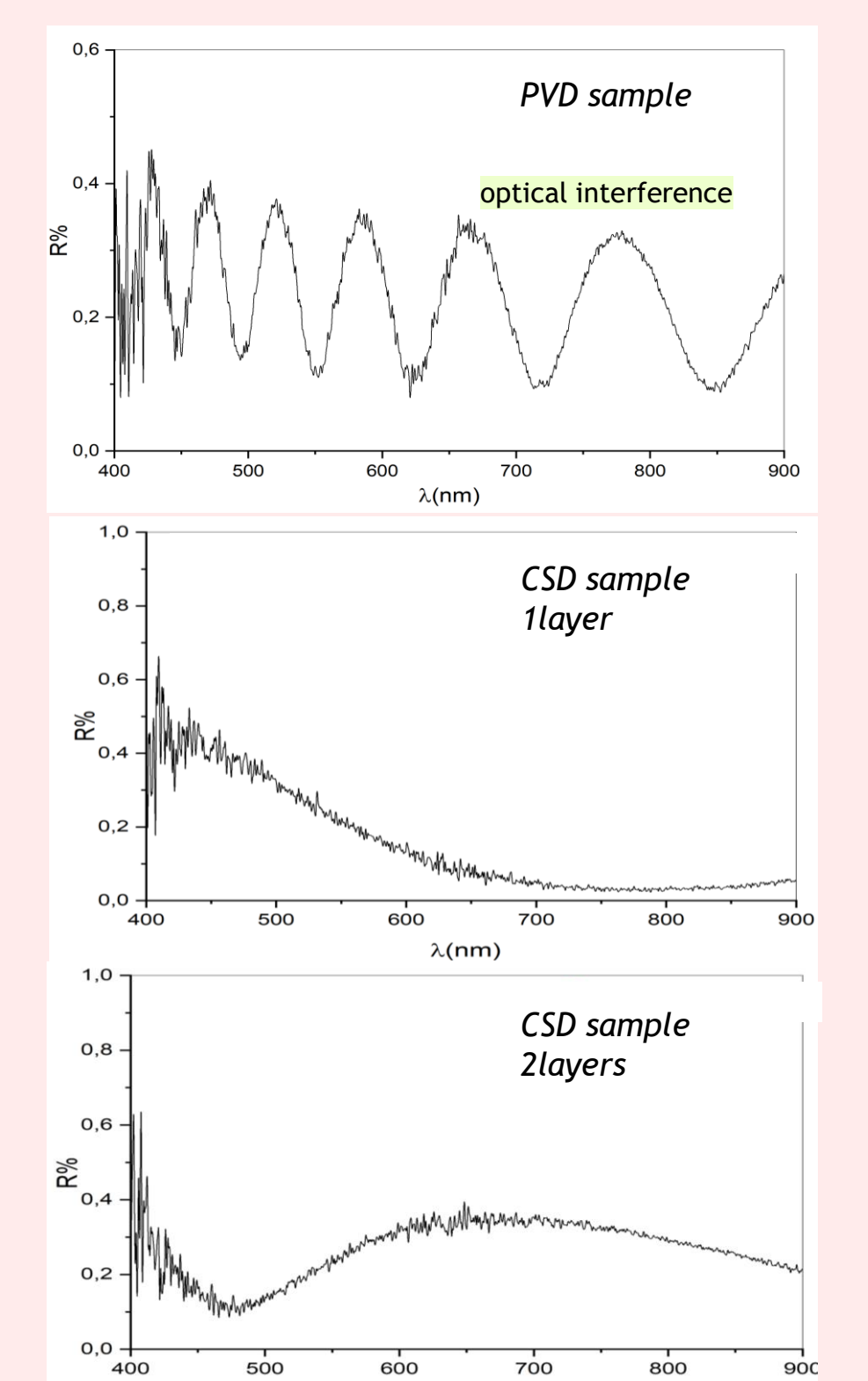
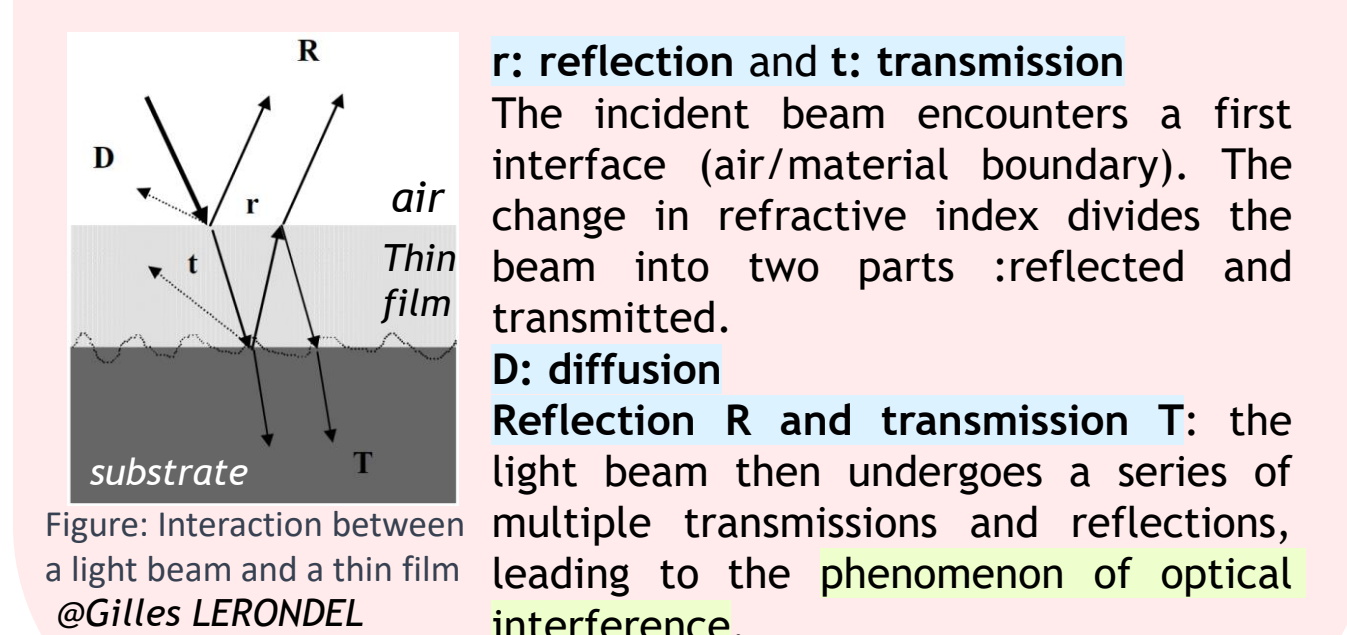


Figure : Reflectance measurement in integrating sphere



Conclusion

- For CSD prepared thin films, many parameters are crucial : annealing $T^\circ C$, precursors, pH, etc. A deep study had to be done to find the right conditions to have the appropriate thickness and homogeneity.
- Structure has been confirmed, in principle, with XRD diffraction and highscore software.
- SEM images proves the final aspect of homogeneous, uniform and crack free films.
- Reflectance measurement reflects the presence of optical interference phenomenon.

Future work

- Electrical and mechanical characterisation
- Make multilayers for pn junction and fabricate the first device