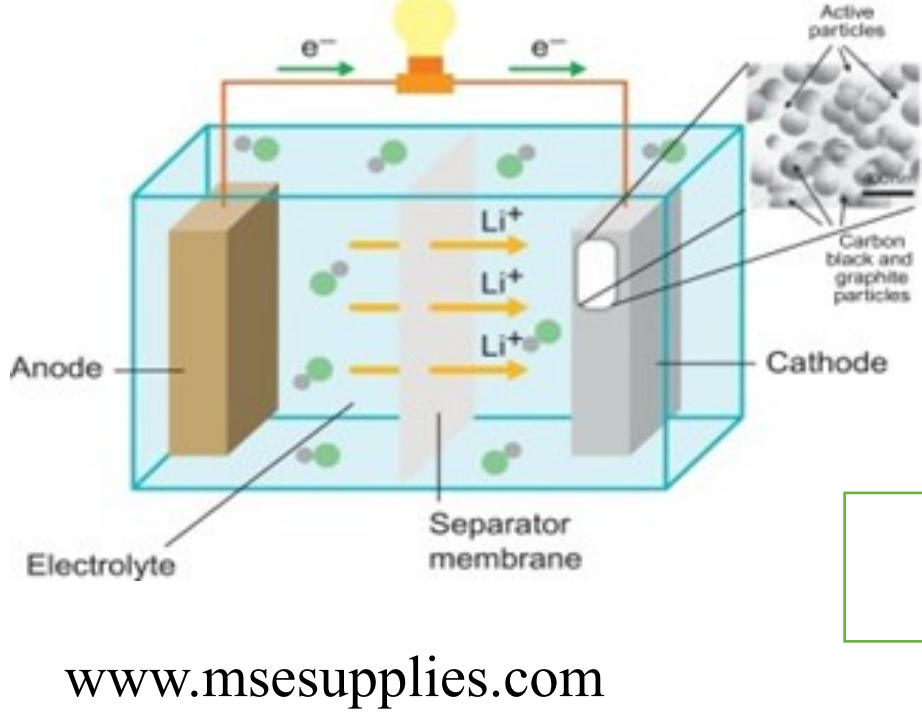


1. Introduction

Li-ion batteries (LiB)



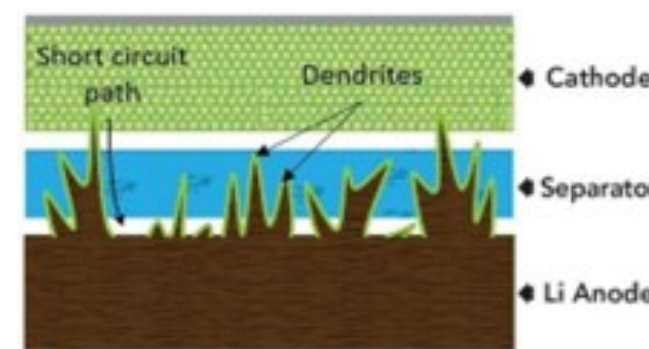
www.ms-supplies.com

Problems LiB

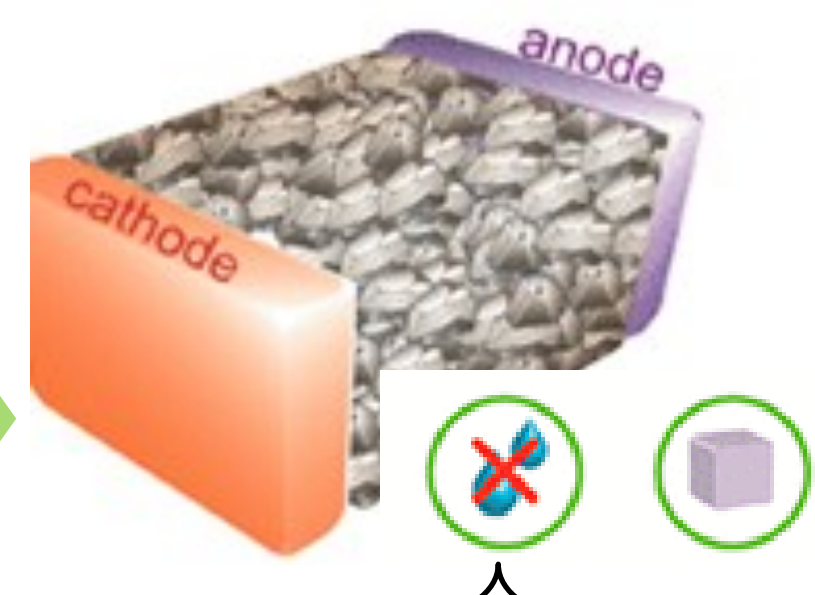
Thermally unstable electrolyte



Dendrite growth during charging



All solid-state battery (ASSB)



- ⇒ Inorganic solid battery
- ⇒ Solid Polymer battery
- ⇒ Composite solid battery

Chem. Rev., vol. 120, no. 14, pp. 6820–6877, 2019.

Solid electrolytes

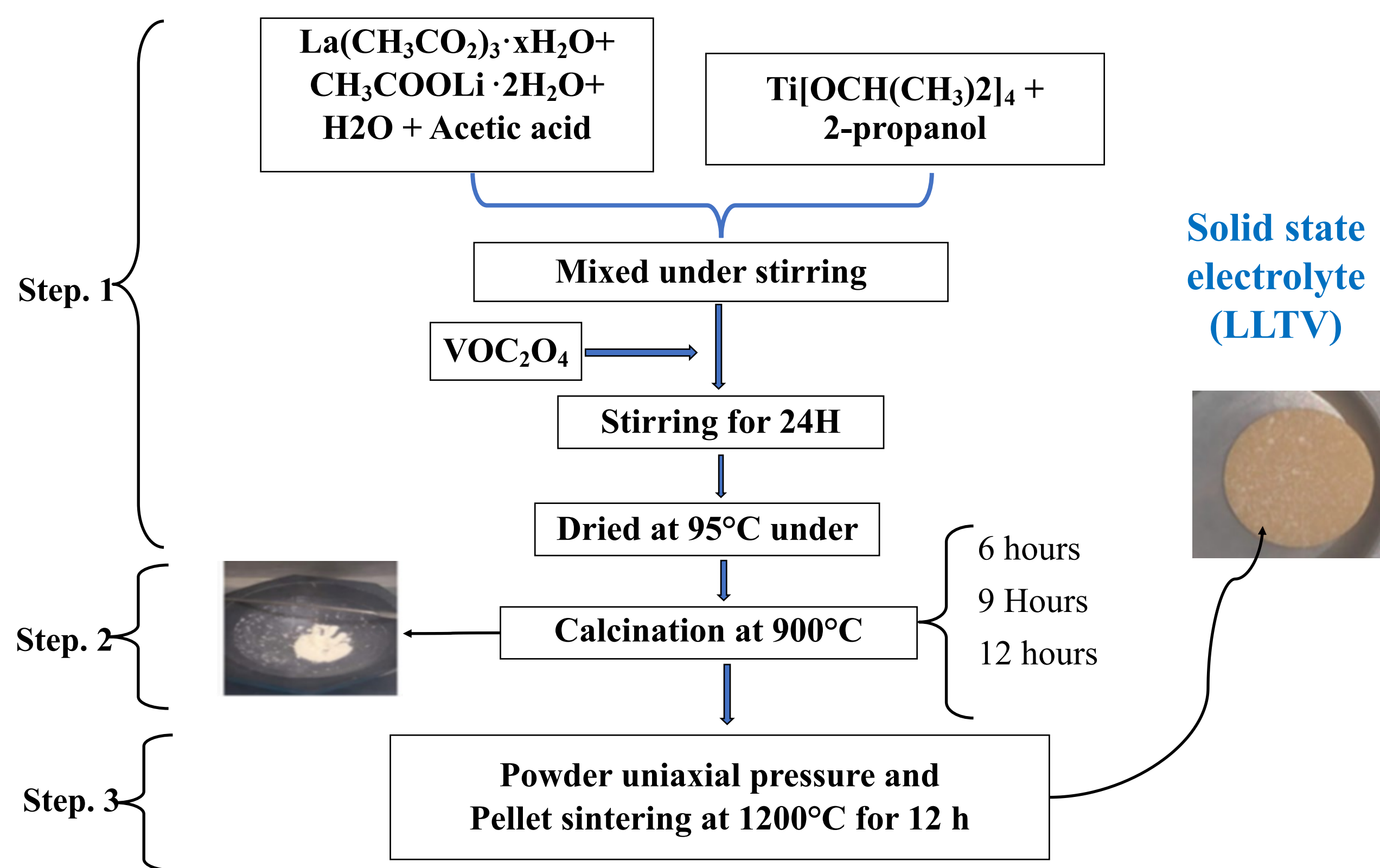
- Perovskite-type oxides and sulfide-type are promising solid electrolytes for all-solid-state batteries. Although the Li_{0.34}La_{0.51}Ti_{0.94} perovskite (ABO₃) shows high chemical stability, high bulk ionic conductivity (1.0x10⁻³ S/cm), the total ionic conductivity is lower (1.96.0x10⁻⁵ S/cm) because of the grain boundary resistance, which reduces the transport.
- To reduce the grain-boundary resistance it has been proposed the reduction the activation energy. Doping the B site of the perovskite structure with cations of smaller ionic radius is an alternative to decrease the interatomic bonding forces and improve the lithium conductivity [1][2].

Objective

To explore the synthesis of the material Li_{0.3}La_{0.57}Ti_{1-x}V_xO₃ (LLTV; x = 0, 0.01, 0.02 and 0.03) through the coprecipitation method, the effect of the calcination time of the powders and the sintering at high temperature (1200°C) to obtain a solid electrolyte. with potential use in Li-ion batteries.

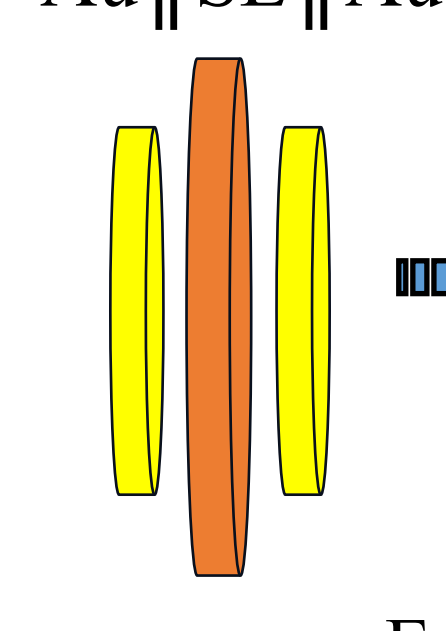
2. Methodology

Synthesis: The coprecipitation Method was used to obtain the solid electrolytes (SE) Li_{0.3}La_{0.57}Ti_{1-x}V_xO₃.



Electrochemical Characterization

Au || SE || Au



- ⇒ Electrochemical impedance spectroscopy.
- ⇒ Chronoamperometry

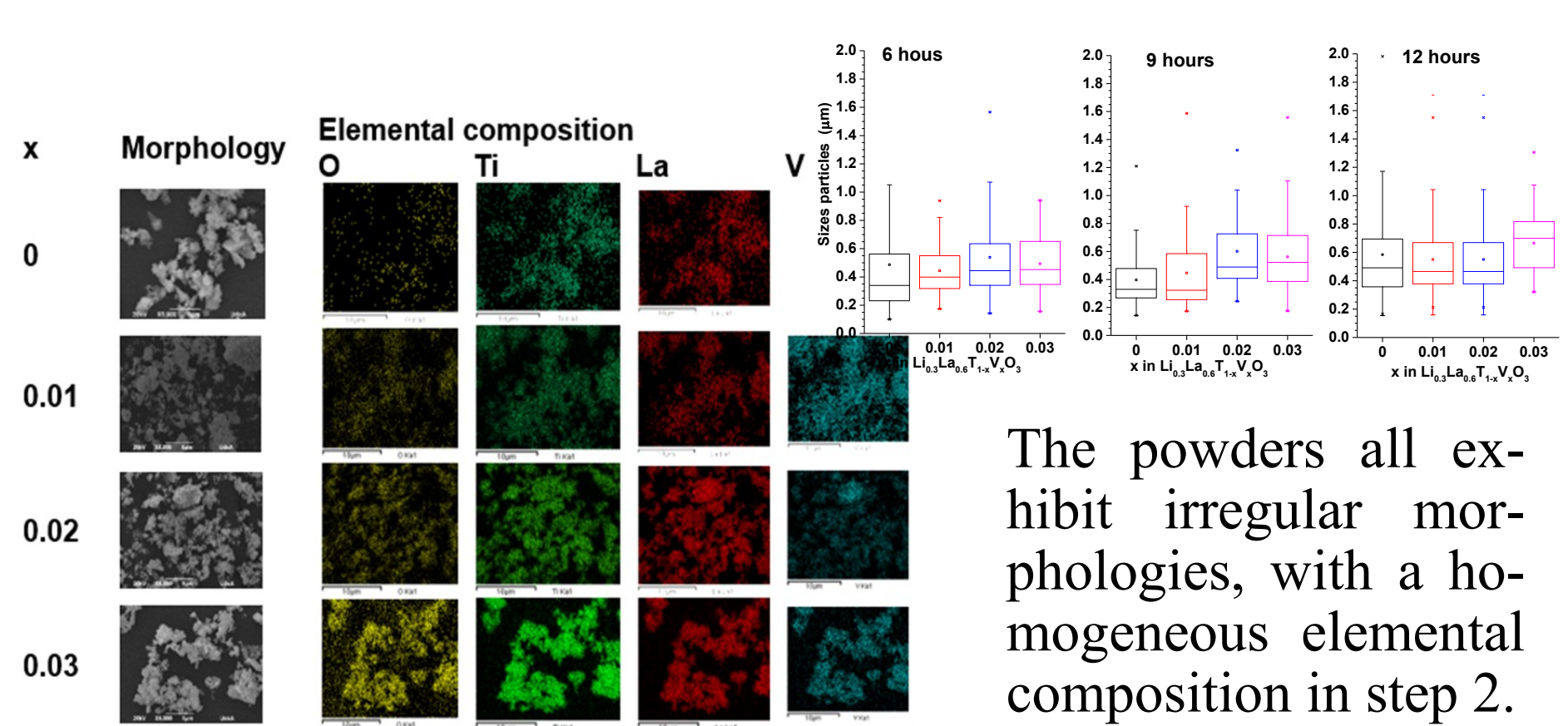
Eq. 1 was used to calculate the ionic and electronic conductivity, and the Arrhenius relation (Eq. 2) for the activation energy.

$$\sigma = \frac{L}{RA} \quad \text{Equ. 1}$$

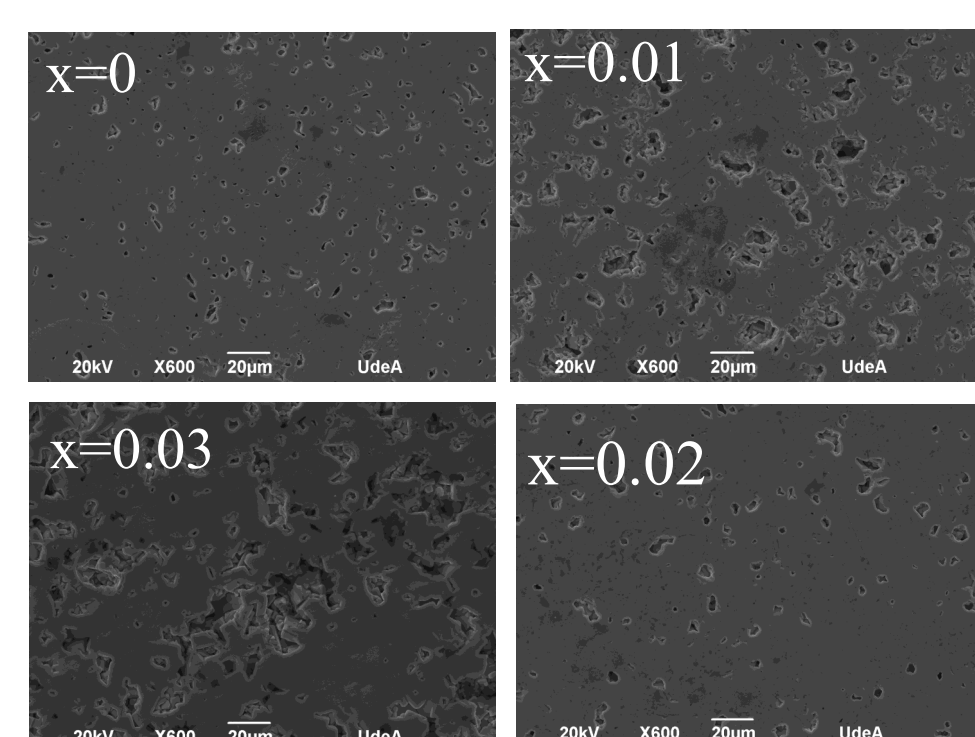
$$\sigma(T) = \sigma_0 e^{-\frac{Ea}{kBT}} \quad \text{Equ. 2}$$

3. Results.

Physic-Chemistry Characterization Step 2

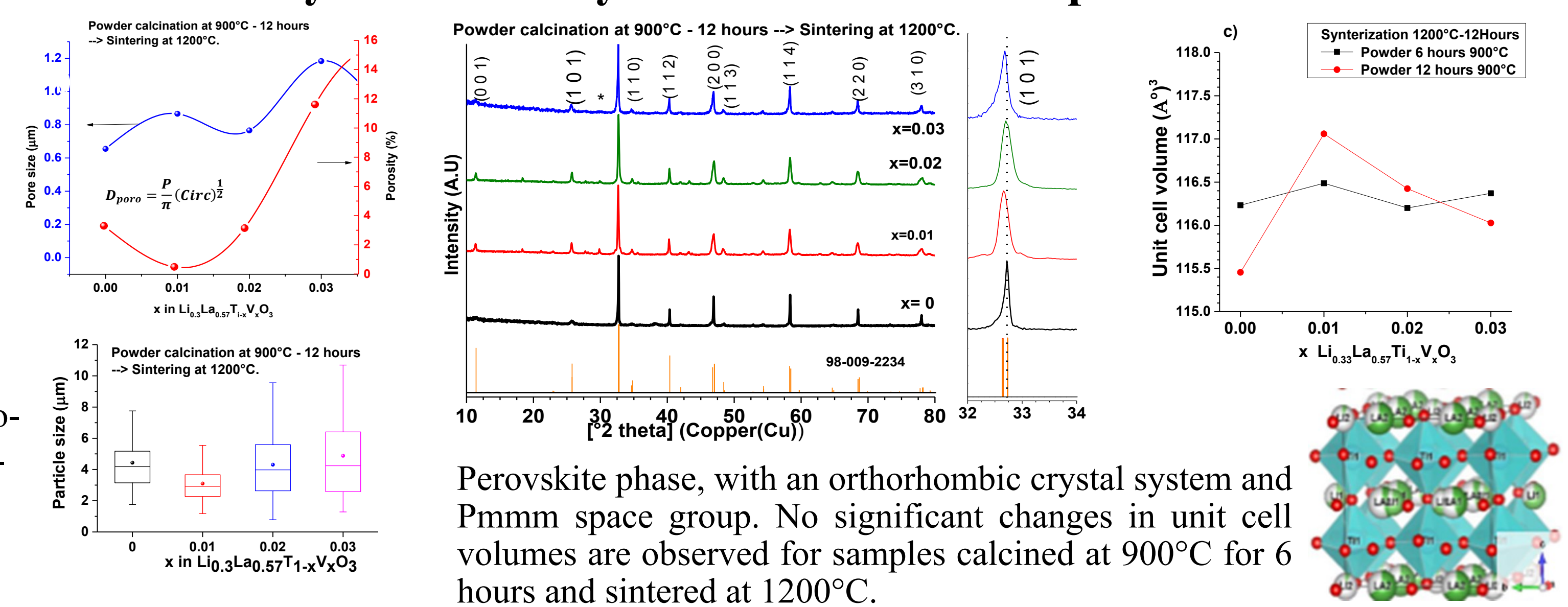


The powders all exhibit irregular morphologies, with a homogeneous elemental composition in step 2.



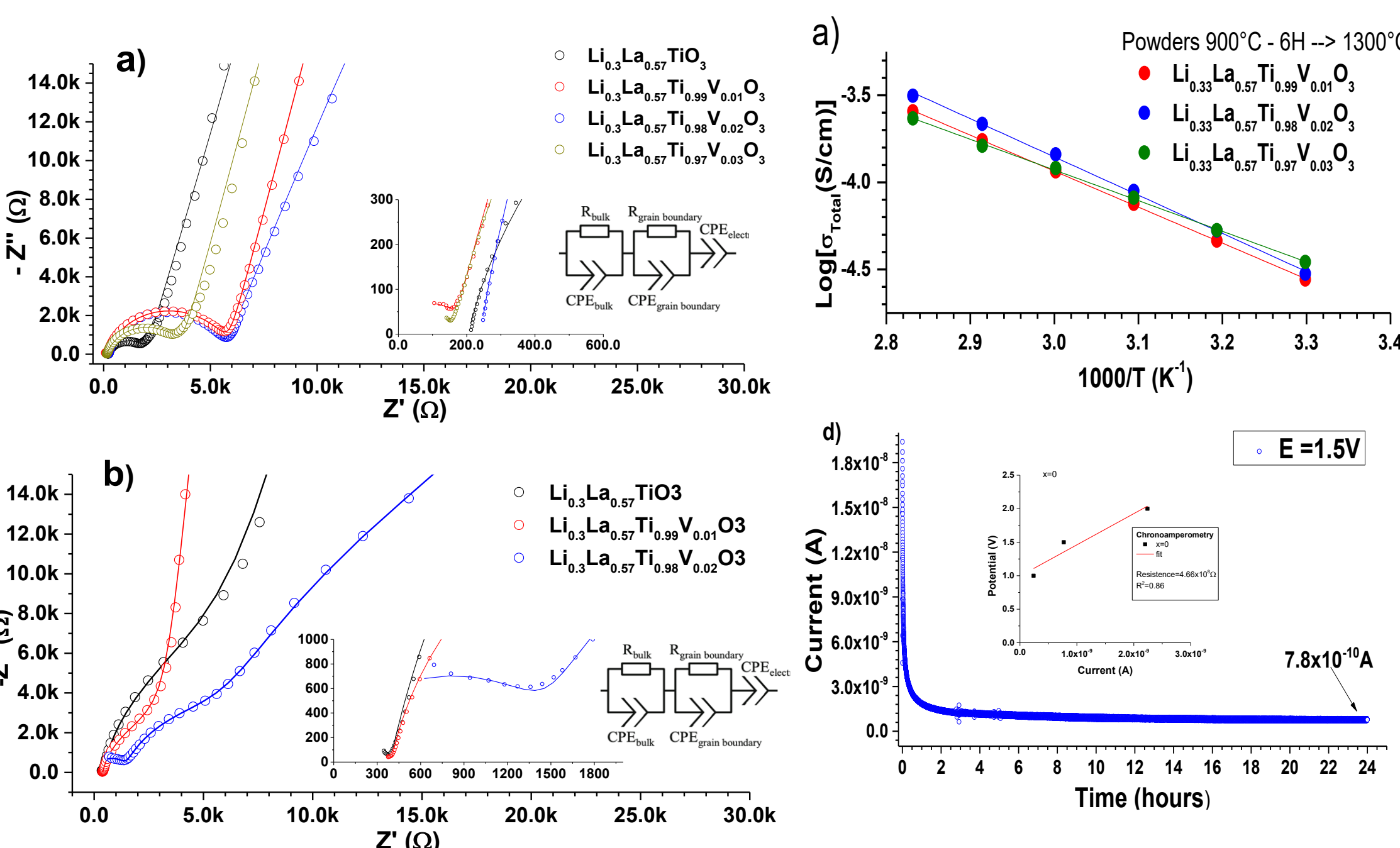
Cross section morphology solid electrolytes (SE) Li_{0.3}La_{0.57}Ti_{1-x}V_xO₃ Calcination at 900°C-6h-->Sintered. at 1200°C

Physic-Chemistry Characterization Step 3



Perovskite phase, with an orthorhombic crystal system and Pmmn space group. No significant changes in unit cell volumes are observed for samples calcined at 900°C for 6 hours and sintered at 1200°C.

Electrochemical Characterization solid electrolyte LLTV (step 3)



Simplex Li _{0.3} La _{0.57} Ti _{1-x} V _x O ₃	σ_g (10 ⁻³ S/cm)	σ_{bg} (10 ⁻⁵ S/cm)	σ_{Total} (10 ⁻⁵ S/cm)	Ea (eV)	
Calcination 6 hours at 900°C (1200°C)	x=0	4.83	3.88	3.59	0.36
	x=0.01	8.9	0.44	0.44	0.44
	x=0.02	1.54	1.40	1.28	0.16
Calcination 12 hours at 900°C (1200°C)	x=0	4.38	5.07	4.54	0.45
	x=0.01	6.17	3.75	3.53	0.41
	x=0.02	7.43	2.25	2.18	0.44
Calcination 6 hours at 900°C (1300°C)	x=0.01	7.34	8.53	7.6	-
	Li _{0.3} La _{0.55} TiO ₃ Solid state reaction (1300°C) [3]	10	2	1.96	-
Li _{0.5} La _{0.5} Ti _{1-x} Zr _x O ₃ sol-gel (1300°C) [4]	-	-	5.63	0.47	

Where, σ_g , σ_{bg} and σ_{Total} are the ionic conductivity of grain, in boundary grain limits and Total respectively, Ea is the activation energy.

maycolf.mena@udea.edu.co

4. Conclusions

The solid electrolyte Li_{0.3}La_{0.57}TiO₃ without vanadium exhibits the highest total ionic conductivity 4.54x10⁻⁵ S/cm, and the Li_{0.3}La_{0.57}Ti_{0.98}V_{0.02}O₃ exhibits the best grain conductivity (7.43x10⁻⁴ S/cm).

A remarkable result was obtained for the solid electrolyte Li_{0.3}La_{0.57}Ti_{0.99}V_{0.01}O₃, calcined at 900°C for 6 hours and sintered at 1300°C, which exhibited the highest ionic conductivity in grain boundaries, reaching a value of 6.853 x10⁻⁵ S/cm. The electronic conductivity values were lower than 10⁻⁸ S/cm.

5. Acknowledgements and References.

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