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V CONGRESO COLOMBIANO DE ELECTROQUÍMICA
VIII SEMINARIO INTERNACIONAL DE QUÍMICA APLICADA
III Escuela Andino-Amazónica de Química
WORKSHOP QUÍMICA Y BIOLOGÍA DE HONGOS CON POTENCIAL BIOTECNOLÓGICO

Desarrollo de Heteroestructura "capa-espinela" como promisorio material de cátodo para baterias de Ion-Litio de alta estabilidad

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Content

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Renewable sources - Storage systems

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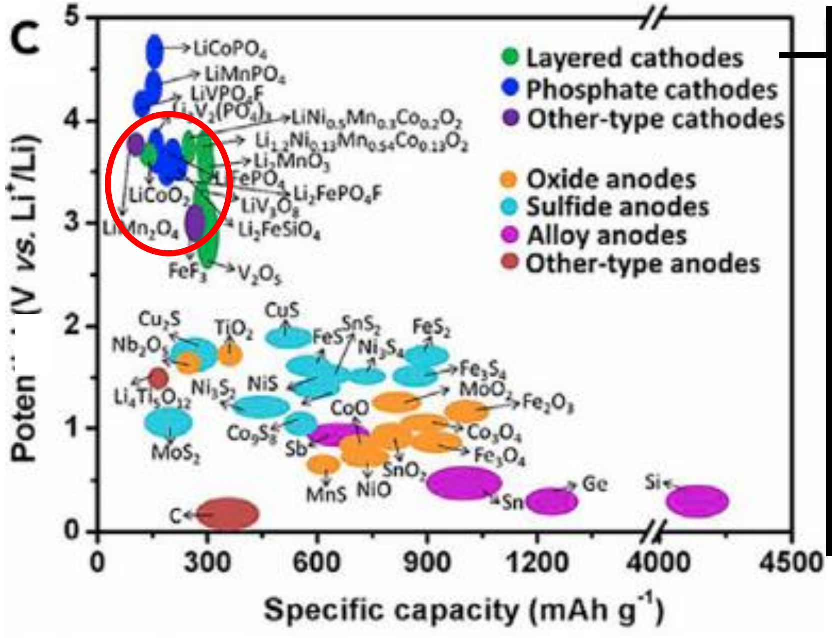
Global energy demand

Projection

Generate → Renewable sources

Find → **Storage systems** → **Li-Ion Batteries LIBs**

LIBs



- High voltage
- High Capacity

Meng, Jiashen, et al. Joule, 2017, Vol. 1, 522.

¿Why the Li-ion batteries are still under developmpent?

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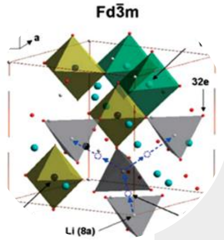
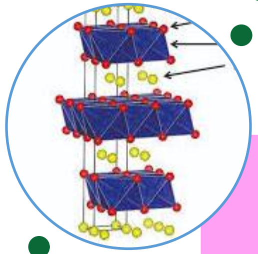
Cathode material

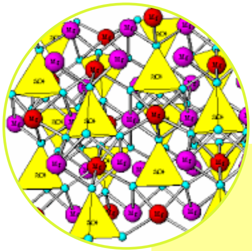
High energy capacity
Long life cycle
Lower Cost
Eco-friendly.
High coulombic efficiency



Spinel



Layered



Olivine

Layered-Spinel Heterostructre

Lithium ion battery

Wang, Sihui et al, Journal of Power Sources, 245 (2014) 570-578.
Ngoc Hung Vua (2017)

Na:Spinel – Layered Heterostructure

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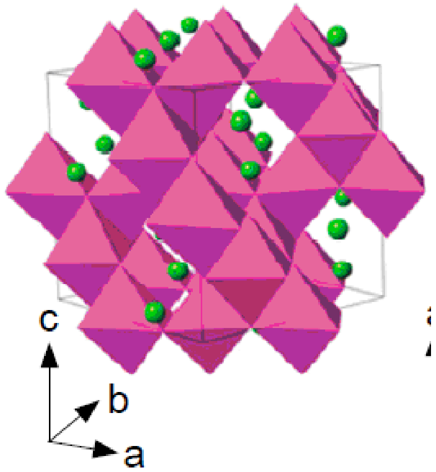


spinel $LiMn_2O_4$

3D

Faster ion and electron transport (3D)

Low structural stability

Modification

Ti^{4+}

$Li_2VTi_xO_4$

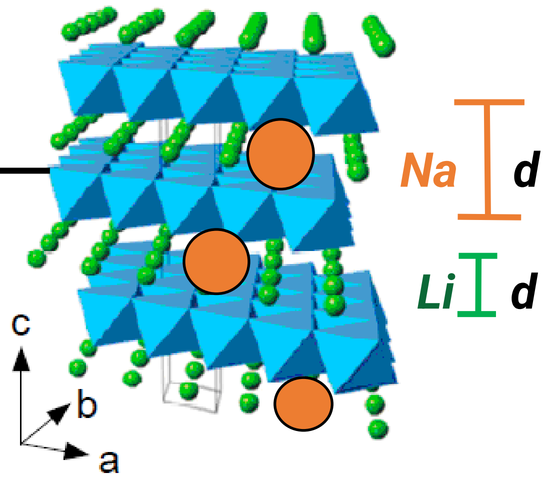
➢ Improving the stability of the material

Specific theoretical capacity: 272 (137) $(mAhg^{-1})$

Fast capacity fade at high current rates

Modification

Na^{+}



layered $LiCoO_2$

2D

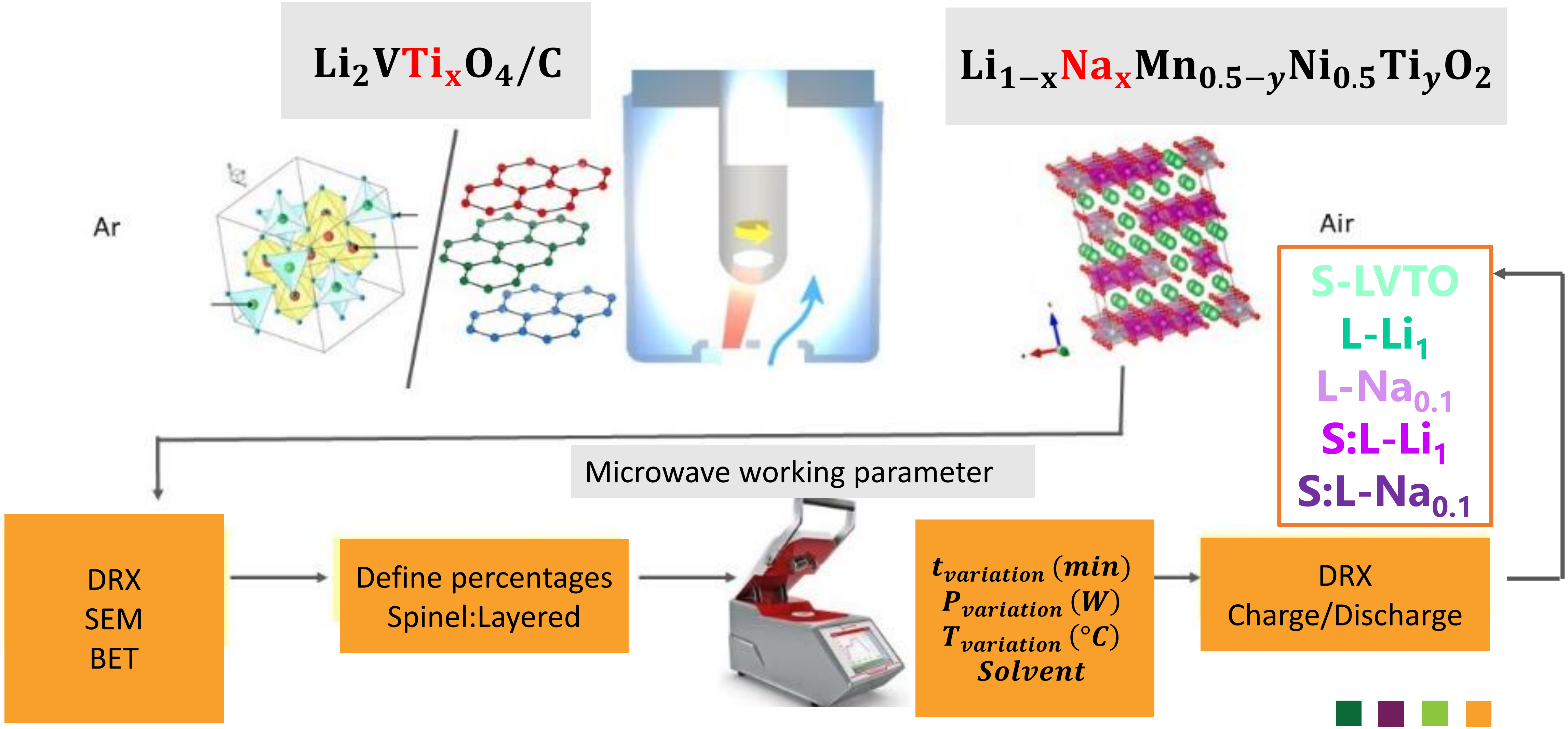
$Li_{1-x}Na_xMn_{0.5-y}Ni_{0.5}Ti_yO_2$

➢ 1-D Li^{+}transport during discharge and charge

Li, Y. Wu, M. Ouyang, C. (2015).
Schmidt, et al. J. of Power Sources. 196 (2011) 5342.
Yinhua, Z. Xingyu, Z. Xu, Y. Le, Zhang, X. Chen, H. Yang, J.P.S. 321 (2016) 120–125.
J. Zheng et al. Advanced Energy Materials, 1601284 (2017) 1-25.

Methodology

¿What it was the methodology strategy for the formation of the Layered-Spinel Heterostructures?



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RESULTS

Morphological and Structural characterization

SEM

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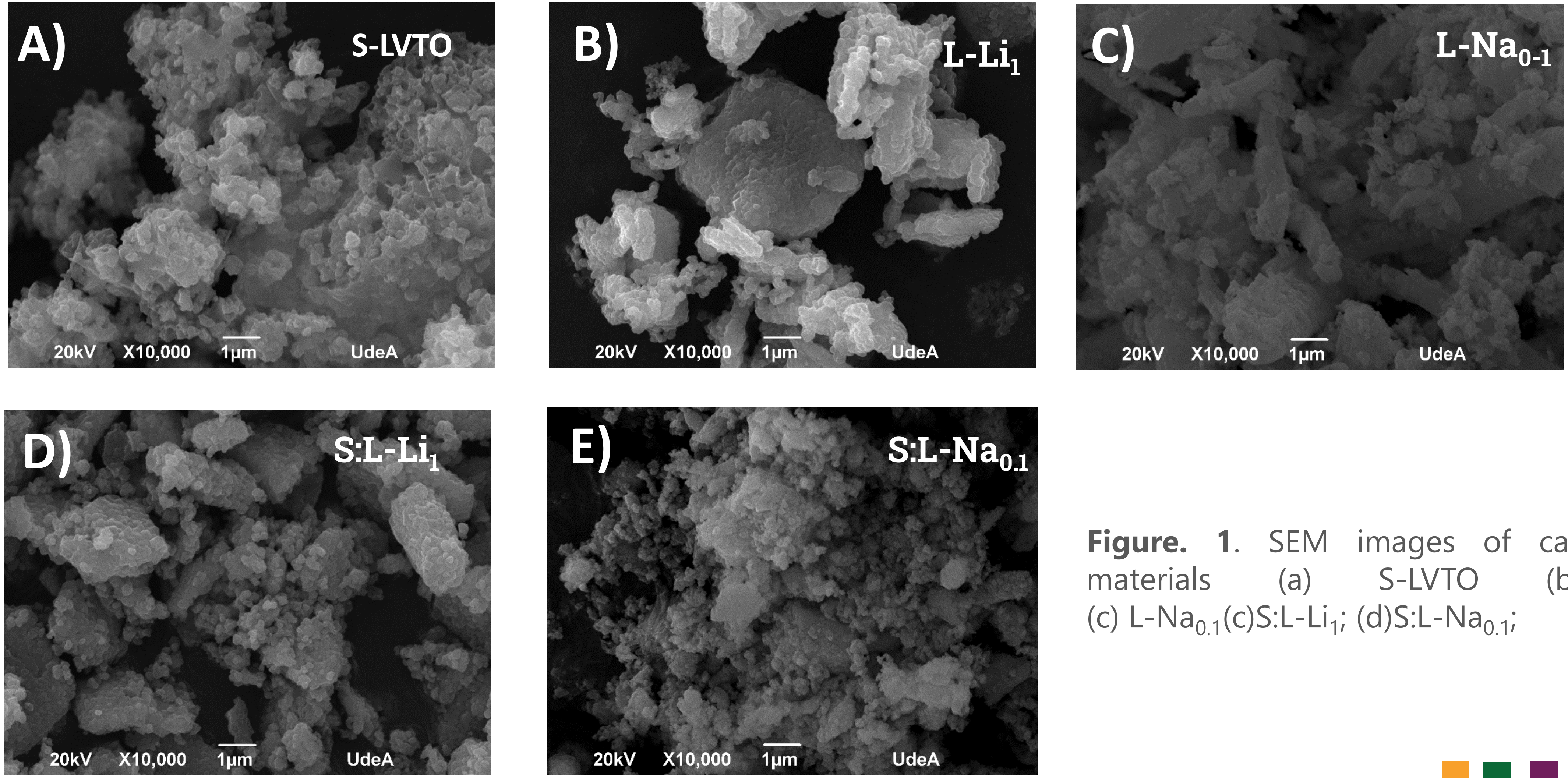

Figure. 1. SEM images of cathode materials (a) S-LVTO (b)L-Li_1; (c) L-$Na_{0.1}$(c)S:L-Li_1; (d)S:L-$Na_{0.1}$;

HR-TEM

Heterostructure S:L-Li_1 Vs S:L-$Na_{0.1}$

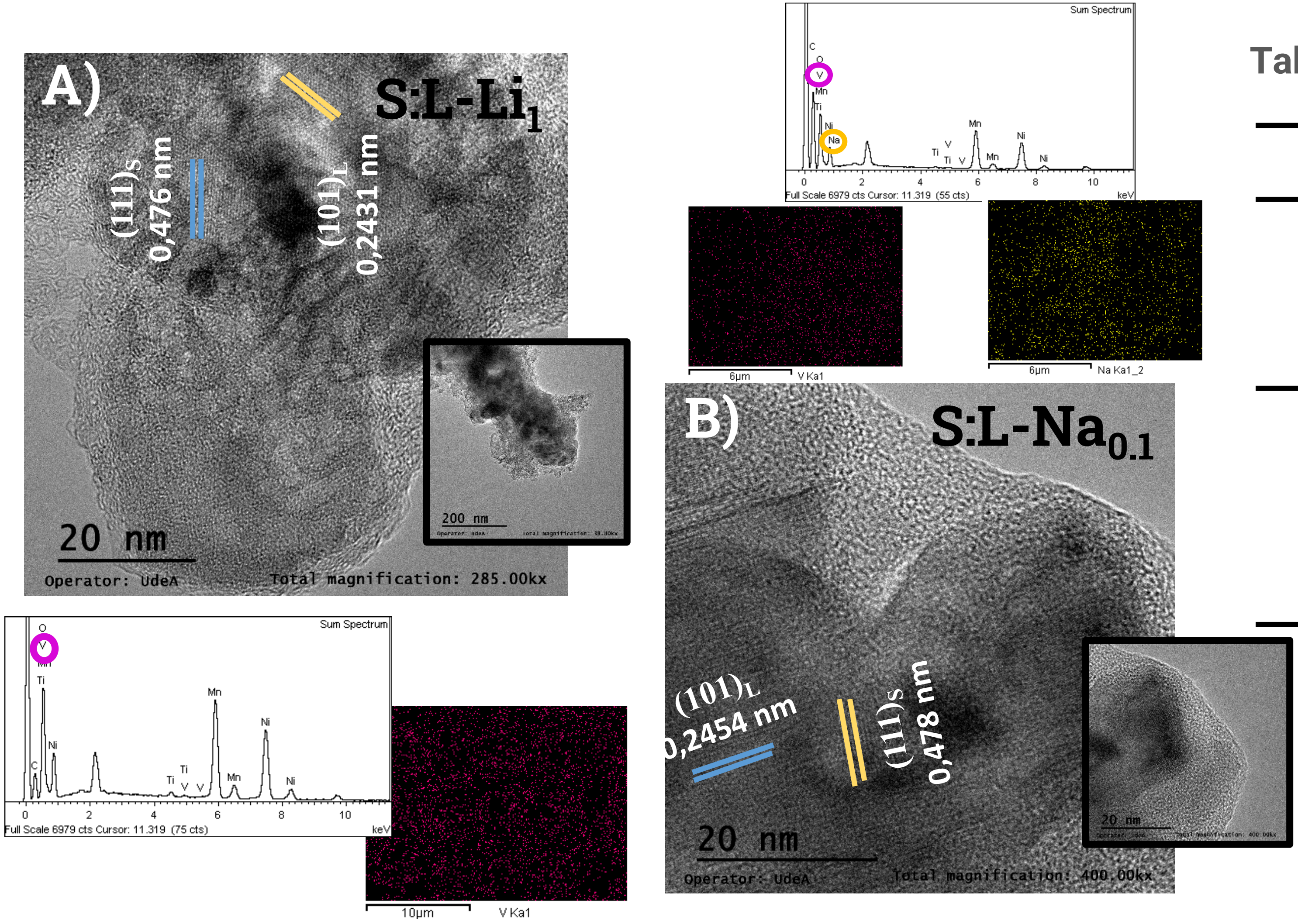

Figure 2: HRTEM images of A) S:L-Li_1 and (B)S:L-$Na_{0.1}$;

Table 1: Rietveld Analysis

Formula	S:L-Li_1	S:L-$Na_{0.1}$
Space group	Fd3m	Fd3m
a=b=c (A)	8.2794 (5)	8.2793 (4)
Volume (Å)	544.9 (2)	544.8(3)
Space group	C 12-m1	C 12-m1
a (Å)	4.95 (1)	4.97
b (Å)	8.51 (1)	8.52 (1)
c (Å)	4.99 (2)	5.14 (2)
Volume (Å)	199.06(3)	203.017 (2)

RESULTS

Electrochemical characterization

↓

Li-Ion batteries (LIB)

Li-Ion batteries

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Discharge specific capacity of the active materials

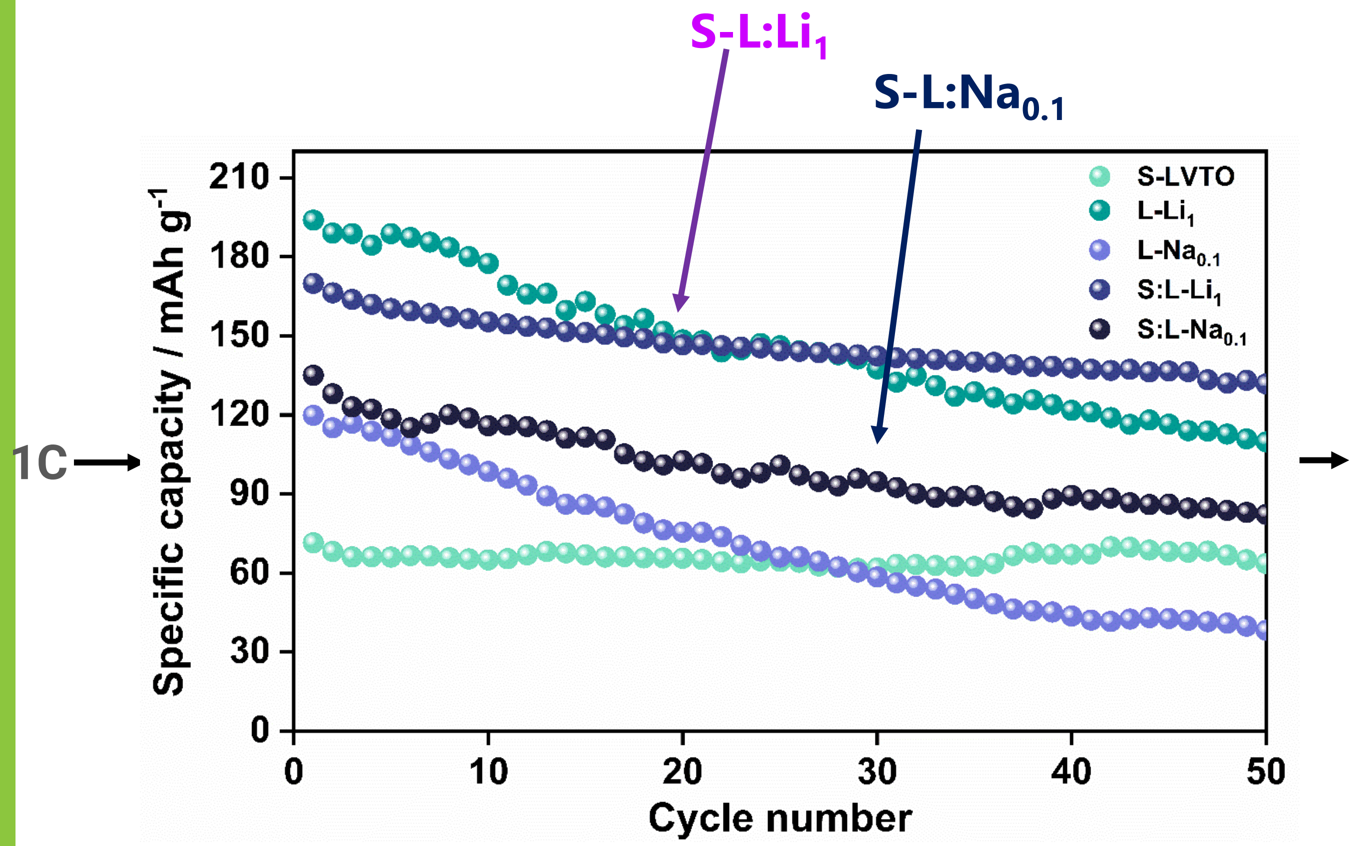

Figure 3. Discharge specific capacity of active material at a constant current of 28.1 mA g^{-1} (1C) between 4.8 and 2.0 V vs. Li|Li^+.

Table 3: Specific capacity of the cathode Materials at 0.1C

Materials	Specific capacity/mA h g-1	
	Cycle 1	Cycle 50
S-LVTO	71	64
L-Li_1	193	110
L-$Na_{0.1}$	120	50
S-L:Li_1	169	135
S-L:$Na_{0.1}$	135	83

Li-Ion batteries

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Discharge capacities at different C rates of the active materials

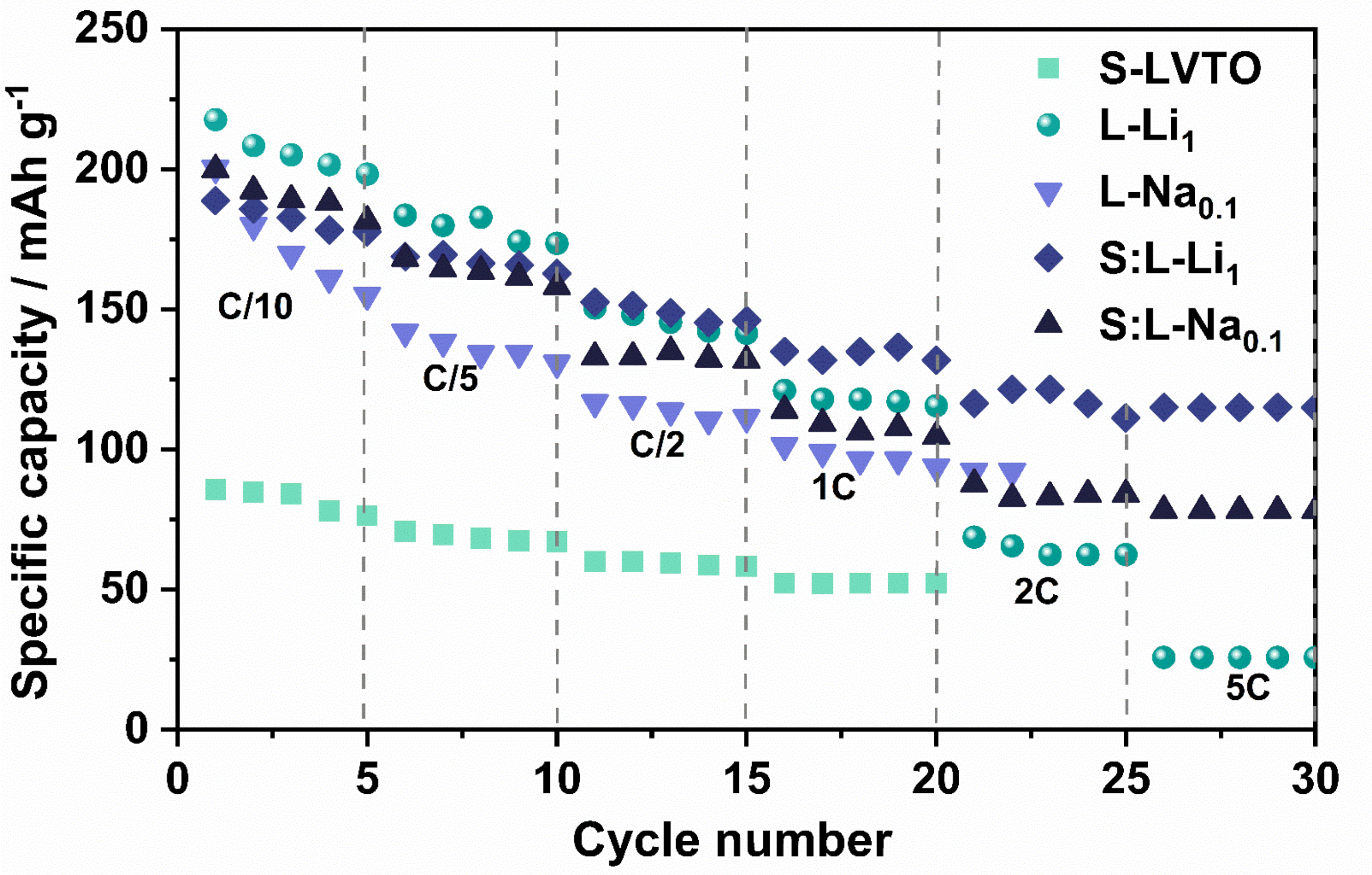

Figure. 4: Discharge capacities of the active materials: S-LVTO, $L\text{-}Li_1$ $L\text{-}Na_{0.1}$, $S{:}L\text{-}Li_1$, $S{:}L\text{-}Na_{0.1}$; at different C rates between 4.8 and 2.0 V vs. $Li|Li^+$.

Excellent response the layered-spinel: **$S{:}L - Li_1$** and **$S{:}L - Na_{0.1}$** at high C.R:

Li-Ion batteries

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Charge/discharge curves of cathode materials

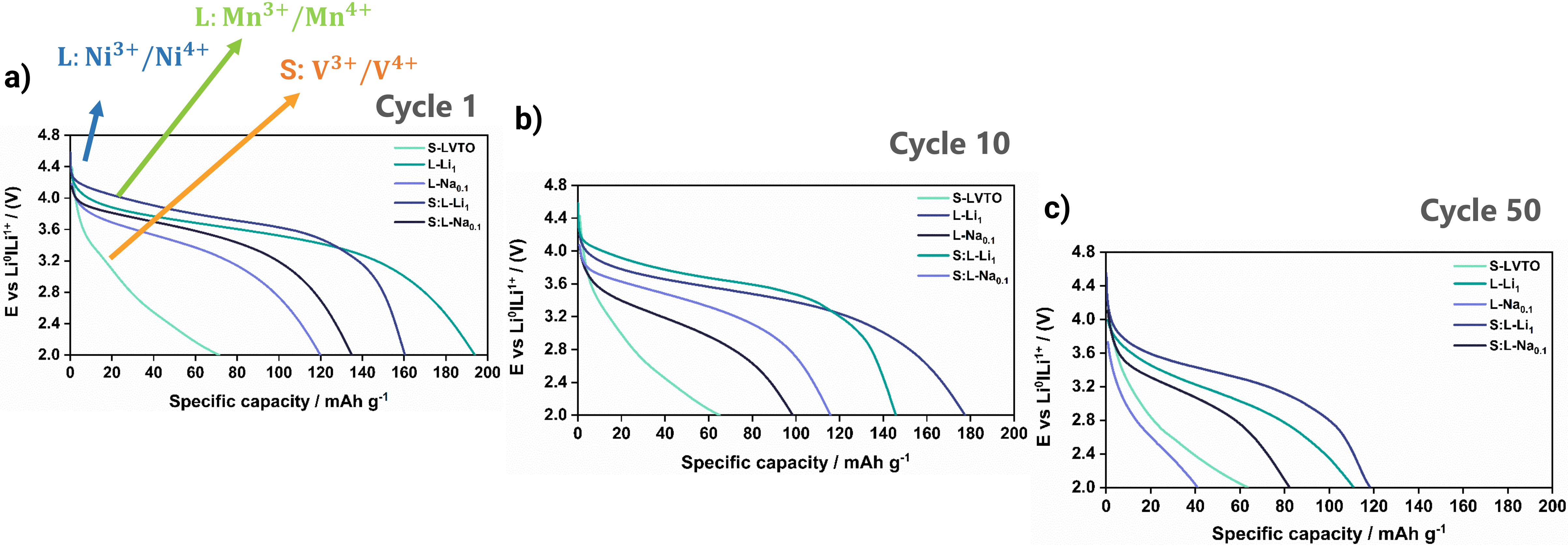

Figure 5. Charge/discharge curves of cathode materials corresponding to cycle numbers (a) 1st; (b)10th and (c) 50th. The tests were performed at 28.1 mA g^{-1} (1 C-rate) in a voltage range of 2.0 - 4.8 V vs. $Li|Li^{+}$ in a 1.0 mol L^{-1} $LiPF_6$ EC: DMC electrolyte.

Li-Ion batteries

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Spectroscopy Impedance Electrochemical: EIS

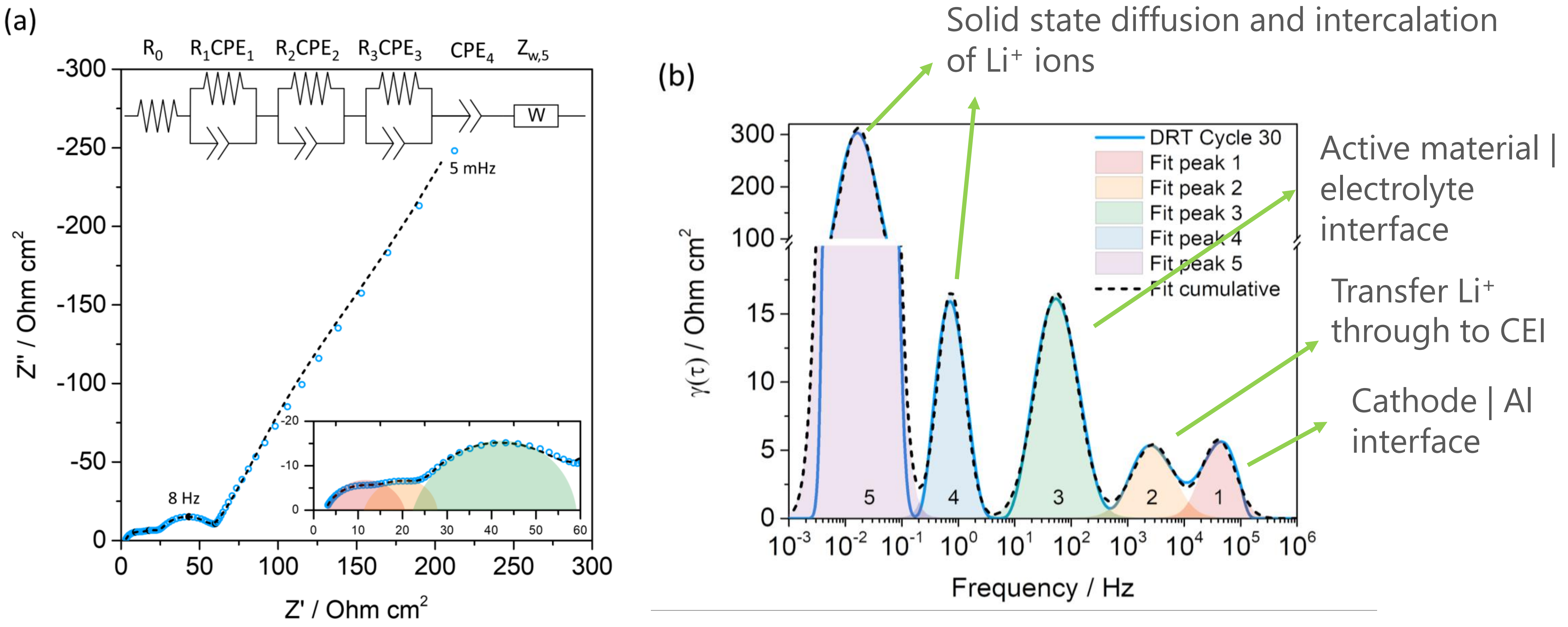

Figure 6. a) Nyquist plot of a typical impedance spectra for the system S:L-$Na_{0.1}$ | 1.0 mol dm^{-3} $LiPF_6$ EC:DMC 1:2 | Li metal recorded at 4.0 V E vs. Li|Li^+/V and after 30 cycles through a window potential of 4.8 – 2.0 V E vs. Li|Li^+/V, inset shows the equivalent electrical circuit fitted to the spectrum. b) Computed DRT spectra with time constants associated to the five observable processes and respective deconvoluted peaks.

Conclusions

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<u>Heterostructure</u>

Spinel -Layered

S:L-Li_1

S:L-$Na_{0.1}$

- For LIB cycling the stoichiometry S:L-L_1 and S:L-$Na_{0.1}$ showed at a constant current of 28.1 mA g^{-1} (1C-rate) a maximum specific capacity, ca 169 and 135 mA h g^{-1} respectively a mild decrease of the specific capacity during cycling was evident, it where maintains 80% of its charge capacity after 50 cycles compared with Li_1 undoped which maintains 57% of its charge capacity after 50 cycle.

- By possessing interesting properties electrochemical we believe that these materials could be a potential electrode for the development of high-power rechargeable Li-ion batteries.

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References

- Wang, Sihui et al, Journal of Power Sources, 245 (2014) 570-578.
- Ngoc Hung Vua (2017)
- Li, Y. Wu, M. Ouyang, C. (2015).
- Schmidt, et al. J. of Power Sources. 196 (2011) 5342.
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Thank,
for your attention

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