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# Multiscale characterization approach to correlation of synthesis of layered oxides to their structure and chemistry

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Li-rich layered oxides (LROs) are amongst the most promising high voltage cathode materials with regards to their practical density and cost, to increase the efficiency of Li-ion batteries (LIBs). LROs are reported to exhibit capacities reaching  $>250$  mAh/g. However, LROs suffer from low initial coulombic efficiencies, voltage decay and low-rate capabilities. The origin of these issues is difficult to interpret, and thereby tackle, due to the inherent complexity of the oxide. These oxides consist of two crystal structures, monoclinic and rhombohedral, the combination of which is still under scrutiny in the scientific community. In this work, LROs are synthesized through sol-gel synthesis; different parameters are varied and their effect on the structure of the material is studied through lab-scale to synchrotron techniques. The study indicates clear distinction in particle size and ordering of monoclinic and rhombohedral phases in local and bulk range. The results of this work illustrate the need for in-depth characterization of LROs to adequately understand and compare LROs synthesized by differing parameters, in order to establish a clear foundation for further work in this growing field.

**Primary author:** ABBASI, Rabail Badar (National Institute of Chemistry)

**Co-authors:** AQUILANTI, Giuliana (Elettra - Sincrotrone Trieste); Dr PLAISIER, Jasper Rikkert (Elettra - Sincrotrone Trieste); BELE, Marjan (National institute of chemistry); TCHERNYCHOVA, Elena (National Institute of Chemistry); Prof. DOMINKO, Robert (National institute of chemistry)

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