Limitations and capabilities of micro-Raman spectroscopy. Electrode materials for lithium battery

Alexander Ryabin, Alexei Nikiforov, Dmitry Pelegov*
Institute of Natural Sciences and Mathematics, Ural Federal University, Yekaterinburg, Russia
*E-mail: dmitry.pelegov@urfu.ru

Raman spectroscopy is an inexpensive and convenient tool for prompt structural characterization. Most research groups have access to confocal Raman microscopes with claimed submicron spatial and subsecond temporal resolutions. Raman spectroscopy is widely used in material science, solid-state chemistry, and electrochemistry. But this unique tool is often considered to be auxiliary to other methods and is commonly used as a "black box" without proper understanding of its limitations and capabilities.

Limitations often originate from the specifics of the objects under study. The first is that electrode materials for lithium batteries are granular objects with particle sizes of micron and submicron scale. Unlike single crystals and nanoparticles, microparticles are maybe the most complicated objects for an accurate physical description since their size is close to the probing wavelength and the Raman study can be considered neither local nor intergral.

Another limitation is that Raman spectroscopy can't be considered as a "non-destrative" tool of structural characterization. Most part of popular electrode materials alter under the action of the probing laser beam and we have shown a variety of degradation products and pathways.

The issues mentioned above limit the accurate interpretation of the obtained Raman spectra, but Raman spectroscopy is still a power tool for structural characterization and detection of imperfections. Its limitations can be overcome by using either the single-particles approach, increasing spatial resolution, or the statistical approach, enabling mesoscale characterization.

Acknowledgement

The research was funded by the Russian Science Foundation (project No 22-22-00350, https://rscf.ru/project/22-22-00350).