**Li-ION ANODE AND CATHODE CHARACTERISATION BY EX-SITU AND OPERANDO RAMAN SPECTROSCOPY**

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**Abstract**

Energy is one of the keystones of prosperity, and electrochemical energy storage plays a significant role in the ongoing transition towards a low-carbon economy. It enables the decarbonisation of both the transport and power sector and is already an essential technology for several strategic industries. The complexity of physicochemical processes inside these devices renders any development dependent on the proper description and monitoring of all materials' inherent evolution and interaction inside an electrochemical cell. Rarely has any progress in a technology depended so much on characterisation and understanding of all basic processes as for electrochemical energy storage devices. The current work focuses on characterising Li-ion-based electrodes, namely anodes and cathodes by Raman spectroscopy, either by ex-situ means, namely, post mortem analysis or in operando mode, where the lithiation and delithiation of the active material can be characterised during the discharging and charging mode respectively.

In the current study, the cathode consists of LiMn2O4  as the active material and carbon black as the conducting element. The Raman spectrum exhibits the main peak at 620 cm-1 related to the A1g mode related to Mn3+-O bonds vibration in MnO6 octahedra and the D (~1350 cm-1) and G (~1580 cm-1) characteristic bands for carbon black. The cathodes are cycled until 60% specific capacity, namely End of Life (EOL). The correlation of Raman spectra acquired for Fresh and EOL presents a shift of the peak at about 350 cm-1 to lower wavenumbers and a shift of the peak at about 620 cm-1 to higher wavenumbers. An exemplary deconvolution of the LiMn2O4 spectral area using a template with six Lorentzian–shaped bands, according to Slautin et al. [1], in order to correlate the variation of molecular bonds to material degradation by delithiation process.

**ΛΕΞΕΙΣ ΚΛΕΙΔΙΑ:** Li-ion batteries, Raman, LMO, cathode, operando

**REFERENCES**

 [1] Slautin, B., Alikin, D., Rosato, D., Pelegov, D., Shur, V., Kholkin, A. Local Study of Lithiation and Degradation Paths in LiMn2O4 Battery Cathodes: Confocal Raman Microscopy Approach. *Batteries* (2018), 4, 21.