In situ nuclear magnetic resonance microscopy of batteries and supercapacitors

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Lithium-ion batteries and supercapacitors are complex composite storage devices. Batteries store energy through redox reactions in the electrodes while supercapacitors function through the reorganization of the ionic charges in the electrolyte soaking nanoporous carbon electrodes. *In situ* measurements are essential to capture and understand their current limitations in terms of power and stored energy.

In some cases, the signals of the components of the battery/supercapacitor overlap in *in situ* measurements. The combination of spectroscopy and imaging can give access to localized chemical information on the components of interest, but their short dephasing times makes it challenging. Classical methods (such as standard chemical shift imaging) based on echoes do not detect those relevant components in the device.

We develop and apply approaches to circumvent those issues. We managed to record[1] *in situ* the ^{7}Li signal in the thick electrodes of a lithium-ion battery with a resolution of 100 µm. Limitations during fast charge were identified and characterized thanks to those localized measurements. For supercapacitors we also managed to obtain the 1D concentration profiles of the electrolytic ions in the porosity of the electrodes.[2] Those measurements bring insight into the parameters that influence the charge mechanism.

[1] M. Tang, V. Sarou-Kanian, P. Melin, J.-B. Leriche, M. Ménétrier, J.-M. Tarascon, M. Deschamps, E. Salager, *Nat. Commun.* **2016**, *7*, 13284.
[2] G. Oukali et al., *submitted* **2019**.