

***In situ* Magnetic Resonance Spectroscopy and Imaging of Li-plating onto and Diffusion within Anodes of Li-Ion Batteries**

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Li-ion batteries are considered nowadays as the main source of energy for an electric vehicle (EV) application. However, a significantly longer “refueling” time in comparison with the standard internal combustion engine vehicles is a substantial disadvantage from the end-user’s perspective. An increase of charging current by a factor of three should significantly reduce the gap and promote further penetration of EV on the mass market. Lithium plating on the negative electrode is a drawback of a fast charging. If the current exceeds the intercalation rate at which lithium diffuses into the negative electrode, then a film of metallic Li will deposit on the surface. The plated metal reacts with electrolyte leading to an increase of the cell internal resistance, its capacity fading, and potential short-circuiting in an extreme case.

Here we report an application of the parallel plate RF probe to monitor *in situ* deposition of Li metal on a graphite anode during charging of a single layer prismatic cell, assembled with electrodes extracted from a commercial battery. We have demonstrated that part of the plated lithium was able to intercalate into the graphite after the current was turned off. A signal of deposited Li consists of two resonances corresponding to a “Li film” on a surface of the electrode and to dendrites orthogonal to electrodes’ planes. Our data demonstrate that the Li reintercalation to the graphite is primarily happening from the former type of deposited metal, while the lithium stored in dendrites can partially dissolve into the electrolyte during the consecutive discharge of the cell. We were able to quantify amount of reversibly and irreversibly deposited lithium. Finally, a coexistence of three stages of intercalated into graphite Li (2L, 2 and 1) is demonstrated during fast charge, suggesting a non-uniform lithiation of the electrode in that case.

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