PhD 2018-2021 LRCS

Subject: Degradation mechanisms study at the positive electrode in Li/S system: influence of degradation product on the cycling performances.

Laboratory : Laboratoire de Réactivité et Chimie des Solides (LRCS, UMR CNRS 7314)

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Key words: lithium/sulfur battery, degradation mechanisms, electron microscopy (TEM, SEM, EDX, EELS), analytical electrochemistry.

Context:

Among the system in development for energy storage (Na-ion, all solid state …), lithium/sulfur batteries (Li/S) possess higher theoretical electrochemical characteristic than actual commercialized lithium-ion batteries. However, this system has some drawbacks inducing a capacity loss due to auto-discharge phenomenon (redox processes during the resting time of the battery), the soluble polysulfides diffusion and/or the formation of insoluble and insulating products (Li_2S_2/Li_2S) at the cathode at the end of the discharge. To overcome those issues, fundamental studies are necessary to understand and control the reactions taking place at the electrodes.

In this context, this PhD subject aim to understand the degradation mechanisms intrinsic to the positive electrode with abstraction of the ones taking place at the negative one. To perform those investigations, the soluble polysulfides (first discharge products) will be confined at the cathode by designing specific working cells. Then the impact of (i) the electrolyte family (carbonate, ether type solvent …) and (ii) the characteristics of the C/S composite electrode (porosity, specific surface …) on the discharge and degradation products formation (Li_2S, solid electrolyte interphase …) will be studied. The long-term battery performance will be followed in relation with the discharge products characteristics.

The PhD candidate will have to develop specific working cells to answer the cited problematic. The morphological, structural and chemical characterization will be performed by using electron microscopy (SEM, TEM) and associated techniques (EDX, EELS). The use of specific electrochemical techniques such as electrochemical impedance spectroscopy (EIS) and spectroscopic techniques (IR, Raman …) will allow fine characterizations of the electrode/electrolyte interfaces by obtaining information on the conductivity evolution at the interface and the chemical bonding nature of the deposited compounds at the positive electrode surface.

Candidate:

The candidate must be in possession or in acquisition of a Master 2 degree or equivalent in chemistry, electrochemistry or materials science. Knowledge in the battery domain and/or in characterization techniques (electron microscopy, electrochemistry …) will be appreciated.

Bibliography

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