

## Abstract

Lithium sulphur batteries are one of the most promising candidates to take primacy of the lithium-ion batteries in the field of energy storage due to their desirable features, such as competitive cost of production and low environmental impact. In addition, their exceptional theoretical energy density is much higher than commercial Li-ion batteries based on intercalation materials. Despite of these advantages, the mass commercialization of Li-S batteries is still hampered by the many challenges associated with rapid loss of capacity, mainly due to the loss of active material and the electrochemically unstable passive layer between lithium metal and various types of electrolytes. Cellulose is the most abundant polymer material on the Earth and, due to its good mechanical properties, easy modification and biodegradability, is a suitable candidate for addressing Li-S battery problems and it can be used as separation layer between sulphur cathode and lithium metal anode. The primary role of the separator in the battery cell is to prevent contact between the anode and the cathode, with appropriate modification and fabrication; it can also affect the processes in the battery cell. Appropriate cellulose properties and the ability to influence processes through separator has been the main focus of this doctoral dissertation.

In presented work, we first constructed self-standing separator membranes from nano-fibrillated cellulose (NFC) and proved that they improve the performance of Li-S batteries compared to commercial separator membranes. Using XPS spectroscopy and FIB-SEM microscopy, we showed that the separator membranes from NFC has, in particular, good effect on the lithium metal electrode.

To address the problem associated to the diffusion and migration of soluble polysulphides species from the sulphur cathode, two different NFC materials were synthesized: fluoro NFC and polyaniline coated NFC, and implemented in a Li-S battery. Both materials had a positive effect on the migration of soluble polysulphides species across the Li-S battery cell, but did not completely solved the problem of rapid capacity loss of Li-S batteries.

Positive effect of NFC materials on the metal lithium electrode was verified with implementation of protective layers based on cellulose directly on the lithium metal surface using trimethylsilyl cellulose. The results of the analyses showed that a thin NFC based protective layer successfully inhibits dendritic growth of lithium, preventing corrosive reaction between the lithium metal and the electrolyte, thus stabilizing the lithium metal electrode.

**Keywords:** Li-sulphur battery, cellulose separator, nanofibrillated cellulose modification, lithium dendrites, cellulose protective layer, optimization, FIB-SEM.