Towards more sustainable Li-O_2 batteries using bio-renewable organogels

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The growing need for clean energy production, due to global warming, has addressed the research towards the study of cleaner and more performing energy storage solutions and electric vehicles technologies. One of the most promising technologies currently being studied is the lithium - air battery, thanks to its high theoretical energy density of the order of 11000 Wh kg^{-1}. This extraordinary value is explained by the use of a metallic lithium anode but, above all, by the use of porous carbon cathodes (GDL) where the active material, oxygen, flows from the outside. The use of metallic lithium anodes, however, results in many drawbacks that limit the stability and cycling of these batteries. For this reason, in this work, two biorenewable organogel membranes have been studied for lithium protection.

The first membrane studied is based on gelatine from cold water fish skin. After a single step methacrylation in water, methacrylated gelatine is directly cross-linked in presence of liquid electrolyte through UV- initiated radical polymerization. The obtained gel polymer electrolytes present good thermal and mechanical properties, good electrochemical stability against Li metal and ionic conductivities as high as 2.51 mS cm^{-1} at room temperature. the Li-O_2 cells assembled with this bio-renewable gel polymer electrolytes were able to perform more than 100 cycles at 0.1 mA cm^{-2}, under constant O_2 flow, at room temperature and at a fixed capacity of 0.2 mAh cm^{-2}. Cathodes post- mortem analysis confirmed that the cross-linked gelatin matrix was able to slow down solvent degradation and therefore enhance the cell reversibility [1].

The second membrane studied is based on chitosan, a polysaccharide obtained from the deacetylation reaction of chitin. Once again, the methacrylation was performed through a simple, one-step reaction, in water, and the methacrylated chitosan was then cross-linked by UV induced radical polymerization. The obtained membranes were successively activated in liquid electrolyte (LiTFSI 0.5 M in DMSO) and used as lithium protection layer. The cells prepared with protected lithium were able to perform more than 40 cycles at 0.1 mA cm^{-2}, at a fixed capacity of 0.5 mAh cm^{-2}, under a constant O_2 flow of 4 ml min^{-1}, at room temperature, conserving 100 % coulombic efficiency. This is actually more than twice the lifespan of a similar cell containing bare metallic lithium, which failed in the same testing conditions, after 19 cycles [2].

References

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