Materials Today Energy 6 (2017) 264–270

Contents lists available at ScienceDirect

Materials Today Energy

journal homepage: www.journals.elsevier.com/materials-today-energy/

Polyimide-polyether binders—diminishing the carbon content in lithium–sulfur batteries

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ARTICLE INFO

Article history:
Received 4 September 2017
Received in revised form
16 October 2017
Accepted 2 November 2017

Keywords:
Lithium-sulfur batteries
Polyimides
Redox mediators
Redox-active binders
Diminishing carbon

ABSTRACT

Lithium-sulfur batteries are on the run to become the next generation energy storage technology. First of all due to its high theoretical energy density but also for its sustainability and low cost. However, there are still several challenges to take into account such as reducing the shuttle effect, decreasing the amount of conductive carbon to increase the energy density or enhancing the sulfur utilization. Herein, redox-active binders based on polyimide-polyether copolymers have been proposed as a solution to those drawbacks. These multiblock copolymers combine the ability of poly (ethylene oxide) to act as poly-sulfide trap and the properties of the imide groups to redox mediate the charge-discharge of sulfur. Thus, poly (ethylene oxide) block helps with the shuttle effect and mass transport in the electrode whereas the polyimide part enhances the charge transfer promoting the sulfur utilization. Sulfur cathodes containing pyromellitic, naphthalene or perylene polyimide-polyether binders featured improved cell performance in comparison with pure PEO binder. Among them, the electrode with naphthalene polyimide-PEO binder showed the best results with an initial capacity of 1300 mA h g^{-1} at C/5, low polarization and 70% capacity retention after 30 cycles. Reducing the amount of carbon black in the cathode to 5 wt%, the cell with the redox-active binder was able to deliver 500 mA h g^{-1} at C/5 with 78% capacity retention after 20 cycles. Our results demonstrate the possibility to reduce the amount of carbon by introducing polyimide-polyether copolymers as redox-active binders, increasing the sulfur utilization, redox kinetics and stability of the cell.

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https://doi.org/10.1016/j.mtener.2017.11.001
2468-6069/

Acknowledgements

Authors thank Dr. G. Patricia Leal and Dr. Maitane Salsamendi for their contribution with the SEM characterization. This work was financially supported by the Starting Grant Innovative Polymers for Energy Storage (iPes) 306250 from the European Research Council (ERC). Guiomar Hernández thanks Spanish Ministry of Education, Culture and Sport for the predoctoral FPU fellowship.