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Contribution of organometallic/polymer chemistry to post lithium ion battery research

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Without a doubt the"holy grail" of battery research is the development of a post lithium ion technology. This may require a shift towards batteries containing a pure metal anode. Li metal is an attractive metal anode in part due to its high volumetric capacity (2062 mAh cm^{-3}), a high reductive potential of -3.0 V vs. NHE and the wide availability of lithium electrolytes. However, its deposition occurs unevenly with formation of dendrites, which leads to safety concerns during cycling. In contrast to lithium metal, magnesium metal deposition is not plagued by dendritic formation. However, magnesium has a reductive potential of -2.36 V vs. NHE and has a unique electrochemistry which prohibites the use of magnesium analogues of lithium electrolytes. Since the oxidative stability of electrolytes governs the choice of cathodes it is of paramount importance to develop a non-corrosive magnesium electrolyte with wide electrochemical windows which will permit discovery of high voltage cathodes. Here I will present the latest developments and future challenges which must be overcome to achieve the goal. Elemental sulfur is a very attractive cathode for the post Li ion battery since the sulfur has high theoretical capacity of 1672 mAh/g. Despite these attractive properties, practical application of Li-S battery is still unrealized due to some big challenges for the sulfur cathode such as high resistance, low loading of active material and dissolution of the intermediate polysulfide into the electrolyte during charge and discharge. These issues cause low columbic efficiency, fast capacity fade and self-discharge of the Li-S battery. In order to suppress the dissolution of the intermediate polysulfides and minimize the addition of conductive carbon, our group has created a controlled nano-architecture template in which sulfur nanoparticles encapsulated with the conductive polyelectrolyte nano-membranes coated with nano-carbon (Figure 1). The findings of this work will be discussed.

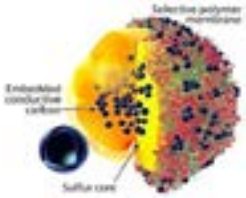

Fig.1 A three-dimensional view of our concept depicting the carbon infused sulfur core, the hollow carbon nanoparticles and multilayer selective polymer membrane decorated with functionalized carbon

Recent publications

1. Muldoon, J., Bucur, C.B., Oliver, A.G., Sugimoto, T., Matsui, M., Kim, H.S., Allred, G.D., Zajicek, J. and Kotani, Y., Energy Environ. Sci., 2012, 5, 5941-5950.
2. Muldoon, J., Bucur, C.B. and Gregory. T. Chem. Rev., 2014, 114, 11683-11720
3. J. Muldoon, C. B. Bucur and T. Gregory, Angew. Chem. Int. Ed., 2017, DOI: 10.1002/anie.201700673
4. C. B. Bucur, T. Gregory, A. G. Oliver and J. Muldoon, J. Phys. Chem. Lett., 2015, 6, 3578–3591.
5. Osada, N., Bucur, C. B, Aso, H. and Muldoon, J. Energy and Environ. Sci., 9,1668-1673 (2016).
6. Bucur, C. B, Lita, A. and Muldoon, J. Energy and Environ. Sci., 9, 992-998 (2016).

Biography

John Muldoon received his BSc (Hons) degree in Chemistry from Queens University of Belfast. He completed his PhD degree at the University of Notre Dame under the direction of Professor Brown, studying air oxidation of organics using terminal oxo complexes of late transition metals. He worked as a Research Associate at the Scripps Research Institute under Professor Sharpless (Nobel Laureate in Chemistry 2001) and Professor Fokin, developing applications of click chemistry including *in-situ* click chemistry to discover HIV protease inhibitors and acceleration for chemical reactions on water. He is currently a Principal Scientist at Toyota Research Institute of North America. His research interests include future energy solutions such as multivalent batteries, lithium/sulfur batteries, Li-ion batteries, all-solid batteries and fuel cells. He has numerous patents in the area of new battery chemistry and fuel cell.

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