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Moving beyond lithium-ion batteries

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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. normal hydrogen electrode (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 prohibited 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 non-corrosive magnesium electrolyte with wide electrochemical windows which will permit discovery of high voltage cathodes. I will present the latest developments and future challenges which must be overcome. 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 nanomembranes coated with nanocarbon. The findings of this work will be discussed.

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