Advanced Lithium Ion and Beyond "Lithium Selenium Sulfur & Lithium Superoxide Close System"

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In other to enable 40 miles PHEVs and long electric drive range EVs, there is a need of developing advanced battery systems that offer at least 250 to 300 wh/kg energy density at the cell level. The most significant technical barrier to developing commercially viable Plug-in Hybrid Electric Vehicles (PHEV) is the energy storage system. The challenge is to develop batteries that are able to perform the requirements imposed by a PHEV system and yet meet market expectations in terms of cost and life. In this case, the PHEV battery will experience both deep discharge, like an electric vehicle, and shallow cycling necessary to maintain the battery for power assist in charge sustaining HEV mode. Conventional lithium-ion batteries based on metal oxides and graphite have made significant progress in recent years for HEV applications, however, durability with the PHEV duty cycle and the ultimate cost and safety of the technology remain key challenges. To achieve a very high all electric drive range, a new battery system with advanced high capacity cathode materials and stabilized high capacity anode is needed. In this talk, we will disclose several strategies to increase significantly the energy density of lithium battery trough the development of high energy and continuous gradient cathode material coupled with nonflammable high voltage electrolyte. We also describe some new approach of improving the cycle life of Si/carbon composite anode by impregnating nano-silicon particles within graphene sheets and addressing the poor initial efficiency of this system by developing a novel pre-lithiation concept using Li2O as source of lithium. In this case a small amount of Li2O is mixed with the cathode and is activated during the formation process to release Li to the anode. We will then finish by describing a novel lithium superoxide based close battery system that offer 500wh/kg energy battery and a sulfur doped selenium system coupled with novel electrolyte that suppress the dissolution of polysulfide species and improve significantly the electronic conductivity because of the Se doping.