NEW DIRECTIONS FOR ENHANCING THE ELECTROCHEMICAL PROPERTIES OF CLOSO(CAR)-BORATE ELECTROLYTE SYSTEMS

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Since the discovery of ionic conductivity in $LiBH_4$,[1] there has been a significant interest in this phenomenon in metal hydrides. Recent developments have focused on understanding ion transport phenomenon in boron-rich hydrides such as the metal closo(car)-borates for solid-state electrolytes in metal batteries.[2,3] While significant advancements have been made to understand the structure-dynamics and function relationships of closo(car)-borate electrolytes in the solid-state,[4] little is known about their behaviour or electrochemical properties in solution or a semi-solid (gel) matrix. By looking beyond a pure solid-state electrolyte, it may be possible to overcome two of the research needs for the realization of closo(car)-borate electrolytes in practical battery systems: 1.) reduce the thickness of the electrolyte layer, 2.) operation at sub-ambient temperatures. Recent work from our group has evaluated the electrochemical properties of a lithium closo-borate salt in liquid electrolytes and in a gel polymer electrolyte (GPE).[5,6] The lithium closo-borate infused GPE showed excellent ionic conductivity below and above ambient temperature and allowed for operation at -35 °C in a coin cell format. Additionally, it was demonstrated that the GPE can also be used to fabricate a thin/flexible pouch cell battery ($Li/GPE/LiFePO_4$) that can be cut and still power LEDs (Figure 1). The aforementioned approaches, along with other new approaches to address additional research needs for closo(car)-borate electrolytes, will be discussed.

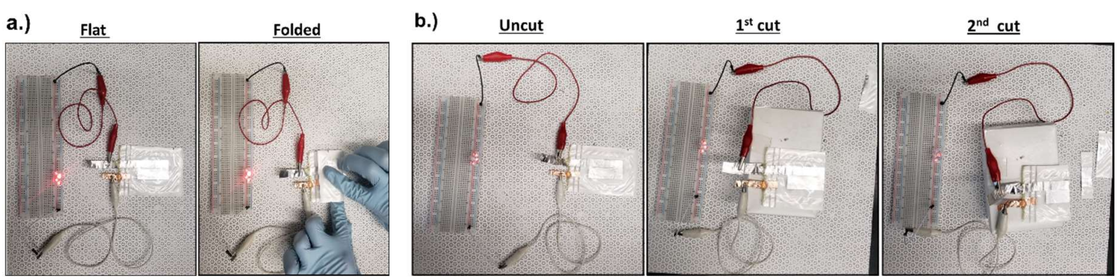

Figure 1. a.) Flexible pouch cell using GPE, b.) Pouch cell powering LEDs after being cut twice.

References: 1.) ***Appl. Phys. Lett.*** 2007, *91*, 224103, 2.) ***Cell Rep Phys Sci.*** 2020, *1*,100217, 3.) ***Nat Rev. Mater.*** 2017, *2*, 16091, 4.) ***Molecules***, 2021, *26*, 3239, 5.) ***Appl. Sci.***, 2022, *12*, 2273; 6.) ***Adv. Sci.***, 2022 (Just Accepted)

Joseph received his Ph.D in Chemistry from Lehigh University in 2008. He worked at Savannah River National Laboratory as a post-doctoral research scientist from 2009-2011 and was a staff scientist from 2011-2017. Since 2017 he is a professor at California State University Northridge. He has a diverse series of publications and patents regarding the use of metal hydrides in a variety of energy storage and conversion applications. This research includes the electrochemical synthesis of alane (AlH_3) for portable power systems, boron based hydrides as ion conductors, alantes as high capacity anodes, metal intercalated carbon nanostructures for hydrogen storage, and metal hydrides for thermal energy storage.