Guangyue Liao et al., J Fundam Renewable Energy Appl 2018, Volume 8
DOI: 10.4172/2090-4541-C5-063

Integration of all-solid-state electrolytes into carbon fibres for development of multifunctional structural batteries

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Multifunctional structure integrated batteries are capable of storing energy whilst they are also able to bear mechanical load. Thus, this type of structure integrated battery can be used as engineering material for different energy storing components like wings for planes or frames for electric bikes. Such devices, act as power supplier, are usually desired for their potential to both reduce weight and increase safety of future electrical applications. It is essential because light weight and high safety are two vital characters for new generation mobiles, especially for satellites and unmanned air vehicles. One of the approaches to realize the multifunctional structural battery is to combine carbon fibres with battery materials. This hybrid material can then act as electrode and reinforcing element simultaneously. Meanwhile the solid polymer electrolyte works as matrix for Li-ion transport and is also responsible for the mechanical load transfer in the same time. To manufacture this hybrid material, an infusion process was utilized to combine the adjusted battery matrix with carbon fibre laminas which is presented in this work. Here, poly (ethylene oxide) (PEO) modified by lithium bis (trifluoromethanesulfonyl) imide (LiTFSI), a commonly used solid electrolyte, is thoroughly investigated as the matrix material. For the infiltration process the PEO/LiTFSI powders have to be solved in a solvent and were then characterized in terms of rheological properties. This measurement helps to select solutions with suitable viscosities for the infusion process. The ionic conductivity as well as the mechanical performance of dried PEO/LiTFSI films is demonstrated by electrochemical impedance spectroscopy and tensile strength tests. The results show that PEO based solid electrolytes combine high ionic conductivities and good mechanical properties and are promising to be utilized for the structural lithium ion batteries in the future.

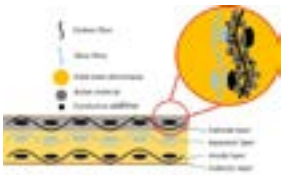

Figure 1: Materials and configurations of the all-solid-state electrolyte based multifunctional structural battery.

Recent Publications:

1. Yu Y, Zhang B, Feng M, Qi G, Tian F, Feng Q, Yang J and Wang S (2017) Multifunctional structural lithium ion batteries based on carbon fiber reinforced plastic composites. Composites Science and Technology 147:62-70.
2. Singh A K, Cao L, Ma J, Seo J, Bakis C, Zhang Y, Hickner M and Rahn C (2015) Design, manufacture and test of a novel structural battery based on sandwich construction. Journal of Sandwich Structures and Materials 17:666-690.
3. Asp L E and Greehalgh E S (2014) Structural power composites. Composites Science and Technology 101:41-61
4. Javaid A, Ho K K C, Bismark A, Steinke J H G, Shaffer M S P, Greenhalgh E S (2015) Carbon fibre-reinforced poly(ethylene glycol) diglycidylether based multifunctional structural supercapacitor composites for electrical energy storage applications. Journal of Composite Materials 50:2155-2163.

Biography

Guangyue Liao, is a M. Sc, Research associate at the Institute for Particle Technology (iPAT) in the research group Battery Process Engineering since 2017. She completed her PhD student at German Aerospace Center (DLR e.V) Institute of Composite Structures and Adaptive Systems from 2013-2017. Her field of research in All-Solid-State Batteries.

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