Solid polymer electrolytes for future energy storage devices

Bilge Saruhan[1*] and Apurba Ray

[1] Institute of Materials Research, German Aerospace Center (DLR), 51147 Cologne, Germany

Contact E-Mail: bilge.saruhan@dlr.de

With the global trend of decarbonized energy concerns and decreasing dependence on non-renewable energy sources, next generation energy systems have shifted towards renewable energy sources [1]. In recent years, the global electric power technologies such as electric vehicles (EVs), wearable and portable electronics, smart e-textiles, internet-of-things (IoT) devices, aircraft and aerospace energy are looking for significant developments of current energy storage devices [2]. Current electrochemical energy storage devices such as market leading lithium-ion batteries (LIBs), supercapacitors (SCs) etc. are struggling with serious challenges such as Li-dendrite penetration, safety issues due to internal short circuiting, lower voltage windows, lower energy density and higher self-discharge rate etc. In this context, solid polymer electrolytes, as a one of the significant components for energy storage devices, have been received a huge amount of modern research interest due to their exceptional physical and chemical properties, such as wide electrochemical stability window, leakage free, good flexibility, low flammability, excellent processability, high safety and higher thermal stability [3,4]. Therefore, the design and development of new solid polymer electrolytes can be one of the promising solutions to solve above mentioned issues. The way to design and prepare electrode and electrolyte materials and fabrication of devices are always the vital points to improve the overall performance of future supercapacitors and batteries. Being for the aerospace applications, lightweight power storage supercapacitors are also suitable for powering satellites through decentralized power supplies when they are on the dark side of the raceway and for use on board of e-aircrafts and can be integrated into systems and structures. On these lines, we concentrated our recent studies on the development of lightweight, flat-structured cells with stable solid and/or semi-solid polymer electrolytes incorporating highly conductive and non-flammable electrolytes such as ionic liquids leading to high voltages and longer cycle numbers. In this context, a general overview on the importance of solid polymer electrolytes in terms of energy storage, their working processes, will be demonstrated with examples from our ongoing research and worldwide work. Overall, it is observed that sustainable new solid polymer electrolytes can be an essential component for future energy storage devices while focusing on performance, sustainability, and economy considerations. Accordingly, current challenges and future perspectives for the development of high-performance solid polymer electrolyte will be highlighted.

References

[1] João C. Barbosa et al. *ACS Omega* ***2022*** *7 (17), 14457-14464*
[2] Rui-Yang Wang et al. *Adv. Mater.* ***2023****, 35, 2203413*
[3] Junyan Zou et al. *Polymers* ***2022****, 14, 4804*
[3] Juan C. Verduzco et al. *ACS Omega* ***2021****, 6, 15551−15558*

Dr.-Ing. habil Bilge Saruhan-Brings is a material scientist with PhD-degree on high-performance functional ceramic and the lecturing qualification (habilitation) on nanomaterials and nano-/micro-technologies. She is leading the Research Activities of the Functional Coatings Group at the Institute of Materials Research of DLR. Her research fields cover energy storage systems, development of catalysts and functional nano-structured coatings for energy applications and thin film gas sensor devices.

Presentating author: Bilge Saruhan, e-mail: Bilge.Saruhan@dlr.de