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Towards smart flexible batteries

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Abstract:

The focus on shifting towards miniaturized products, coupled with the booming demand for consumer electronics, are some of the key driving factors behind the flexible-battery market. In the development of innovative power sources, freedom from design limitations, along with the synthesis of reliable electrochemical materials with well-tuned features, is considered to be the most important technical prerequisite.

Two approaches for the fabrication of flexible free form-factor batteries, developed in our group, will be presented. The first one is a unique, single-step method for the preparation of a membrane-electrode assembly [1]. Concurrent electrophoretic deposition (EPD) of positive and negative battery electrodes (LFP and LTO) on opposite sides of a commercial nanoporous membrane (Celgard 2325) results in the formation of a three-layer-battery structure. The cell comprising this electrophoretically deposited structure ran for more than 150 cycles with 125-140mAh/g capacity, which approaches the theoretical value of lithium iron phosphate. The electrodes can be deposited either cathodically or anodically by replacing the interchangeable charging agents, such as polyethyleneimine and polyacrylic acid. These polyelectrolytes, when adsorbed on the particles of the active material, also serve as the binders. The simultaneous EPD, which we developed, can be used for the simple and low-cost manufacturing of a variety of cathode and anode materials on nanoporous polymer- and ceramic ion-conducting membranes for energy storage devices.

The second approach utilizes printing techniques. These technologies are still at an early stage, and most currently printed batteries exploit printed electrodes sandwiching self-standing commercial polymer membranes, produced by conventional extrusion or papermaking techniques, followed by soaking in non-aqueous liquid electrolytes. We suggest a novel flexible-battery design and report the initial results of the development and characterization of novel 3D printed all-solid-state electrolytes prepared by fused-filament fabrication (FFF) [2, 3]. The electrolytes are composed of LiTFSI, polyethylene oxide (PEO), which is a known lithium-ion conductor, and polylactic acid (PLA) for enhanced mechanical properties and high-temperature durability. The flexible all-solid LiTFSI-based electrolyte exhibited bulk ionic conductivity of 3×10^{-5} S/cm at 90°C and 156 ohm/cm^2 resistance of the solid electrolyte interphase (SEI). These results pave the way for a fully printed solid battery, which enables free-form-factor flexible geometries.

Date & Location:

Monday, June 15, 2021, 11:00

References:

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2. Heftsi Ragones, Svetlana Menkin, Yosi Kamir, Alex Gladkikh, Tzach Mukra, Gabor Kosa and Diana Golodnitsky Towards Smart Free Form-Factor 3D Printable Battery, *Sustainable Energy & Fuels*, 2018, 2, 1542

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