Electropolymerized Solid Polymer Electrolytes for Three-dimensional Microbatteries

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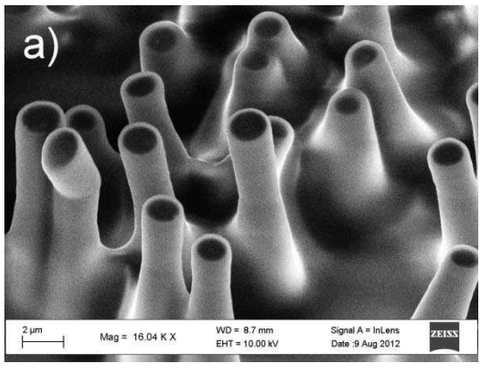
Solid polymer electrolytes (SPEs) have been considered to be a cost-effective and safe alternative as a replacement for conventional liquid/gel electrolytes in Li-ion batteries. Although the low room temperature conductivity of most SPEs pose limitations, it has been demonstrated that the poor ionic conduction in SPE can be compensated by minimizing the electrolyte thickness in three-dimensional microbattery (3DMB) applications, thus reducing the Li^+ diffusion path length [1]. Both high energy and power densities could be realized in the 3DMB by proper utilization of the electrode surfaces in all three dimensions. To achieve this goal, a conformal and pinhole-free solid electrolyte with a thickness on the micro- and nano-scale would be required during the assembly of whole-cell 3D batteries.

This work presents results of our studies on the integration of electrodeposited SPEs onto different 3D electrode architectures and materials (e.g., 3D Cu-nanopillars and polyaniline-coated porous RVC foam). Through cathodic electroninitiated polymerization of vinyl monomers – such as poly(propylene glycol) diacrylate and a novel bifunctional poly(oxypropylene) triamine-based monomer [2] – conformal and thin SPE layers consisting of cross-linked polypropylene glycol diacrylate doped with LiTFSI were deposited on these 3D surfaces.

Both SEM (Fig. 1) and XPS characterization results confirmed the presence of a conformal polymer electrolyte after self-limiting electropolymerization. Electrochemical impedance results also indicated that the thin polymer electrolytes obtained may have useful ionic conductivities, e.g. 10^{-5}-10^{-6} S cm^{-1}, at room temperature.



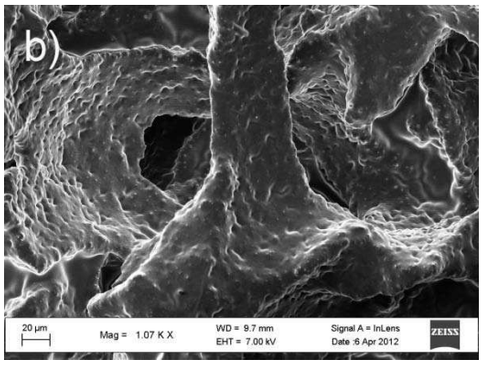


Figure 1. SEM micrographs of electrodeposited SPE on 3D Cu-pillar (a) and polyaniline-coated RVC foam (b), respectively.

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References

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[2] B. Sun, I-Ying Liao, S. Tan, T. Bowden, D. Brandell, *J. Power Sources*, **238**, 435(2013).