Advanced 3D printed electrode based on Si and wet-jet milled few layers graphene for Li-ion batteries

Hossein Beydaghi
Sara Abouali, Sanjay B. Thorat, Antonio Esau Del Rio Castillo, Sebastiano Bellani, Vittorio Pellegrini, and Francesco Bonaccorso
BeDimensional S.p.A, Lungotorrente Secca, 30R 16163 Genoa, Italy
h.beydaghi@bedimensional.it

Development of Li-ion batteries with specific geometries and form factors meeting the requirements of the newly emerged technologies is gaining increasing attention [1]. Three-dimensional (3D) printing is an attractive technology for the manufacturing of advanced electrodes for portable electronics and energy storage devices [2]. Herein, we report for the first time,[3] the fabrication of a 3D printed Si-based anode using a simple and cost-effective fused deposition modelling (FDM) for Li-ion batteries. The anode is composed by polylactic acid (PLA) as host polymeric matrix, Si nanoparticles as active material, and wet-jet milled few layers graphene (WJM-FLG)[4] mixed with carbon black doped-polypyrrole (PPy) as conductive additives. This composition has been optimized to produce 3D filament fulfilling the printability and providing a good electrochemical behaviour. The doped-PPy and WJM-FLG nanoflakes uniformly coat the exterior surface of Si nanoparticles, creating a conductive network through the PLA-based filament as well as mitigating the large volume changes during charge-discharge cycling, thus improving the electrochemical performance of the Si-based 3D printed anode [5,6]. The flexible 3D printed anode shows a stable rate capability up to a current density of 50 mA g^{-1}, high coulombic efficiency (97%), a specific capacity of ~ 345 mAh g^{-1} at the current density of 20 mA g^{-1} with the capacity fade rate of only 0.01% after 350 cycles (Figure 1). This work offers a promising strategy for the fabrication of polymeric-based and flexible 3D electrodes with programmable architectures toward next-generation electronic applications.

References

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Figures

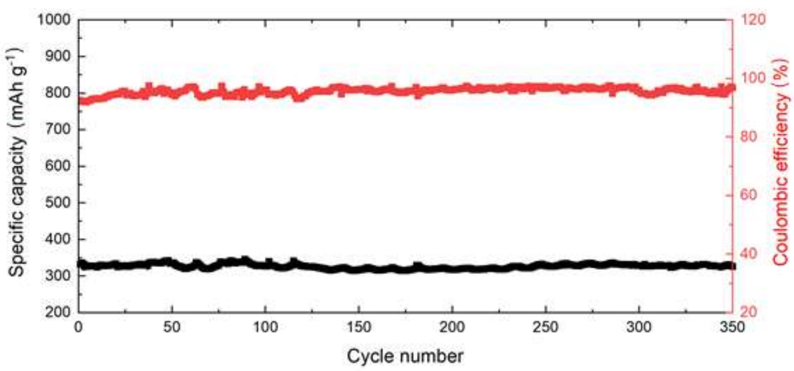

Figure 1: Long-term cyclic performance and coulombic efficiency of the half-cell assembled with the 3D printed optimized electrode at the current rate of 20 mA g^{-1}.

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