02300
Novel 3D Structured Electrode Fabrication as Free-Standing Carbon Lattice for Al –Air Batteries

A. Solid state ionics: bulk, interfaces and integration in devices

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Abstract

Rechargeable batteries are gaining attention as an environmentally friendly and sustainable alternative for fossil fuel. Aluminium-air batteries are superior to batteries based on other active material such as magnesium (2.20 A h g^{-1}) and zinc (0.82 A h g^{-1}) in terms of theoretical electrochemical equivalent value (2.98 A h g^{-1}) [1]. The electrode fabrication process can determine the morphology and the interface properties of the batteries and thereby affect the overall performance. Additive manufacturing accompanied with simple post-processing treatments can produce free-standing three-dimensional (3D) carbon electrodes with different complex geometries. Carbon lattice-based electrodes with excellent functionalities for batteries have been fabricated through 3D printing followed by pyrolysis [2]. This enables the effective fabrication of active material by markedly eliminating the passive components along with reducing the cost. Herein we propose a novel structure for support-free carbon lattice electrode for batteries. Furthermore, the surface morphology and texture of the material have been optimized by testing with varying pyrolysis conditions. The surface morphology of the pyrolyzed electrode has been analysed using scanning electron microscopy and resulted that the optimized and pyrolyzed electrode showing the better morphology. We have successfully created preliminary 3D carbon electrodes based on a diamond-crystal-like geometry with unit-cell sizes of ~700 µm and feature sizes of ~120 µm, by shrinking 3D polymer templates fabricated via stereolithography by a factor of ~3 (from an initial unit-cell size of 2 mm) after pyrolysis. The electron dispersive spectroscopy analysis revealed the major carbon composition with traces of silicon dioxide impurities. The initial results are very promising and additional electrochemical measurements will

be performed to investigate whether the material can exhibit practical level energy density and cyclic stability.

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