Ultralow Interfacial Resistance in Current Collector Engineered by Hierarchical Graphene Interlayer

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Abstract

The hierarchical graphene functional layer on Al foil (hG-Al foil) was synthesized by low temperature plasma enhanced chemical vapor deposition.[1] The hierarchical structure consists of conformal planar basal layer and vertical divergent branches, which provides both highly conductive tight contact with foil base and high effective contact area with coated materials. This unique rational designed graphene interlayer leads to both lower ohmic polarization and lower electrochemical polarization than bare Al foil, which shows ultralow interfacial resistance.[2,3] Further, we assembled the high load (>10mg/cm2) $LiFePO_4$ coin cells. Both the half cells and full cells evidenced the great improvement of the energy density at high current density, and even higher than using commercial high rate current collector (special optimized carbon-coated Al foil). We believed that the CVD-grown hierarchical graphene made the commercial application of high rate batteries possible in a universal way of ultralow interfacial resistance current collector.

References

[1] Wang, M. Z. et al., Advanced Materials, 29(2017) 201703882.
[2] Arai Y. et al., ECS Transactions, 50(2013) 153-160.
[3] Zhu, C. B. et al., Science, 358(2017) eaao2808.

Figures

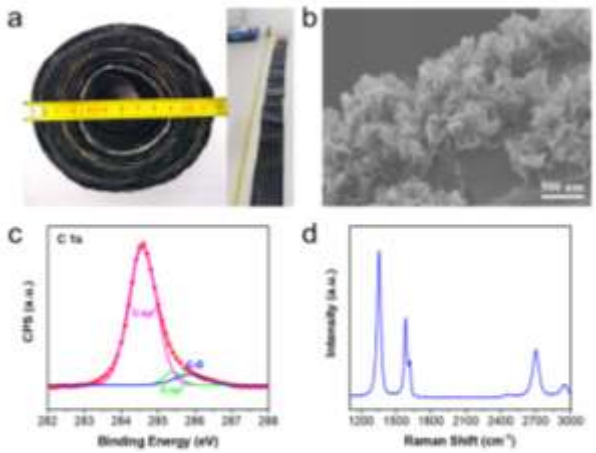

Figure 1: (a) Optical photos of hierarchical graphene functionalized Al foil (hG-Al foil) by CVD batch preparation; (b) SEM image of hierarchical graphene structure; (c) XPS C-1s spectrum of hG-Al foil; (d) Typical Raman spectrum of hG-Al foil.

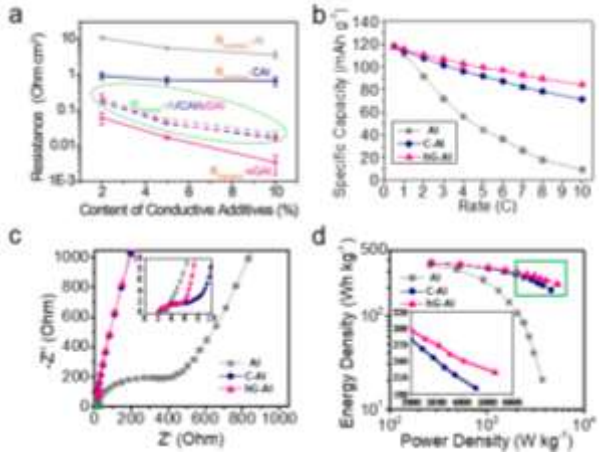

Figure 2: (a) The material/interface resistance of $LiFePO_4$ electrodes on bare Al, carbon-coated Al and hG-Al foil; (b) Rate performance of using different current collectors; (c) Electrochemical impedance spectroscopy of using different current collectors; (d) The Ragone plot of using different current collectors.