SILICON NANO-SCOOP ANODES FOR HIGH-POWER LITHIUM-ION BATTERIES

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Keywords: lithium-ion batteries, high power/rate capability, C-Al-Si nanoscoops, functionally strain-graded materials

Lithium-ion batteries show poor performance for high-power applications involving ultrafast charging/discharging rates. Here we report a functionally strain-graded carbon-aluminum-silicon (C-Al-Si) anode architecture that overcomes this drawback. It consists of an array of nanostructures each comprising an amorphous carbon nanorod with an intermediate layer of Al that is finally capped by a Si nano-scoop on the very top. The gradation in strain arises from graded levels of volumetric expansion in these three materials on alloying with lithium. The introduction of Al as an intermediate layer enables the gradual transition of strain from C to Si, thereby minimizing the mismatch at interfaces between differentially strained materials and enabling stable operation of the electrode under high-rate charge/discharge conditions. At an accelerated current density of ~51.2 A/g (i.e., charge/discharge rate of ~40 C), the strain-graded C-Al-Si nano-scoop anode provides average capacities of ~412 mAh/g with a power output of ~100 $kW/kg_{electrode}$ continuously over 100 charge/discharge cycles. A paper related to this work was recently published in *Nano Letters* (R. Krishnan, T.-M. Lu, and N. Koratkar, "Functionally strain graded nanoscoops for high power Li-ion battery anodes," *Nano Letters*, 2011, dx.doi.org/10.1021/nl102981d).