Rapid Synthesis of Thin-Flesh-Thick-Seed-Cucumber-Like Bismuth Nanoparticles@Carbon Composite via Supercritical Acetone for Superior Li-Ion Batteries

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The extensive outlooks for high-energy-density anode materials in LiBs foresees Bi as an attractive candidate, favoring its ultrahigh volumetric capacity (3430 mAh cm^{-3}) and large interlayer spacing (3.95 Å). However, Bi is vulnerable to severe volume variation impeding the stability and long lifespan. Herein, as an approach, we introduce a fine flesh-like carbon embedding densely packed seed-like Bi nanoparticles via a facile one-pot supercritical route. Acetone utilized as the carbon source decomposes under supercritical conditions and in the presence of HNO_3 (surface modifier), the carbon and Bi tailors into a cucumber-inspired microstructure. A two-step calcination process was further conducted at 120 °C and 700 °C to form sturdy carbon-coated Bi. The material delivers unprecedented initial capacity (614 mAh g^{-1}) and cyclability (337 mAh g^{-1} after 70 cycles at 50 mA g^{-1}). The enhanced Li storage performance can be attributed to the balance between mix-ester-ether electrolyte, well-defined carbon layer, and nanosized Bi, which resolves for capital initial capacity loss, provides continuous electronic conductivity, and improves kinetic reactions.