Engineering Carbon Nanostructures and Architectures

for High Performance and Multifunctional Electrodes

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Over the past decade, researches on sp^2 nanostructured carbon materials (CNT, graphene, nanostructured graphite) designed for high performance electrode materials in advanced energy storage systems have made remarkable progress. Here we present some of our recent progress in fabricating highly organized and controlled carbon nanostructures and architectures for high performance and multifunctional electrodes by combining state-of-the art synthesis, molecular level engineering and transfer based nanomanufacturing strategy developed in our laboratory. For examples, a generic synthetic approach to rationally design extremely short tubular carbon nanostructure inside anodic aluminum oxide templates will be presented. Using extremely short nanochannels, 3D architectures engineered from graphitic carbon, revealing unique large area nanoporous ultra thin film, were fabricated. The nanoscale porous graphitic films are highly effective to contain solid-state electrolyte polymers enabling multi-component and multifunctional flexible and transparent solid-state thin supercapacitor films. We also demonstrate precisely controlled and well-defined allotropic transformations in sp2 nanostructures and formation of their molecular junctions over large area of networks using controlled alternating voltage pulses. Small-diameter single-walled carbon nanotubes (SWCNTs) bundles and fibers can be selectively transformed into (1) larger diameter SWCNTs, (2) multi-walled carbon nanotubes, and (3) multi-layered graphene nanoribbons with significantly improved thermal and electrical properties. This re-engineering of carbon bonds evolves via a coalescence-induced reconfiguration of sp^2-hybridizion, terminating with the negligible introduction of defects and remarkable reproducibility.