Carbon Nanospheres

Carbons in the form of uniform micro- and nanospheres have been synthesized by hydrothermal synthesis (HTS), a facile, low environmental impact and minimal energy consumption process for preparing carbon materials using readily available organic sources, including carbohydrate sugar precursors, industrial biomass waste derivatives (e.g. bourbon stillage) and recycled materials (e.g. packaging materials, rice water, potato starch). The HTS process may be regarded as “green” as it uses no toxic organic solvents, initiators, or surfactants as is common with other methods described for the preparation of polymer micro- or nanospheres. The simplicity, mild reaction temperatures (ca. 200 °C), and versatility of HTS enables detailed control of the size, monodispersity, chemical composition and microscopic structure of electrode materials for this type of application, opening new prospects for decreasing manufacturing costs and improving material performance. Recently, we have demonstrated the ability to control carbon sphere size by adjusting hydrothermal process parameters. The mean diameter of the carbon nanospheres can be tuned easily by adjusting the operational conditions such as precursor solution concentration, temperature and reaction time. Our research group has prepared carbon spheres ranging from 50 nm to about 10 µm using a variety of commercial sugars and industrial biomass products. The HTS has very good conversion yields (C in/out ~ 90%). Finally, functional groups have been added to the sphere surface which greatly improves hydrophilicity and chemical reactivity.

Figure 1. Representative electron micrographs showing (A) pristine carbon nanospheres prepared by HTS, (B) carbon spheres after carbonization, (C) carbon spheres after graphitization.