CNMS Staff Science Highlight

Controlled Synthesis of Mesoporous Carbon Nanostructures via a "Silica-Assisted" Strategy

Scientific Achievement

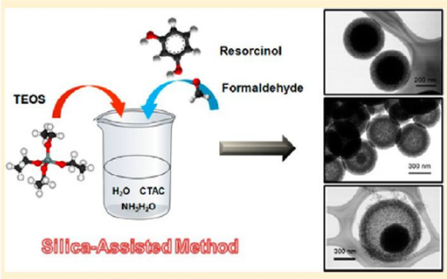
We developed a low-cost and flexible "silica-assisted" synthesis for diverse mesoporous carbon spheres (MCNs) by using phenolic resol polymers as a carbon precursor, silicate oligomers as an inorganic precursor, and cetyltrimethylammonium chloride (CTAC) as a template.

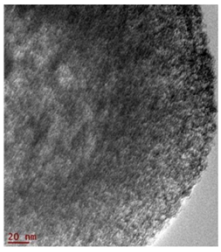
Significance

The MCNs obtained using the "silica-assisted" method exhibit not only promising properties for supercapacitors with high capacitance and favorable capacitance retention but also an ideal model system for advanced energy storage materials, adsorbents, catalyst supports, drug delivery carriers, and templates.

Research Details

- Silica-assisted synthesis involves carbonization of the polymer component and etching of the silica in the carbon/silica nanocomposites, resulting in the formation of MCNs. The mesostructures were retained while the MCN diameters are tuned from 180 to 850 nm by simply adding a controlled amount of ethanol during the polymerization of phenolic resols and silica in a mixture of CTAC and aqueous ammonia.





Top: Silica-Assisted Strategy with Tetraethylorthosilicate (TEOS) precursor and CTAC template.
Left: TEM image of hollow MCNs fabricated with the "silica-assisted" method showing mesoporous structures.

Z.-A. Qiao, B. Guo, A. J. Binder, J. Chen, G. M. Veith, S. Dai, *Nano Lett* **13**, *207-212* (2013).

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Highlight Narrative Text

We have demonstrated a new concept, a silica assisted method, for producing individual and dispersible MCNs, including MCNs, HMCNs, and YSMCNs. The synthesis with high yield (≥76.6%) can be carried out on a relatively large scale (grams) by using CTAC as a template, phenolic resol as a carbon source, and silicate oligomers as inorganic precursors. The particle sizes of the carbon nanospheres are uniform and easily tunable from 180 to 850 nm by simply varying the ethanol concentrations. The MCNs have high surface areas and large pore volumes. The three types of MCNs obtained using this method exhibit not only promising properties for supercapacitors with high capacitance and favorable capacitance retention but also an ideal model system for advanced energy storage materials, adsorbents, catalyst supports, drug delivery carriers, and templates. Furthermore, it is easy to envisage that this silica-assisted strategy can also be applied to the preparation of other mesoporous metal and mesoporous metal oxide nanomaterials with highly controlled nanostructures.

Reference

"Controlled Synthesis of Mesoporous Carbon Nanostructures via a "Silica-Assisted" Strategy"

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