Hierarchical nanostructured carbon materials for ultrahigh electrical charge storage

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Porous carbonaceous materials, especially activated carbons and carbon blacks (e.g., Pearls 2000),[1] have been commonly investigated as electrode materials for electrical double-layer capacitors (EDLCs) because of their relatively low cost and very large specific surface area. However, specific capacitances obtained from these conventional carbon materials are usually much lower than expected, resulting in a lower energy density from EDLC, which greatly hinders its practical application in some areas where a high energy density is required. Hierarchical nanostructured carbons (HNCs) particularly mesopores in combination with macropores/micropores, have demonstrated enhanced properties compared with single-pore-sized porous materials due to improved mass transport through the macropores/mesopores and enhanced selectivity and maintenance of specific surface area on the level of fine pore systems through micropores/mesopores.[2]

In this study, HNCs consisting of hollow core carbon sphere (HCCS) and multimodal porous carbon (MPC) structures have been prepared through simplified synthesis strategies and examined for EDLCs. Compared with their counterparts such as Norit SX Plus activated carbon and Pearls 2000 carbon black, the HNCs have demonstrated much higher specific capacitance and energy, and better cycling performance and rate capability. This is mainly attributable to their excellent structural characteristics such as large specific surface area and mesoporous volume, and particularly well-developed hierarchical nanostructures composed of macropores, mesopores and micropores, facilitating fast mass transport and electron transfer. [1,3]

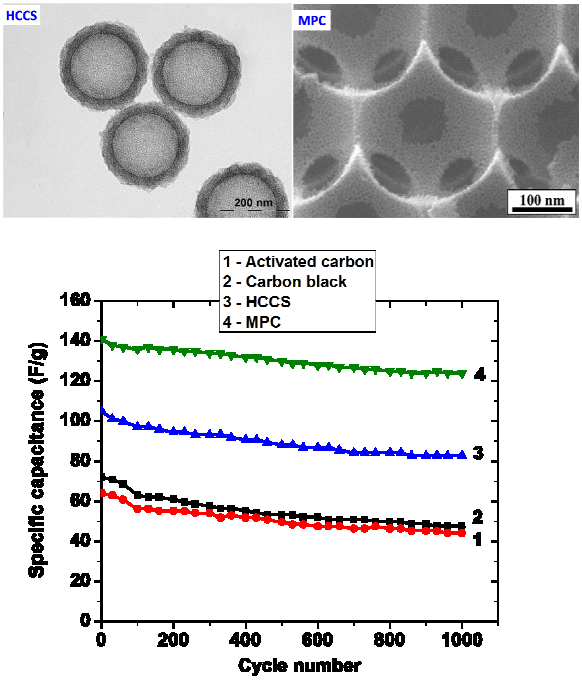

Figure 1. Typical SEM images for the HNCs and the variation of specific capacitances with cycle numbers at 12 mA/cm^2 for various porous carbon materials.

References

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