Thermal Conversion of Core-Shell Metal-Organic Frameworks: A New Method for Selectively Functionalized Nanoporous Hybrid Carbon

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Porous carbons have attracted keen interest because of their wide range of potential applications.[1] Here we propose a new method for preparation of nanoporous carbons. Core-shell structured ZIF-8@ZIF-67 crystals are well designed and prepared through a seed-mediated growth method. A zeolite imidazole framework (ZIF) is a well-known subfamily of MOFs formed through the coordination interaction between the metal ions and the imidazole derivatives. Therefore, we prepared core-shell MOFs (ZIF-8@ZIF-67) crystals, which consist of ZIF-8 ($[Zn(MeIm)_2]_n$) (MeIm=2-methylimidazole) crystals as the core and ZIF-67 ($[Co(MeIm)_2]_n$) crystals as the shell. By thermal treatment of ZIF-8@ZIF-67 crystals, novel selectively functionalized nanoporous nitrogen-doped carbon@graphitic carbon (NC@GC) nanocomposites consisting of nitrogen-doped carbon (NC) as the core and highly graphitic carbon (GC) as the shell are successfully prepared. This is the first example of the integration of NC and GC in one particle at the nanometer level.[2]

A supercapacitor is an electrochemical energy-storage device that can rapidly store and give out energy over a number of repeated cycles. This unique feature makes it a promising candidate to meet the increasing power demands in the field of portable electronic devices, hybrid electric vehicles, and memory backup.[3] Electrochemical data strongly demonstrate that this nanoporous hybrid carbon material integrates the advantageous properties of the individual NC and GC, exhibiting a distinguished specific capacitance (270 $F \cdot g^{-1}$) calculated from the galvanostatic charge–discharge curves at a current density of 2 $A \cdot g^{-1}$. Our study not only bridges diverse carbon-based materials with infinite metal-organic frameworks but also opens a new avenue for artificially designed nanoarchitectures with target functionalities.

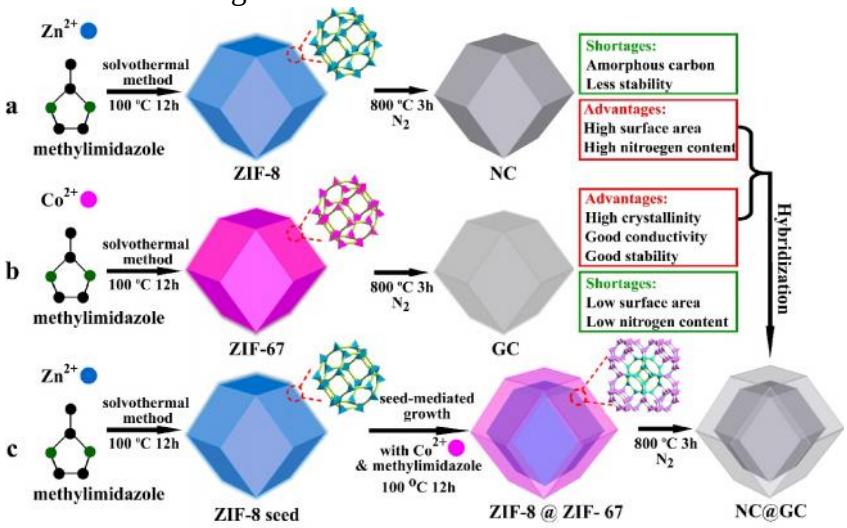

Figure 1 Synthetic scheme for the preparation of core–shell ZIF-8@ZIF-67 crystals and NC@GC.

Reference:

[1] J. Tang, Y. Yamauchi *et al.*, *Chem. Asian J.*, **9**, 3238-3244 (2014); *Nano Today*, **9**, 305-323 (2014); *Electrochim. Acta*, in press; *Angew. Chem. Int. Ed.*, **54**, 588-593 (2015).

[2] J. Tang, R. R. Salunkhe, Y. Yamauchi *et al.*, *J. Am. Chem. Soc.*, **137**, 1572-1580 (2015).

[3] R. R. Salunkhe, J. Tang, Y. Yamauchi *et al.*, *ACS Nano*, **9**, 6288–6296 (2015).