Hierarchically Porous Inorganic Oxide Materials with Three-Dimensionally Interconnected Networks

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Hierarchically porous oxide materials have immense potential for applications in catalysis, separation, and energy devices, but the synthesis of these materials is hampered by the need to use multiple templates and the associated complicated steps and uncontrollable mixing behavior. Here we report a simple one-pot strategy for the synthesis of inorganic oxide materials with multiscale porosity. The inorganic precursor and block copolymer are coassembled into an ordered mesostructure (microphase separation), while the in situ-polymerized organic precursor forms organic-rich macrodomains (macrophase separation) around which the mesostructure grows. Calcination generates hierarchical meso/macroporous SiO2 and TiO2 with three-dimensionally interconnected pore networks. The continuous 3D macrostructures were clearly visualized by nanoscale X-ray computed tomography. The resulting TiO2 was used as the anode in a lithium ion battery and showed excellent rate capability compared with mesoporous TiO2. This approach expands the base of conventional BCP self-assembly from mesostructures to hierarchically porous structures.