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Rational Design of Macro/Mesoporous Metal Oxides with Extended Cycle Stability for Battery Application

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We designed and developed a series of interconnected macro/mesoporous metal oxide nanostructures through a facile, scalable nanocasting method using the functionalized bromomethylated poly (2,6-dimethyl-1,4-phenylene oxide) (BPPO) membrane as the sacrificial template. This project was firstly highlighted by the successful preparation of the macroporous functionalized BPPO membrane through a novel breathe figure method. Using as the sacrificial template, various types of metal oxides with interconnected macro/mesopores could be subsequently reverse replicated. Due to the synergetic coupling of favorable characteristics for the battery application, the electrochemical measurements were therefore conducted to demonstrate the superiority of the proposed structural design. Take the as-fabricated Fe-doped manganese oxides for example, the cycling performance of which exhibited the high reversibility, excellent rate capability as well as an exceptional cycle life at the high current density (1500 mA g-1) up to 900 cycles, which presents the best cycling performance among manganese oxide anodes to date. This remarkable performance in Li^+ storage could be attributed to the interplay of the structural features: The optimized iron doping leads to high intrinsic electrical conductivity and provides a kinetic boost for the reversible conversion reaction of manganese oxide; meanwhile the 3-d interconnected macro/mesopore network facilitates the diffusion of electrolyte, thereby affording a highway for the lithium ions transport throughout the electrode. In addition, the structural properties and electrochemical performance of other macro/mesoporous metal oxides were also characterized to confirm the universal applicability of the proposed sacrificial template-assisted method.