3D V_6O_{13} nanotextiles as high-energy cathode materials for lithium ion batteries

With the support by the National Natural Science Foundation of China, Prof. Yu Yan's laboratory at the Department of Materials Science and Engineering, University of Science and Technology of China, reported the 3D nanotextile structures of V_6O_{13} by a facile solution-redox-based self-assembly route at room temperature, which was published in *Nano Letter* (2015, 15: 1388—1394).

V_6O_{13}, a mixed-valence vanadium oxide, can show better electrochemical performance than well-known V_2O_5. Theoretically, V_6O_{13} can electrochemically incorporate up to 8 Li per formula unit, giving a high theoretically specific capacity and energy of 417 mAh g^{-1} and 900 Wh kg^{-1}, respectively, much higher than those of conventional cathode materials, such as $LiCoO_2$ (140 mAh g^{-1}, 540 Wh kg^{-1}), $LiMn_2O_4$ (148 mAh g^{-1}, 500 Wh kg^{-1}), or $LiFePO_4$ (170 mAh g^{-1}, 500 Wh kg^{-1}). Moreover, V_6O_{13} shows a metallic characteristic at room temperature, which is beneficial for high-rate charge and discharge. In recent years, three-dimensional (3D) hierarchical nanostructures have been demonstrated as one of the most ideal electrode materials in energy storage systems owing to the synergistic combination of the advantages of both nanostructures and microstructures. In this work, we report 3D V_6O_{13} nanotextiles built from interconnected 1D nanogrooves via a facile solution-redox-based self-assembly method at room temperature, and the mesh size in the resulting textile structure can be controllably tuned by adjusting the precursor concentration. When employed as cathodes for lithium ion batteries (LIBs), the products deliver reversible capacity of 326 mAh g^{-1} at 20 mA g^{-1} and 134 mAh g^{-1} at 500 mA g^{-1}, and a capacity retention of above 80% after 100 cycles at 500 mA g^{-1}. Importantly, the resulting textiles exhibit a specific energy as high as 780 Wh kg^{-1}, 44%—56% higher than those of conventional cathodes (e.g., $LiMn_2O_4$, $LiCoO_2$, $LiFePO_4$). In addition, the 3D architectures retain good structural integrity upon cycling. This work not only presents an inexpensive and up-scalable method for preparing 3D nanotextiles at a very mild condition, but also demonstrates their application as cathodes for high-energy LIBs.

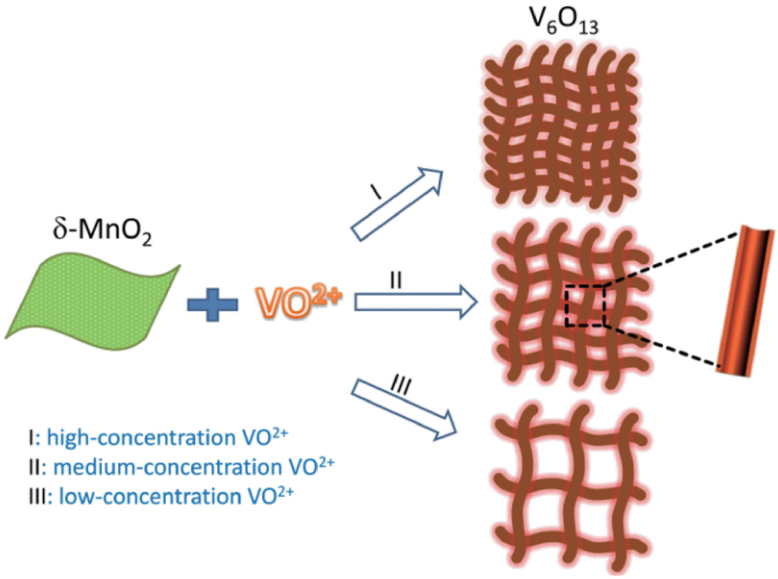

Figure The schematic diagram of 3D V_6O_{13} nanotextiles with interconnected nanogrooves prepared by a solution-redox-based self-assembly route at room temperature.