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Metal Oxide Nanoparticles for Improved Electrochromic and Lithium-Ion Battery Technologies

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ABSTRACT

Various transitional metal oxides have been investigated extensively for a variety of applications including catalysis, gas sensors, fuel cell membranes, electrochromic (EC) windows and Li-ion batteries. The kinetics of the insertion reaction is often limited by the solid-state diffusion of the ions. Both the chemical diffusion coefficient and the length of the diffusion path determine the time constant of the process. While the former depends on the chemical and crystal structure of the metal oxide, the later is determined by the microstructure. In the case of a nanoparticles, the smallest dimension represents the length of the diffusion path. Therefore, designing a nanoparticle with a small radius while maintaining the right crystalline phase is key to a material with fast insertion kinetics and superior overall device performance. Recently, Hot-wire chemical vapor deposition (HWCVD) has been employed as an economically scalable method for the deposition of crystalline tungsten oxide nanorods and nanoparticles. TEM analyses show that the smallest dimension of these nanostructures is ~ 10 – 50 m. The incorporation of these particles into porous films led to profound advancement in state-of-the–art EC technologies. HWCVD has also been employed to produce crystalline molybdenum oxide nanostructures at high density. It is possible to fabricate large area porous films containing these MoO_3 nanostructures. Furthermore, these films have been tested as the negative electrode in lithium-ion batteries, and a surprisingly high, reversible capacity has been observed. The synthesis of these novel nanostructured materials and their potential for improving EC and battery technologies will be presented.