Frame Stability of Tunnel-Structured Cryptomelane Nanofibers: The Role of Tunnel Cations - DTU Orbit (09/11/2017)

Frame Stability of Tunnel-Structured Cryptomelane Nanofibers: The Role of Tunnel Cations

The role of tunnel K+ ions on the growth and stability of tunnel-structured cryptomelane-type MnO2 nanofibers (denoted as cryptomelane nanofibers hereafter) has been discussed by means of X-ray diffraction and electron microscopy. Cryptomelane nanofibers with typical diameters of 20–80 nm and lengths of 1–6 μm have been synthesized by means of a simple hydrothermal reaction of KMnO4 and MnSO4 aqueous solutions at 140 °C. The growth of cryptomelane nanofibers under hydrothermal conditions follows a dissolution–recrystallization process and involves a morphological transformation from a layered precursor to the tunnel-structured cryptomelane, in which the K+ ions play important roles in templating and stabilizing the tunneled framework. The presence of tunnel K+ ions also enhances the frame stability of the cryptomelane nanofibers at elevated temperatures. The formation of a layered KxMn2O4 (x ≈ 0.26) with a hexagonal phase structure has been observed at about 900 °C. The transformation from tunneled cryptomelane to layered KxMn2O4 also follows the dissolution–recrystallization growth mechanism, in which the diffusion of K+ ions at high temperatures represents a critical process. The topological correlation between the tunneled and layered MnO2 materials might provide useful information for the synthesis of MnO2 nanomaterials with controlled microstructures for different applications.

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