The Journal of Physical Chemistry C
2014
Volume 118, Number 27, pg. 15068-15078

Versatile Growth of Freestanding Orthorhombic α-Molybdenum Trioxide Nano- and Microstructures by Rapid Thermal Processing for Gas Nanosensors

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https://doi.org/10.1021/jp5038415

Abstract

We demonstrate a new technique that requires a relatively low temperature of 670–800 °C to synthesize in 10–20 min high crystalline quality MoO3 nano- and microbelts and ribbons. The developed technological process allows rapid synthesis of large amounts of MoO3 nano- and microsheets, belts, and ribbons, and it can be easily scaled up for various applications. Scanning electron microscopy (SEM) studies revealed that the MoO3 nano- and microbelts and ribbons are synthesized uniformly, and the thickness is observed to vary from 20 to 1000 nm. The detailed structural and vibrational studies on grown structures confirmed an excellent agreement with the standard data for orthorhombic α-MoO3. Also, such freestanding nano- and microstructures can be transferred to different substrates and dispersed individually. Using focused ion beam SEM, MoO3-based 2D nano- and microsensors have been integrated on a chip and investigated in detail. The nanosensor structures based on MoO3 nano- and microribbons are quite stable and moderately reversible with respect to rises and drops in ethanol vapors. It was found that MoO3 nano- and microribbons of various sizes exhibit different sensitivity and selectivity with respect to ethanol, methanol, and hydrogen gases. The developed technique has great potential for further studies of different metal oxides, nano- and microsensor fabrication, and especially for multifunctional applications.