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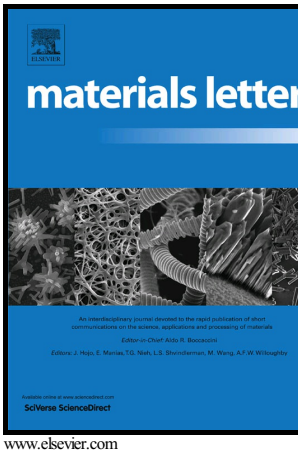

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Enhancing Phase-transition Sensitivity of Tungsten-doped Vanadium Dioxide by High-temperature Annealing

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ABSTRACT:

Vanadium dioxide (VO_2) has been considered as a remarkable candidate for temperature-sensing switching and thermochromic materials. However, the reduction of phase transition temperature for tungsten (W) doped VO_2 always comes together with broadening range, which impedes its application at room temperature even much lower. The W doped VO_2 with sensitive phase transition was synthesized via a facile solid reaction and subsequently high temperature annealing. With the heat treatment at 1000 °C, the phase transition of W doped VO_2 could maintain a narrow temperature range at room temperature or even much lower. Interestingly, electrical resistance as one of physical characteristics is simultaneously sensitive in the phase transition.

Keywords: Tungsten doping; Vanadium dioxide; Phase transformation; Thermal analysis; Annealing; Electrical resistance

1. Introduction

Vanadium dioxide (VO_2) has been considered as one kind of the intelligent materials owing to its thermo-sensitive metal–insulator phase reversible transitions (MIT) nature at ~67°C.[1-4] It also has always attracted continuous attention as a remarkable candidate for temperature-sensing switching and thermochromic materials in more than half a century.[3-7] In recent years, the phase-transition temperature of VO_2 could be regulated to a wider range through doping other atoms and finite size.[6-8] Specifically, the phase transition temperature of doped VO_2 materials can be depressed to room temperature or even much lower by several approaches including sputtering, sol–gel synthesis, hydrothermal synthesis and thermolysis.[6-11] However, the reduction of phase transition temperature always comes together with range broadening.[7-13] This phenomenon can be attributed to structural distortion, defects and amorphous phase formed in VO_2 due to replacement of vanadium with tungsten.[4-6] Hence, it is a great challenge to keep narrow range at low phase transition temperature.

On the other hand, the range broadening of the phase transition temperature would reduce the sensitivity of temperature to the phase transition for VO_2, [5-9] which is significantly detrimental to its actual application. For example, the abrupt changes of optical and electrical properties for doped VO_2 would gradually disappear with the doping contents increasing, impeding the application in temperature-sensitive material especially at low temperature.[5, 10, 13] This problem has been