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Thermochromism of vanadium dioxide films controlled by the thickness of ZnO buffer layer under low substrate temperature

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Abstract

High-quality vanadium dioxide (VO_2) thermochromic thin films were fabricated on ZnO/soda-lime glass via direct current magnetron sputtering at a low temperature of 320 °C. The ZnO polycrystalline film was used as a buffer layer between glass substrate and VO_2 film to improve the thermochromic property of VO_2 film. The results of XRD, Raman spectrum, SEM and visible-infrared spectrum indicated that the thickness of the ZnO buffer layer has a significant effect on the physical and thermochromic performance of VO_2 films. The surface morphologies of all VO_2 films can be divided into three groups by employing ZnO buffers with different thicknesses. The film with thin buffer (56 nm) exhibited a weak crystallinity, low phase temperature and low solar energy modulability compared with the pristine sample. However, the crystallinity and solar switching efficiency of VO_2 films noticeably increased as the thickness of the buffer layer increased further (thicker than 56 nm). The calculated modulability of solar energy of the VO_2 film with a 235-nm thick ZnO buffer layer is about 13.11%, which may be beneficial in the application of VO_2 films for smart energy-efficient windows.

Keywords: vanadium dioxide, magnetron sputtering, ZnO buffer layer, thermochromic performances.

1. Introduction

Vanadium oxide compounds (VO_2, V_2O_3, V_2O_5, etc.) have been reported to exhibit abrupt changes in electrical and optical properties with varying temperature [1-4]. Among these compounds, vanadium dioxide (VO_2) is the most interesting due to its transition temperature of approximately 68 °C, which is close to room temperature [5]. Below the phase transition

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