Effects of annealing on thermochromic properties of W-doped vanadium dioxide thin films deposited by electron beam evaporation

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Abstract

Thermochromic vanadium dioxide (VO₂) undergoes a fully reversible semiconductor-metal transition (SMT) at a critical temperature T₁ of ~68 °C with a dramatic change in electric and optical properties, which makes it an attractive candidate for use in smart windows. Switchable VO₂ and W-doped vanadium dioxide (WₓV₁₋ₓO₂) thin films are grown successfully over quartz substrates via electron beam evaporation technique by using VO₂ / WₓV₁₋ₓO₂ as targets at room temperature (RT) followed by a post annealing process at different temperatures. The films were characterized by X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy, scanning electron microscopy (SEM) and optical transmittance measurement. The XRD analysis shows that the as-deposited films are amorphous, and that transform into (011)-preferred orientation of monoclinic VO₂ (VO₂(M)) after annealing at 500 °C under vacuum. Moreover, (011) peak of W-doped VO₂ films shifts to a lower diffraction angle as compared with un-doped VO₂ films which confirm the incorporation of W ions into the VO₂ lattice. Temperature dependent optical transmittance (T-T) measurement demonstrates the thermochromic properties, with a reduction in the phase transition temperature (T₁) as observed in W-doped VO₂ films, which is attributed to the variation of electron structure in VO₂ due to doping.

Keywords: annealing, physical vapor deposition, tungsten-doped vanadium dioxide, WₓV₁₋ₓO₂, thermochromic, optical properties

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