VO_2-based Thermochromic Materials for Smart Glazing Systems

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ABSTRACT

Thermochromism is the property of some materials by which they change their optical properties upon heating above a critical transition temperature (T_C), characteristic for each material. Among these materials, Vanadium dioxide (VO_2) has been extensively studied, due to the fact that its T_C, is the closest to room temperature (RT). In specific, for temperature below T_C = 68˚C, it has a monoclinic structure, being a semiconductor and IR transparent, while for temperature above 68˚Cit has a tetragonal rutile structure, metallic behavior and becomes IR reflective. In addition, the visible transmittance remains constant and independent of temperature. Thus, VO_2 is an ideal candidate as thermochromic coating on “smart” glazing systems, in order to regulate the internal temperature in buildings.

In this work, thermochromic VO_2 films were synthesized using two different techniques, namely rf sputtering and hydrothermal synthesis. The former, is a well-known technique for large-scale films’ deposition of high quality, while the latter is an easy and cost-effective method to synthesize materials in the form of powder.

In particular, thermochromic undoped and Mg-doped VO_2 films were grown by rf sputtering technique, at a low deposition temperature of 300˚C, on both rigid [1] and flexible [2] glasses. Undoped VO_2 films were deposited on commercial Pilkington K-Glass (Low-E glass) exhibited a T_C = 56˚C, a width of transmittance hysteresis loop ΔT_C = 8˚C, luminous transmittance Tr_{lum} = 36% and solar transmittance modulation ΔTr_{sol} = 5%, while Mg-doped VO_2 films deposited on the same substrate showed T_C = 49˚C, ΔT_C = 6˚C, Tr_{lum} = 47% and ΔTr_{sol} = 3%. Moreover, undoped VO_2 films which were deposited on flexible Corning glass showed T_C = 51˚C, ΔT_C = 12˚C, Tr_{lum} = 34% and ΔTr_{sol} = 5%.

Finally, undoped VO2 in the form of powder was synthesized by hydrothermal synthesis, using Vanadium pentoxide as Vanadium source and oxalic acid as reducing agent. The VO_2 powder was dispersed in an appropriate solution and drops of it were casted on to glass [3] substrate. The thermochromic films had T_C = 67˚C, ΔT_C = 7˚C, Tr_{lum} = 25-41% and ΔTr_{sol} = 0.35-1.72%.

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