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Improved performance of thermochromic VO_2/SiO_2 coatings prepared by low-temperature pulsed reactive magnetron sputtering: prediction and experimental verification

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Abstract

The paper deals with thermochromic VO_2/SiO_2 coatings prepared by low-temperature pulsed reactive magnetron sputtering on conventional soda-lime glass substrates without any substrate bias and without any interlayer. Thermochromic VO_2 layers were deposited using reactive high-power impulse magnetron sputtering with a pulsed O_2 flow control at a substrate surface temperature of 300 °C. Antireflection SiO_2 layers were deposited using mid-frequency bipolar dual magnetron sputtering onto the top of VO_2 layers at a surface temperature below 35 °C in order to improve the optical and mechanical performance. We focus on the dependence of the luminous transmittance (T_{lum}) and the modulation of the solar transmittance (ΔT_{sol}) on the SiO_2 layer thickness. The measured dependencies are in good agreement with those predicted using properties of pure VO_2 layers measured by spectroscopic ellipsometry. Two different VO_2 layer thicknesses (30 and 88 nm) have been used to demonstrate the tradeoff between T_{lum} and ΔT_{sol}. We show an improvement due to the SiO_2 overlayer of up to 16% (from 40.3% to 56.3%) for T_{lum} measured ar 25 °C and up to 2.6% (from 7.7% to 10.3%) for ΔT_{sol}. The results are important for the design and low-temperature fabrication of high-performance durable thermochromic VO_2-based coatings for smart window applications.