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Low-temperature deposition of thermochromic VO2 films on glass and kapton using reactive deep oscillation magnetron sputtering

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A modified version of HiPIMS, called Deep Oscillation Magnetron Sputtering, with a pulsed O_2 flow control and to-substrate O_2 injection into a high-density plasma in front of the sputtered vanadium target was used for low-temperature (330 °C) deposition of thermochromic VO_2 films onto conventional soda-lime glass (1 mm thick) and flexible kapton polyimide foil (25 μm thick) substrates without any substrate bias voltage and without any interlayer.
The depositions were performed using a strongly unbalanced magnetron with a planar vanadium target of 100 mm diameter in argon-oxygen gas mixtures at the argon pressure of 0.5 Pa. Voltage macropulses, composed of 10 voltage micropulses (pulse-on time of 20 μs and pulse-off time of 30 μs), with a total length of 500 μs and repetition frequency of 640 Hz were used for all depositions with a maximum target power density of up to 735 Wcm^{-2} during pulses at a deposition-averaged target power density close to 20 Wcm^{-2}.
A high modulation of the transmittance at 2500 nm (even between 77% and 17% for VO_2 films on the kapton substrate) was achieved for the VO_2 films on the glass and kapton substrates at the transition temperatures of 57-64 °C.
This low-temperature magnetron sputter technique is of key importance for compatible fabrication of thermochromic VO_2-based multilayer coatings for smart windows and smart radiator devices (spacecrafts) applications requiring enhanced luminous transmittance and solar transmittance modulation at a decreased transition temperature.

Keywords
Reactive DOMS
Thermochromic VO2 films
Low-temperature deposition