Thermochromic Smart Window Performance Enhancement Through Pulsed Laser Dual-Doping of VO2 Thin Films

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Vanadium dioxide (VO2) thin films display an intriguing insulator-to-metal phase transition, which results in a distinct change in infrared (IR) transmittance across the solar spectrum. This unique property makes VO2 an auspicious candidate for the development of thermochromic smart windows capable of saving solar energy efficiently. For practical applications, however, the transition temperature must be tuned close to room temperature while maintaining a large IR transmittance modulation. In this study, pure and tungsten (W) and terbium (Tb) doped VO2 thin films were investigated for performance with dual-doping strategies. Structural and optical properties were assessed to confirm phase behavior and performance. Tungsten doping induced a crystallographic transformation from the monoclinic to the rutile phase, whereas Tb doping preserved the original monoclinic structure. The W-doped films exhibited excellent IR modulation, achieving more than a 50% change in IR transmittance, while Tb doping enhanced the luminous transmittance of the films, which is equally important for indoor illumination to save energy. The ability to simultaneously control both IR and visible transmittance is highly desired and considered to be an effective and systematic strategy for achieving energy-efficient smart window performance. The present work thus provides an effective pathway for engineering advanced VO2-based materials to address the growing global energy crises and also offers a pathway for energy-efficient smart window technologies, which have potential environmental and energy-saving benefits and align with the United Nations Sustainable Development Goals (SDGs).

Awards Won:

Third Award of $1,200