Mechanical Engineering Thesis Defense

Reducing the Vanadium Dioxide Transition Temperature via Tungsten Doping

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Abstract

Vanadium-dioxide-based devices show great switchability in their optical properties due to its dramatic thermochromic phase transition from insulator to metal, but generally have concerns due to its relatively high transition temperature at 68 °C. Doping the vanadium dioxide with tungsten has been shown to reduce its transition temperature at the cost lower optical property differences between its insulating and metallic phases. A recipe is developed through parametric experimentation to fabricate tungsten-doped vanadium dioxide consisting of a novel dual target co-sputtering deposition, a furnace oxidation process, and a post-oxidation annealing process. The transmittance spectra of the resulting films are measured via Fourier-transform infrared spectroscopy at different temperatures to confirm the lowered transition temperature and analyze their thermal-optical hysteresis behavior through the transition temperature range. Afterwards, the optical properties of undoped sputtered vanadium films are modeled and effective medium theory is used to explain the effect of tungsten dopants on the observed transmittance decrease of doped vanadium dioxide. The optical modeling is used to predict the performance of tungsten-doped vanadium dioxide devices, in particular a Fabry-Perot infrared emitter and a nanophotonic infrared transmission filter. Both devices show great promise in their optical properties despite a slight performance decrease from the tungsten doping. These results serve to illustrate the excellent performance of the co-sputtered tungsten-doped vanadium dioxide films.

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Zoom Link: https://asu.zoom.us/j/87872955438