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Spray deposition of V_4O_9 and V_2O_5 thin films and post-annealing formation of thermochromic VO_2

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Abstract

Vanadium oxide (VO_x) thin films were deposited at various substrate temperatures (T_s) by spray pyrolysis technique using 0.05 M vanadyl acetylacetonate precursor. V_4O_9 films are formed at $T_s = 300^\circ\text{C}$, while mixed V_2O_5 phases are formed at higher T_s (400 and 500°C). Annealing in forming gas of V_4O_9 films shows the formation of higher content of thermochromic VO_2 phase than V_2O_5 films. V_4O_9 films show little higher electric resistivity (ρ), higher temperature coefficient of resistance (TCR), and higher thermal carrier activation energy (E_a) than V_2O_5 films. Annealed VO_x films show a 2-3 order of magnitude change in ρ , optical transmission switch of 19-39%, and higher E_a than to the as deposited films. Annealed films deposited at $T_s = 500^\circ\text{C}$ presents a high TCR of $-4.6\%K^{-1}$. Optical absorption, electronic transitions, and energy gaps of the formed VO_x phases have been discussed in relation to its electronic band structure.

Keywords: Vanadium oxide, V_4O_9 , V_2O_5 , spray pyrolysis, thermochromic, annealing, thin films, electric and optical properties

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