Effect of preparation conditions on the optical and thermochromic properties of thin films of tungsten oxide

S.M.A. Durrani[a,*], E.E. Khawaja[a], M.A. Salim[b], M.F. Al-Kuhaili[b], A.M. Al-Shukri[b]

[a] *Laser Research Section, Center for Applied Physical Sciences, Research Institute, King Fahd University of Petroleum and Minerals, Box 1831, Dhahran 31261, Saudi Arabia*

[b] *Department of Physics, King Fahd University of Petroleum and Minerals, Dhahran 31261, Saudi Arabia*

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Abstract

Thin films of tungsten oxide have been prepared by thermal evaporation. The effect of preparation conditions (heating of substrates and oxygen environment) on the optical constants (n and k) of the films has been studied. Satisfactory derivation of n and k from the measured normal incidence transmittance of the films was achieved. It was found that (a) both n and k have larger values for films deposited on heated substrates than for those deposited on unheated substrates, and at a given substrate temperature, (b) both n and k have smaller values for films deposited in the oxygen atmosphere than those deposited without an introduction of oxygen in the chamber.

Thermochromic colouration of the films was carried out by annealing the films in vacuum. The annealing of the films produced significant loss in the oxygen content (measured by X-ray photoelectron spectroscopy) and modulation of the transmittance for the films deposited on unheated substrates with or without the oxygen environment and films deposited on heated substrates with the oxygen. The loss in the oxygen content and the modulation of transmittance, however, were very small for films deposited on heated substrates without the oxygen. For annealed films, satisfactory derivation of n and k was achieved for films deposited on unheated substrates, while for films deposited on heated substrates this was not possible. This study revealed that upon annealing the optical properties of the films prepared in the oxygen environment were mainly absorptance-modulated, and those of the films without the oxygen were reflectance-modulated.

Keywords: Thermal evaporation; Thermochromic properties; WO_3 films