Investigation of the effects of deposition and annealing conditions on properties of thermochromic VO2 films.

Delvina Japhet.

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University of Dar es Salaam, College of Natural and Applied Sciences, 2018.

This study focused on the effects of deposition and annealing conditions on properties of thermochromic VO_2 films. The soda lime glass substrates were used to prepare the films at room temperature using DC magnetron sputtering of vanadium target in argon atmosphere in semi vacuum environment. The working pressure and argon flow rate were $5.2 - 5.6\,x\,10^{-3}$ mbar and 76 ml/min, respectively. The films were thereafter annealed using RTP furnace at different temperatures and time. Films thicknesses were determined using the Alpha Step IQ surface profiler. AFM and XRD were used to study the surface morphology and structure of the films, respectively. Hall Effect measurements system and JANDEL Model RM3-AR test unit in combination with four point probe were used to obtain electrical measurements. FTIR spectrophotometer was used to determine optical switching of the films in the wave lengths range $1800 \leq \lambda \leq 25000$ nm. The XRD results confirmed that all films annealed at different temperatures and time were VO_2 except for films annealed at a temperature of 300 ^{o}C. The average grain size as determined by AFM was found to increase from 374 nm^2 to 1107 nm^2 and 290 nm^2 to 548 nm^2 with an increase in annealing temperature and time, respectively. Four point probe indicated that films obtained after annealing had resistivity change between the semiconducting to metallic phases of one order of magnitude. The transition temperature was estimated to be between $\sim$ 58 ^{o}C to 63 ^{o}C. Hall Effect measurements showed that films conductivity and carrier concentration were decreasing with increasing annealing temperature and time consisted with formation of semiconducting VO_2 films as confirmed by XRD results. The highest peak transmittance of the annealed VO_2 films was 53 % at 2500 nm for film thickness of 44 nm. Film with thickness of 44 nm and annealed at 400 ^{o}C showed best optical switching of about 18 % evaluated at 2500 nm, from 53 % transmittance for semiconducting phase VO_2 at room temperature to 12 % transmittance for metallic phase VO_2 at 100 ^{o}C sample temperature.