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Influence of Thermal Annealing Process on Vanadium Oxide Thin Films for Metal-Insulator Transition Enhancement

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Metal-insulator transitions (MIT) are reversible changes in the conductivity of materials when the temperature above or below the transition point, which are the smart transitions in advanced material. Vanadium oxide (V_xO_y) demonstrated excellent MIT characteristics at the transition temperature (T_c) due to the lattice distortion. However, V_xO_y has many phases such as V_2O_5, V_2O_3, VO_2, VO, which have the different transition temperature. In this work, we study the influence of an annealing process to improve the MIT of V_xO_y thin film on glass substrates. V_xO_y thin films were prepared by the pulsed DC magnetron sputtering technique at room temperature by various gas ratios between Ar and O_2. Then, the crystal structures of V_xO_y thin films were investigated by X-ray diffraction. X-ray diffractrograms of as deposited V_xO_y thin films did not show the crystallinity index of material. To improve the MIT or the crystalinity of V_xO_y films, the controlled ambient annealing process was applied to deform grains and recrystallize of the material. Consequently, as deposited V_xO_y thin films were annealed under control N_2 pressure, and the temperature was set at 400°C to avoid the deformation of thin film at the high annealing temperature. After annealing process, the MIT characteristics of V_xO_y thin films were measured by four points probe technique between 30-150 $^{\circ}$C. Surprisingly, the V_xO_y thin films exhibit the MIT behavior in two orders of magnitude. We found the formation of V_2O_5 from XRD patterns of thin films, and other phases such as V_2O_3, VO_2 also discovered. Moreover, the Raman spectra of thin films show the vibration modes of V_2O_5 to confirm the effect of annealing process on the V_xO_y crystal formation. Our preliminary study is promising method to improve the crystal formation of V_xO_y thin film and enhance the MIT for further electronics applications.

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