

Argon flow rate effects on the optical waveguide properties of DC sputtered TiO₂ thin films

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Abstract: TiO₂ thin films were successfully prepared by DC sputtering using pure titanium target in mixed gases (Argon, Oxygen) plasma on glass substrates. The films were deposited at a constant substrate temperature (350 °C) with different Argon flow rate values (15, 30, 45, and 60 sccm). Raman spectroscopy analysis shows that all films crystallized in the Anatase phase. The crystallinity was found to improve with increasing Argon flow rate up to 45 sccm and then deteriorate sharply at 60 sccm. The crystallite size varied between 9.1 and 9.7 nm. Atomic force microscopy (AFM) revealed that the roughness fluctuated between 1.30 and 6.01 nm with an overall increase. The grain shape went from sharp needles like shape to dome like shape with an enlargement in their size by up to 60 nm. The UV–Vis spectrophotometer displayed that the films were highly transparent. The optical band gap ranged from 3.65 to 3.49 eV. Prism coupler analysis exhibited single guided modes in both transverse electric and transverse magnetic polarizations for the sample prepared at 15 sccm Argon flow rate and bi-guided modes in both polarizations for the rest of the samples. Both ordinary and extraordinary refractive indices decreased over Argon flow by 9.912% and 6.441% respectively. The thickness, porosity as well as the birefringence were found to increase by 155 nm, 16.16% and 0.0832 respectively as Argon flow rate went from 15 to 60 sccm.

Keywords : Ar flow rate, DC sputtering, Prism coupler, Refractive indices, TiO₂, waveguides