A Study on Spectroscopic Ellipsometry Modelling of Dielectric Properties in WO_{3-x} Photonic Thin Films

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The sub-phases of the polymorph and versatile tungsten tri-oxide WO_3 (Magnéli phases) are metal-like electrically conductive, due to strong *n*-type self-doping (up to $n = 10^{21}$-10^{22}cm^{-3} [1-3]) correlated to oxygen vacancies. Deposition by Radio-Frequency sputtering can grow WO_{3-x} films of quite different structures and properties [1,3]. A post-growth thermal annealing step is often added to tailor film stoichiometry and structure in view of selected application.

In the present work, we analyse amorphous thin films of WO_{3-x} of very good optical quality, fabricated by non-reactive RF-sputtering deposition followed by thermal annealing in air. The dispersion of the complex dielectric function $\tilde{\varepsilon}(\omega)$ of the films was measured in the 350 nm < λ < 1700 nm spectral range by Variable Angle Spectroscopic Ellipsometry (VASE) and data analysis was performed using commercially available WVASE32 fitting software. The reference fitting model includes parametric expressions for $\tilde{\varepsilon}(\omega)$ and for the thickness of all the layers involved and is refined by fitting for morphological and structural information of the layers, such as porosity, roughness, homogeneity, and anisotropy, so that this kind of information is provided at the same time with an accurate estimate of $\tilde{\varepsilon}(\omega)$. We discuss the specific graded fitting model for thermally annealed WO_{3-x} films, thicker than 80nm and the nature of the differences in dielectric parameters between the surface of the film, more oxidized, and its bottom, more absorptive. Therefore, deeper knowledge is obtained regarding the effectiveness of using thermal annealing to tailor the stoichiometry of films.

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