

Reactive e-beam evaporation of yttrium: A spectral investigation of yttrium in different chemical environments

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Abstract

In recent decade(s) there has been an increasing interest in the chromic materials because of the remarkable optoelectronic features they possess. Being the fact that the structural evaluation stays still uncertain, yttrium based oxyhydride thin films are the one of the most promising structures with photochromic behaviour. In contemplation of the understanding/constructing, as regards the scope of this research, the relation between crystal arrangements and spectroscopic and electrical characteristics; yttrium, yttrium oxide and yttrium oxyhydride thin films were deposited by e-beam evaporator. The deposition, around 200 nm in thickness, were carried out from metal pieces (% 99.99, Purity) at 298 K (± 5) onto Si (001) and soda-lime glass and kapton substrates. And the following approaches were performed with the intention of creating this correlation: X-ray diffraction and Transmission Electron microscopy (structural investigation), Vacuum Fourier transform infrared spectrometer (vibrational spectrum analysis), Spectroscopic ellipsometer (optical characterization), X-ray photoelectron spectroscopy (oxidation state determination), and X-ray absorption spectroscopy (local structure analysis and chemical state identification). The findings of the absorption edge (K) of yttrium reveal that the oxidation state of Y in oxyhydride structure stays in the between the metallic yttrium and fully oxidized yttrium structure that corresponds to an unusual oxidation state. This result is in correspondence with the outcomes obtained from XPS, where the binding energy (Y 3d) shifts to the higher values depending on the chemical state of yttrium. The fully oxidized yttrium lattice vibrations at around 300, 380 and 550 cm^{-1} were detected by IR spectroscopy for yttrium oxide and yttrium oxyhydride thin films. The differences in the intensities and the widths of the vibration peaks indicates either the H atoms disturb the original cubic structure of sesquioxides and/or formation of new phases. The findings from this study might enhance our understanding on the arrangements of H atoms in the host crystal structure which is directly related to the photochromic demeanour.

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