OR0102

Tailoring optical properties of chromium-silicon mixed oxides by oxygen ion beam implantation

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Mixed metal-silicon oxides are very interesting materials because they are suitable for use, among others, as optical coatings with an adjustable refractive index. In most cases the synthesis of these coatings is completed by chemical vapour deposition (CVD) techniques although undesirable incorporation of chlorine, hydrogen or carboxyl groups to the films is frequently reported. In this paper we investigate the formation of chromium and silicon mixed oxides using a novel alternative method. Starting with chromium deposition on silicon substrates by reactive magnetron sputtering we induce the formation of mixed oxides by reactive ion beam mixing bombarding the Cr/Si interface with oxygen. We have varied the ion dose (from $1x10^{17}$ up to $1x10^{18}$ ions cm^{-2}) and the implantation energy (40-100 keV) in order to modify the final composition of the coating. The composition profiles have been obtained by means of Rutherford backscattering spectrometry (RBS) with He ions at 3.035 MeV to make use of the resonance of alpha particles with oxygen at this specific energy. A more detailed analysis of the composition depth profiles was obtained by changing the He energy from 3.035 up to 3.105 MeV. Results have been compared with secondary ion mass spectrometry (SIMS) depth profiles and Monte Carlo TRIDYN simulations. Chemical and structural characterizations were carried out by X-ray photoelectron spectroscopy (XPS), angle-resolved X-ray photoelectron spectroscopy (ARXPS), X-ray diffraction (XRD) and scanning electron microscopy (SEM). We have determined how structural changes obtained by varying the ion beam implantation parameters are related to the optical properties of the coatings (mainly refractive index and extinction coefficient) as measured by spectroscopic ellipsometry.

Keywords
functional coatings
ion implantation
mixed oxides
optical properties