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**Evolution of microstructural and chemical in-depth changes of variable index chromium-silicon mixed oxides induced by reactive ion beam mixing at the interface.**

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The great interest of mixed metal-silicon oxides lies in their suitability, among other applications, as optical coatings with an adjustable refractive index. In previous studies we performed an extensive depth profiling characterization (RBS, RBS, ERDA-ToF, SIMS and XPS) of chromium-silicon mixed oxide thin films prepared by oxygen ion implantation of metallic Cr thin films deposited on Si substrates [1]. In order to disclose the diffusion mechanisms involved in the development of oxides in the implanted samples we have developed chemical state XPS depth profiles of Cr, Si and O for the different implanted samples together with HR-TEM cross sectional observations. Both techniques point to the formation of a ternary mixed oxide at the interface. Moreover, the formation of a crystalline mixed Cr-O-Si oxide at the interface has been studied by fast Fourier Transform Analysis of the high resolution TEM images. We have combined such results with morphological and structural changes measured by AFM, SEM and XRD. These changes include amorphisation and surface roughening of the samples as a result of the ion implantation. Finally, we have correlated such changes with the optical properties of the implanted samples. In particular, the refractive index decreases linearly with the implanted dose. Samples implanted with low doses ( $\leq 1 \times 10^{17} \text{cm}^{-2}$ ) had a high value of  $n = 3.3$ , similar to the metallic chromium. The refractive index of the  $5 \times 10^{17} \text{cm}^{-2}$  implanted samples is lower than the metal chromium but higher than the  $\text{Cr}_2\text{O}_3$ , while the highest implanted sample ( $1 \times 10^{18} \text{cm}^{-2}$ ) had a  $n = 2.1$  that lies between the  $\text{Cr}_2\text{O}_3$  and the  $\text{SiO}_2$  (1.5). Therefore, by changing the implantation dose we are able to tune the refractive index of the films.

[1] R. Escobar Galindo et al. J. Anal. At. Spectrom., (2012)

**Keywords**

mixed oxides  
ion implantation  
refractive index  
XPS  
TEM