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Empirical method for Ti oxidation state determination in undoped and doped titania films by Auger electron spectroscopy

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Titanium oxide and Nb-doped titanium oxide thin films were prepared by reactive RF sputtering at room temperature from either a pure TiO_2 target and or a mosaic TiO_2 –Nb target, in a Ar-O_2 gas mixtures containing from 0% to 30% oxygen. In this work, the oxidation state of Ti and Nb in Nb-containing titanium oxide films was studied using Auger electron spectroscopy (AES) and Rutherford backscattering spectroscopy (RBS). Film composition, expressed as O/Ti atomic ratio, obtained from AES depth profiling is found lower than that obtained from RBS analysis, due to the well known preferential sputtering phenomena induced by energetic ion bombardment in complex compounds. In order to minimize the errors induced by this phenomenon on the film in-depth composition determination and contrarily to the conventional approach which considers one or two main transition lines of titanium (TiLMM and TiLMV), we considered still both transition lines but together with the associated loss and satellites features. This also allowed to obtain more precise information about the oxidation state of titanium and niobium. The method consists in investigating parameters related to both shape and intensity of the lines which can be related to the oxidation state of Ti when precise O/Ti atomic ratios are available as those obtained by RBS analysis. Besides, it was useful in studying the effect on titanium oxidation state of some deposition process parameters such as the oxygen concentration in the sputtering gas mixture and the self-bias voltage built on the cathode. The effect of Nb on the oxidation state of titanium in Nb-doped titania films was investigated.

Keywords
Auger electron spectroscopy
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Oxidation
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