unisantis

XMF 104 X-ray Micro Analyser

Characterization of Titania based Thin Films

Introduction

Titania (TiO2)-based thin films are widely investigated in several areas of material science because of their appealing functional properties. In addition to interests in photo-catalysis and optical applications, a renewed attention has been recently devoted to the integration of titania thin films in gas sensing devices.

Micro-XRF measurements have been carried out in this study in order to get more insight into the actual chemical composition of the sample as a function of annealing treatments.

Application Note: 501

In cooperation with Chem4tech – University of Brescia (ITALY)

Application Background

The conductivity of titanium dioxide can be improved by the addition of dopants, such as Cr or V, that offer the possibility to tune the electrical response of the sensor devices. Recently, a novel technique based on the film deposition starting from a target addicted with a controlled amount of dopant insets has been developed. It is now essential to understand how this approach to deposition influences the structure and the microstructure of the materials and, as a consequence, the functional properties of the devices. Due to the novelty of the synthesis applied to vanadium and titanium oxides, it is important to identify the composition that is produced and the stability of the film as a function of different thermal cycles.

In this study, Micro-XRF measurements have been carried out in order to get more insight into the actual chemical composition of the sample as a function of annealing treatments.

Instrumentation

Measurements were performed using Unisantis XMF-104 X-Ray Micro Analyser , equipped with a 50 W Molybdenum tube and a high resolution two–stage Peltier cooled, compact Si-PIN detector.

This reduces the dimensions of the instrument significantly and also eliminates the need for cooling of the detector with liquid nitrogen.

The XMF uses a Polycapillary focusing lens which provides the analyst an intensely focused x-ray beam of very small diameter. Typically the focal spot of the lens is 80 microns.

Measurement Conditions

Three different series of V–Ti oxides have been synthesized by using 4, 6 and 12 insets of vanadium. The relative concentration of Ti and V have been investigated using Unisantis XMF-104 under the following conditions:.

kV	μA	Measurement time	Medium	Filter	Element
45	1	300 sec	Air	None	Ti and V

Results

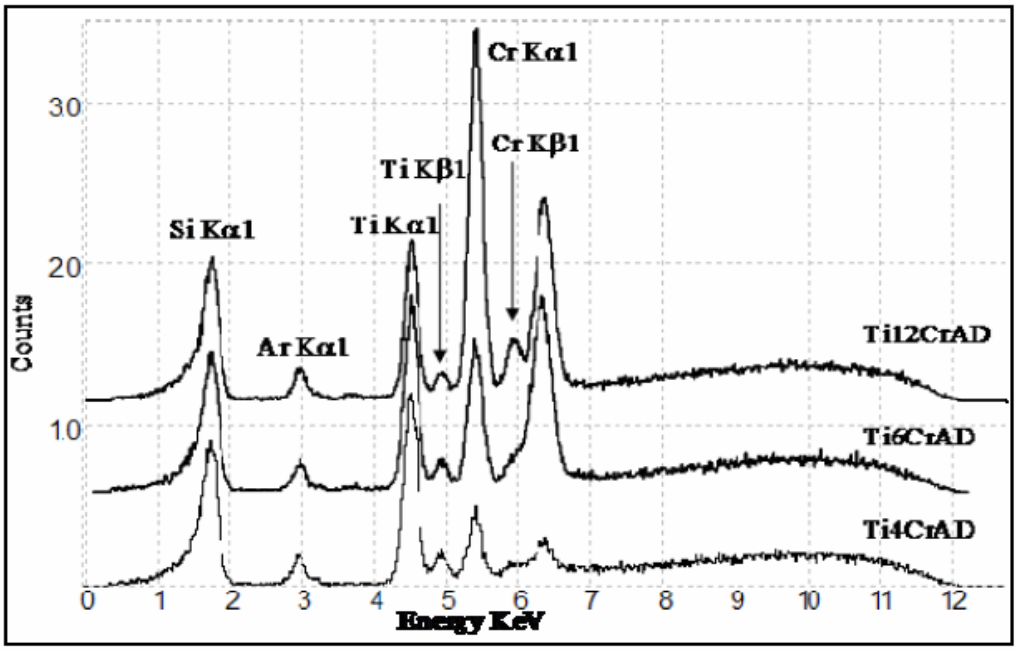

Fig 1. XRF Spectrum of Titania based thin films

Three different series of V–Ti oxides have been synthesized by using 4, 6 and 12 insets of vanadium. The relative concentration of Ti and V were investigated using Unisantis XMF-104 X-ray Micro Analyser. The EDXRF spectrum thus obtained is given in Fig.1.

The V/Ti atomic ratio of the samples treated at 300 °C was found to be about 0.18, 0.25 and 0.82 for sample Ti4V300, Ti6V300 and Ti12V300, respectively.

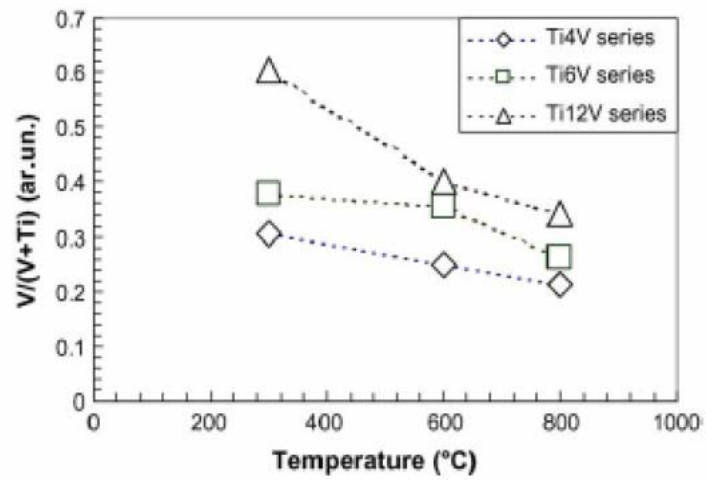

Fig. 2 shows the plot of the V/(Ti+V) K 1 intensity ratio as a function of the thermal treatments. This ratio was determined from the average of the intensity values collected at different points of each sample, and it can be considered as truly representative of the film composition.

Discussion

It can be observed that there is a general decrease of the V content as the temperature increases. Such a behavior is more significant in the case of the sample with higher vanadium content (Ti12V). The vanadium content trends towards similar values after the oxidation at 800°C.

Conclusion

A good correspondence between nominal and actual content of the chemical species has been verified through micro XRF characterization of Titania deposited samples.

The above study amply describes the utility of Unisantis XMF-104 X-Ray Microanalyser (equipped with Kumakhov's polycapillary focusing optics) for such precise studies on coated thin films.

Other unique advantages of Unisantis XMF-104 are:

- No counter gas
- No external water cooling for x-ray tube
- Small footprint
- Low power tube
- Optimized beam path using high performance polycapillary optics

Reference:

The above study was carried out at Chem4Tech, University of Brescia, Italy under the guidance of Dr. L. Depero and her research team.

Unisantis S.A. is a global leader in the development and manufacture of innovative X-Ray analytical instrumentation, complete solutions and software for structure and elemental analysis using proprietary Kumakhov's optics best known for accurate beam collimation. Success in research has enabled Unisantis S.A. to develop new cutting -edge X-ray technology, applications and products for the market. Our products have particular applications in ma-

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