IONIZATION CHAMBER BASED ON RF SPUTTERED ITO THIN FILMS

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The present work presents a new type ionization chambers for x-ray dose meters, based on indium-tin oxide (ITO) thin films. ITO attract our attention as promising material with various applications, here in our study as a transparent conducting coating, but also for transparent conductive electrodes in displays, solar cells and many other applications, where transparent electrodes are needed.

The films microstructure has been studied by TEM and SAED using TEM-400, Philips transmission electron microscope. VIS – UV spectrophotometry analysis showed the high visible transmittance of the RF sputtered ITO films. The dependence of voltage signal from the ionization dose has also been studied.

The main goal of the research activities is developing new technological processes leading to low-cost, highly effective optical coatings for application in ionization chambers.

Keywords: ionization chamber, ITO, RF sputtering, thin films

1. INTRODUCTION

The ionization chamber is an ionization-sensing device, required in x-ray medical apparatuses. It is situated between the beam-limiting device and the patient. If the ionization chamber is specified for use with a light beam diaphragm, the transparency of the ionization chamber to visible light shall be such as to transmit at least 70% of the luminous flux.

In the present research, in order to deposit indium-tin oxide (ITO) thin films the method of RF reactive sputtering is used. Sputtering of two types indium-tin targets in presence of oxygen as reactive gas has been made. The technological parameters have been optimized to obtain films with good optical quality on different substrates. The influences of technological conditions, such as the oxygen partial pressure and deposition time, on the ITO structure and properties, have been studied. The films are deposited on highly transparent plastic substrates. Their microstructure is studied by TEM and SAED. Some their optical and electrical parameters have also been measured in order to be proved the initial conditions for ionization chamber. The dependence of voltage signal from the ionization dose has also been studied.

2. EXPERIMENTAL PART

The film deposition was carried out using vacuum installation A-400VL. The main parameters of the RF reactive sputtering were precisely tuned to get films with optimum properties. The thickness was controlled by the RF power (cathode voltage) and the deposition time. The oxide structure was controlled by the oxygen partial pressure. To obtain stoichiometric ITO films were used values of the oxygen partial pressure more than 1.10-3 Pa. This means that the ITO films are formed in excess of oxygen in the chamber. The films were deposited on unheated substrates. The structure was modified by consequent thermal treatment at temperatures 250-300ºC.

The microstructure of the ITO thin films was studied by transmission electron microscopy (TEM) in coupled with selected area electron diffraction (SAED) using TEM-400, Philips transmission electron microscope. The substrates for RF sputtering deposition of as-deposited thin film samples for direct TEM observations were fresh fractured surfaces of NaCl crystals.

3. RESULTS AND DISCUSSION

As it is seen in Fig.1a the TEM micrographs and SAED patterns show the initial amorphous structure of the investigated layer.

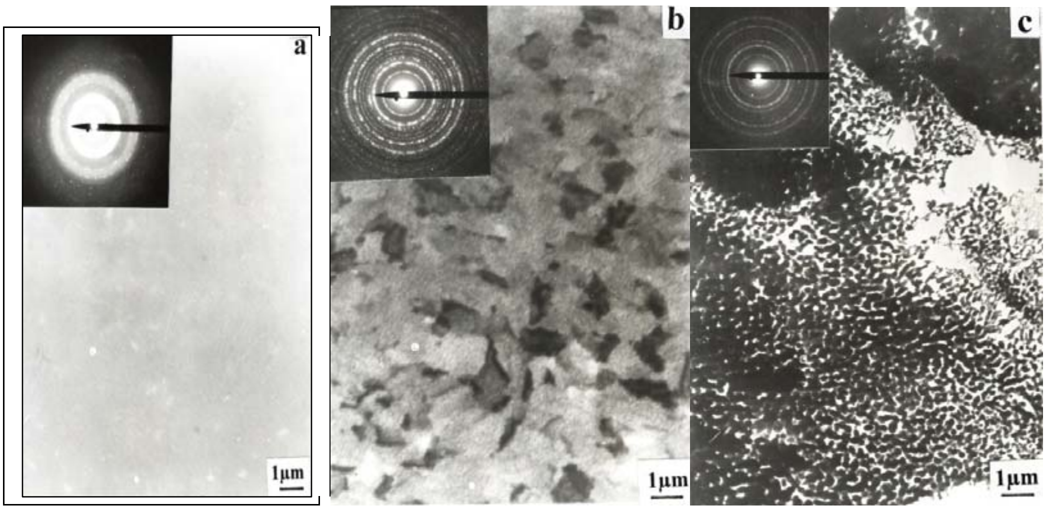

Fig. 1. TEM micrographs and SAED patterns of thin ITO films:
a) amorphous structure before *"in situ"* electron beam heating;
b) separated nano- and microcrystals obtained after the first steps of *"in situ"* electron beam heating;
c) polycrystalline structure due to longer *"in situ"* electron beam heating of the film.

After *"in situ"* heat treatment of the films by electron beam in the microscope, were the temperature arises up to 270 – 300^{o} C, structural evolution was observed and the formation of separated nano- and microcrystals (Fig. 1b) is followed by the appearance of polycrystalline structure (Fig. 1c).

On fig. 2 is shown the transparency in visible range of ITO thin films with thickness 500nm. As for quality ionization chamber is needed 70% transparency, so these films are suitable to be used for ionization chamber manufacturing.

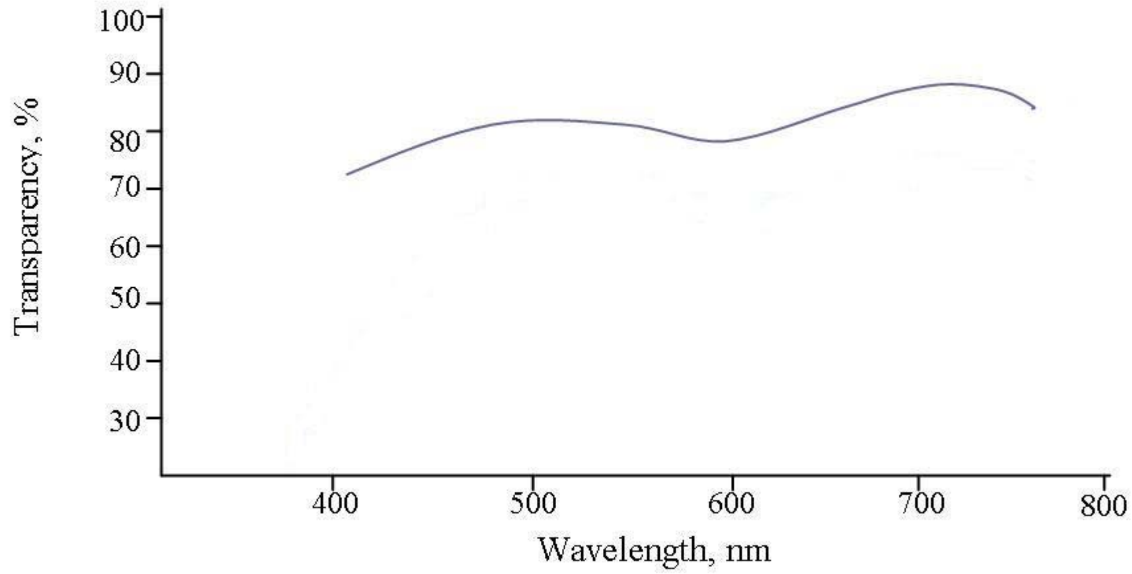

Fig. 2 Curve of transparency in visible spectra of layers with thickness 500nm

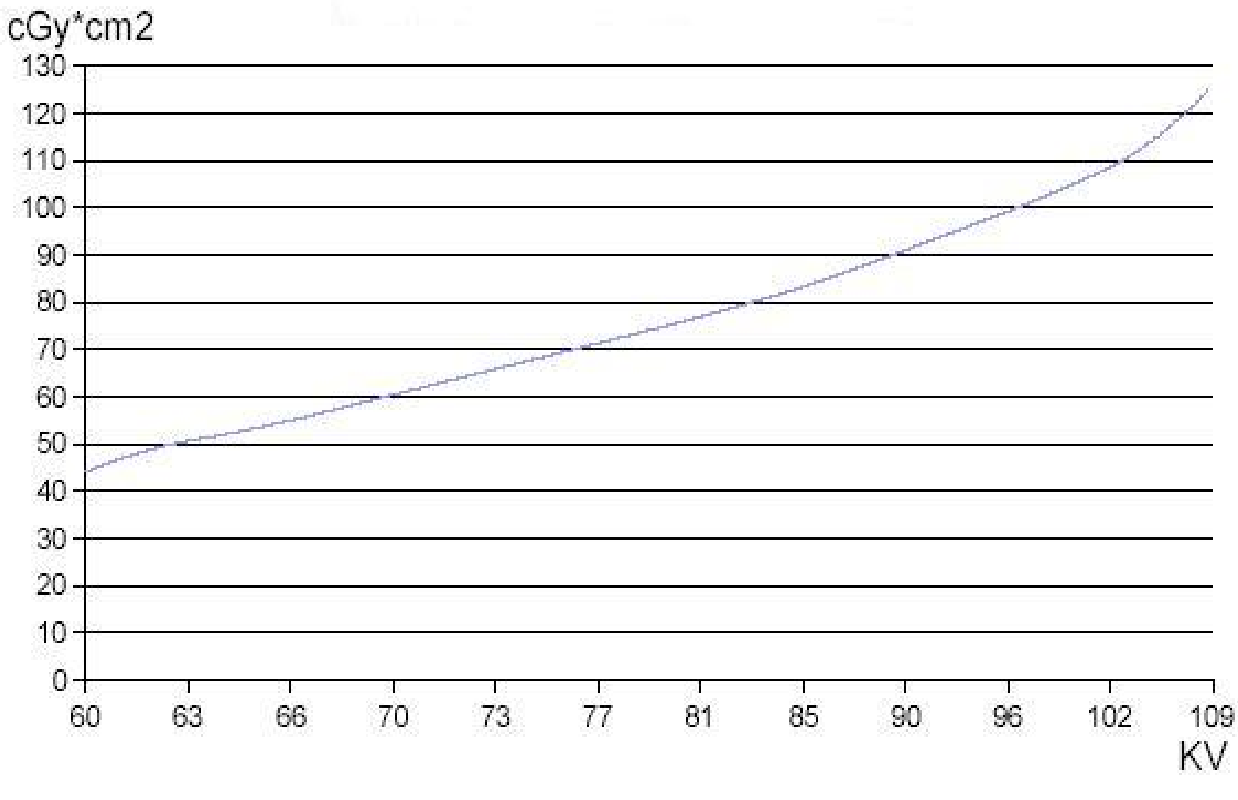

Fig. 3 Dose/voltage dependence

The dependence of voltage signal from the ionization dose is shown on fig. 3. The curve is close to linear, which is convenient for measurement and additional information processing.

On fig. 4 is presented a finished state ionization chamber.

Fig. 4 Ionization chamber

4. CONCLUSION

The reactive sputtering method is found to be suitable for deposition of ITO thin films with high initial optical transmittance. The process applied does not require heating of the substrate. All the films deposited on plastic substrates are highly transparent. The net transmittance is more than 70%, so these films are suitable to be used for ionization chamber manufacturing. The TEM studies show that ITO films RF – sputtered at high oxygen content have amorphous structure with some degree of crystallization. The dose/voltage dependence is close to linear, which is good enough for additional information processing. The follow-up of the research activities is developing new technological processes leading to low-cost, highly effective optical coatings for application in ionization chambers.

5. REFERENCES

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