SICINTILLATION DETECTOR IN ENVIRONMENTAL SEM

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ABSTRACT

This article deals with using of scintillation detector in the conditions of environmental scanning electron microscope. It is shown a new way of use of scintillation detector and the very first experience with this type of detector. At the end of the article there is a discussion about possibilities of optimization of the detector.

1 INTRODUCTION

The ability to create high quality secondary electron images in elevated pressure conditions of an environmental scanning electron microscope (ESEM) could be very useful for many scientitific branches such as medicine, biology or material engineering. Newertheles, the creation of these images is a nontrivial process.

There exist two major ways of secondary electrons detection. The first way consist in using of ionization secondary electron detector (ID). The scintillation detector seems to be another way for the secondary electron detection in the ESEM.

2 PRINCIPLE

Scintillation detector is generally known as the Everhart – Thornley detector [2]. Secondary electrons generated by primary electrons are collected by a grid biased at a voltage of 10 - 200 V. However, collected secondary electrons are not only those generated at the specimen surface but also those created by backscattered electrons on the polepiece and other parts of the specimen chamber.

Secondary electrons are not collected when the bias of the collector grid is negative according to the specimen. The secondary electrons that pass through the collector grid are accelerated to the scintilator with a voltage of about several kV. This voltage is applied to the metallized surface of the scintillator.

This principle is useful for conditions of conventional SEM which operates at vacuum of about 10^{-2} Pa in the specimen chamber. But in the conditions of environmental SEM it is not possible to use voltage of several kV for secondary electrons acceleration because of the gas discharge. This voltage is necessary for secondary electrons acceleration and gives them

sufficient energy for efficient scintillation. We try to find a new method for the usage of the scintillation detector in the ESEM. This possibility is based on the localization of the scintillator in a room with low pressure. This room is separated from the sample chamber by the system of pressure-limiting apertures which work also as the electron lens for secondary electrons. Fig. 1 and 2 show the electron lens principle. Trajectories of secondary electrons of 2 eV energy, accelerated by potential of 50 V and focused by the electron lens into the room of the scintillator are pictured in Fig. 1. The same trajectories of secondary electrons of 5 eV energy are pictured in Fig. 2. Trajectories of secondary electrons in electrostatic fields were simulated by Simion 3D Ver. 7.0 program.

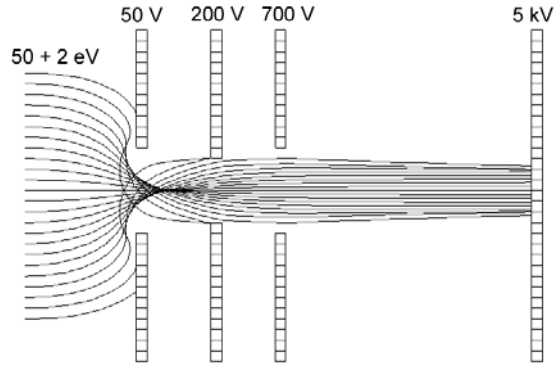


Fig. 1: *Trajectories of accelerated secondary electrons of 2 eV energy focused into the room of scintillator.*

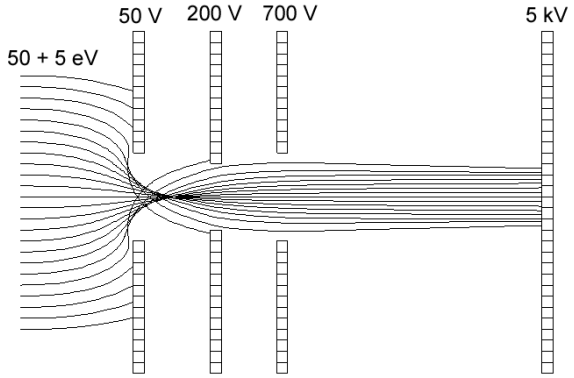


Fig. 2: *Trajectories of accelerated secondary electrons of 5 eV energy focused into the room of scintillator.*

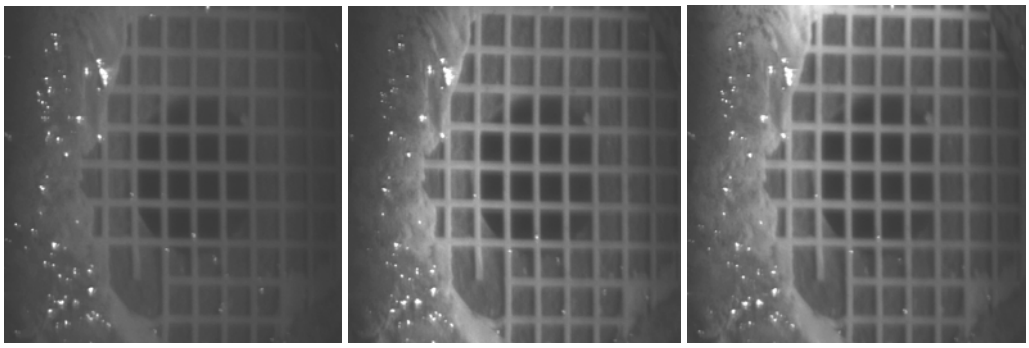
The room with the scintillator is pumped by a turbomolecular pump, pressure in this room is approximately 10^0 Pa. The space between the electrodes of the electron lens is pumped by a rotary pump.

Secondary electrons that pass through the electron lens into the room with the scintillator are accelerated by a positive voltage of 5 kV and obtain enough energy for efficient scintillation.

3 THE FIRST RESULTS OF NEW DETECTOR

The first experiment was arranged in the conditions of the conventional SEM. The possibility of secondary electrons detection when they passed the electrostatic lens was confirmed. The influence of the voltage of the extraction grid on the image quality was verified as well. The first positive results of the effort are shown in the Fig. 3 a 4.

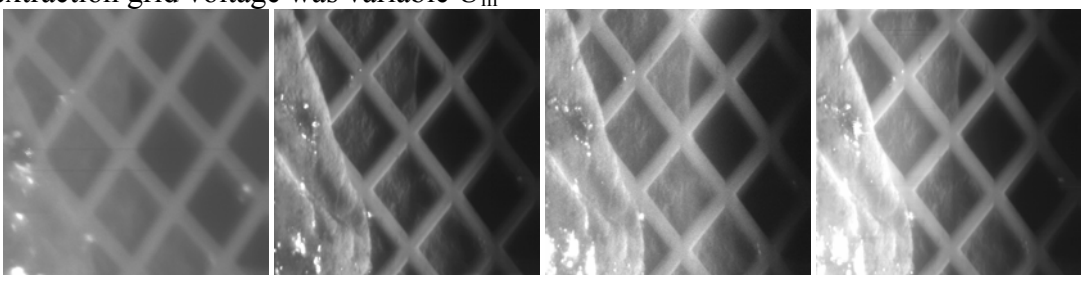
On Fig. 3. the accelerating voltage of primary beam was 15kV, magnification 500x and extraction grid voltage was variable, U_m



$U_m = 20V$ $U_m = 90V$ $U_m = 120V$

Fig. 3: *The influence of extraction grid voltage on the final image quality*

On Fig. 4. the accelerating voltage of primary beam was 15kV, magnification 1000x and extraction grid voltage was variable U_m



$U_m = 10V$ $U_m = 50V$ $U_m = 80V$ $U_m = 130V$

Fig. 4: *The influence of extraction grid voltage on the final image quality*

4 CONCLUSION

Previous experiment confirmed the possibility of secondary electron detection via the scintillation detector in the ESEM. However, there are still many problems with signal electrons lose caused by pressure limiting apertures. This method of detection is new and it is still at the development stage. At present we deal with electrostatic lens modification in order to decrease the signal electrons loss.

5 ACKNOWLEDGEMENT

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