CHARACTERISTICS OF NEW TYPE OF SCITILLATION DETECTOR IN ESEM

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ABSTRACT

This article deals with secondary electrons detection in the ESEM via the entirely new type of scintillation detector. It is shown a way of using scitillation detector in the condition of elevated pressure conditions and there are mentioned several basic characteristics of this new detector as well.

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 perspective 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 [1].

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 shows the electron lens principle. Trajectories of secondary electrons of 5 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 equipotential lines of the detector are shown in fig. 2. Trajectories of secondary electrons in electrostatic fields were simulated by Simion 3D Ver. 7.0 program.

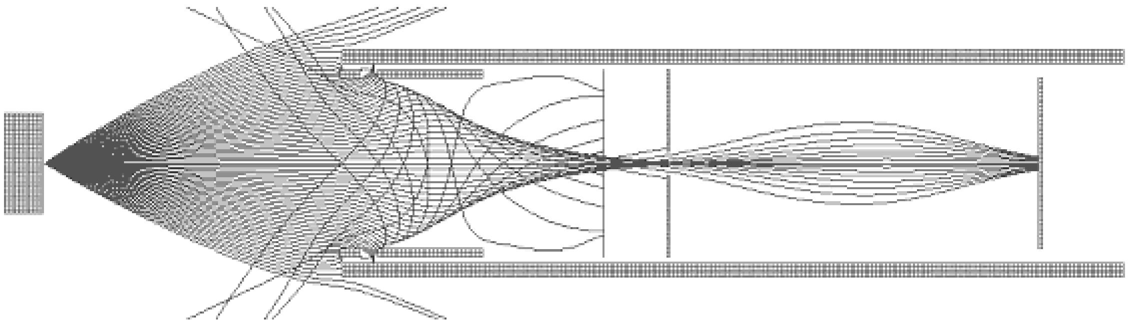

Fig. 1: *Trajectories of accelerated secondary electrons of 5 eV energy focused into the room of scintillator through the system of pressure limiting apertures.*

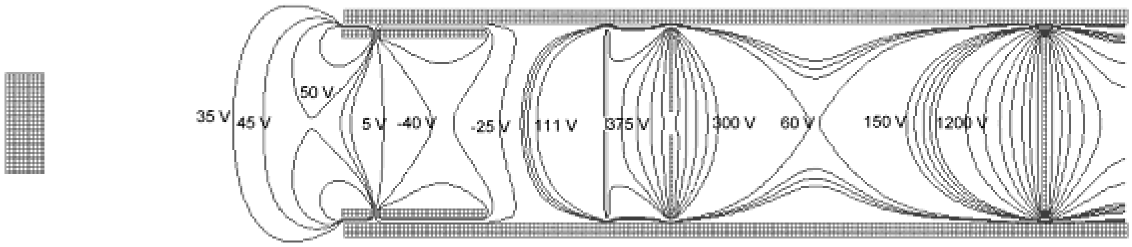

Fig. 2: *The system of equipotential lines of the detector of the prior simulation.*

3 DEPENDECE OF SIGNAL LEVEL ON THE POTENTIAL OF THE APERTURE C1 AND THE PRESSURE IN THE SPECIMEN CHAMBER

The potential of the aperture C1 has the crucial influence on the functionality of entire electrostatic system of the detector. The potential of C1 changes a focal distance of electrostatic lens and that determines the proportion of signal electrons passes the pressure limiting aperture system. At the same time the C1 potential increases the energy of signal electrons attracted by extraction electrode from the specimen surface.

According to the result of the experiment it is convenient to use as higher potential of C1 as possible with respect to the possibility of an electrical discharge in the gas. Also the pressure in the specimen chamber is very important. As you can see in the Fig. 3. the pressure of 500 Pa might be consider as optimal.

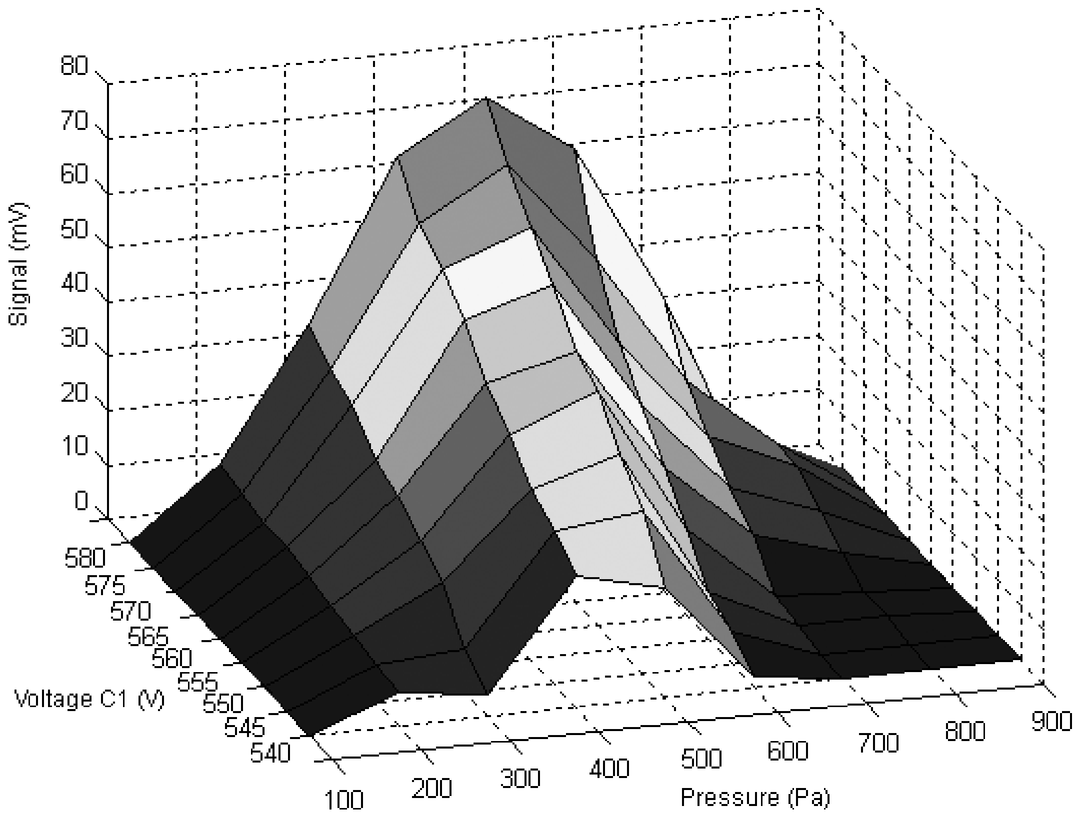

Fig. 3: *Dependencies of the signal level on the variable pressure limiting aperture potential in the range of 540 to 580 V. The pressure in the specimen chamber varies in the range of 300 to 800 Pa. Primary beam = 800 pA, extraction electrode potential = 7 V and the potential of aperture C2 = 750 V, working distance = 3 mm.*

4 CONCLUSION

The possibility of secondary electron detection via the scintillation detector in the ESEM was confirmed by previous experiments, see [4]. 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. We also try to find out all characteristics and dependencies of the detector as was mentioned above.

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