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Detection of Secondary Electrons by Scintillation Detector at VP SEM

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For specimen observation in the scanning electron microscope operating at a higher pressure of gases in the specimen chamber (VP SEM) ionization and scintillation detectors are commonly used. The ionization detector [1] detects a mixture of signals of secondary and backscattered electrons. Detection of predominantly secondary electrons is possible due to a special detector construction [2]. In the ionization detector signal electrons are amplified during the impact ionization process in the electric field with a voltage of several hundred volts created between a grounded specimen and the detector electrode system in the gas environment of the specimen chamber.

Scintillation detectors are routinely used for detection of backscattered electrons in VP SEM. Scintillation detection of secondary electrons requires electron acceleration in an electric field with a voltage of several thousand volts commonly connected to a thin conductive layer deposited on the scintillator surface. In this field the secondary electrons acquire sufficient energy to evoke scintillations in the scintillator. To avoid electric discharges at the voltage of several thousand volts the detector scintillator has to be placed in a special room [3, 4] at the pressure of gases of several Pa at the most at pressures of hundreds of Pa in the specimen chamber of VP SEM.

In the tested scintillation secondary electrons detector according to [5], the detector scintillator is placed in a separately evacuated scintillator room at the pressure of 5 Pa at the most at the pressure of water vapors up to 1000 Pa in the specimen chamber. The pressure decrease is facilitated by usage of two pressure limiting apertures and by a separate vacuum pumping of the room between the apertures as is seen from Fig.1. Voltages up to several hundred volts on electrodes E1, E2 and apertures A1 and A2 create an electrostatic field that allows secondary electrons to pass from the specimen to the scintillator room.

To enhance collection of secondary electrons with this detector especially at lower pressures under 100 Pa in the specimen chamber a grid is newly used at the entry of the detector. The grid is interconnected with the electrode E1, the voltage on this electrode does not exceed 400 V. Distribution of the electric field of the detector with the grid was simulated in the Simion ver. 8 simulation software. In comparison with the version of the electrode system without the grid the electric field protrudes to the observed specimen. The impact of the approach of electric field to the specimen was proved by observation of the PN junction of a power NPN transistor using the voltage contrast method which is patterned with the detection of secondary electrons [6]. Results of PN junction observations by the voltage contrast method at pressures of 20 Pa, 100 Pa and 500 Pa in the specimen chamber are seen on Fig.2.

A modified version of the scintillation secondary electrons detector for VP SEM with the grid at the entry of the detector was verified. Voltage of about 400 V connected to the grid enhances detection of secondary electrons at the pressure range under 100 Pa of water vapors in the specimen chamber.

Further improvement of secondary electrons detection by this detector is expected with usage of novel scintillation material.

References

[1] G.D. Danilatos, *Adv. Electron Phys.*78 (1990) 103.
[2] W.R. Knowles et al., *Microscopy Microanalysis*, 11 (2005) 28.
[3] W. Slówko, *Vacuum, 6*3 (2001) 457.
[4] M. Jacka et al., *Scanning,* 25 (2003) 243.
[5] J. Jirák et al., *Journal of Microscopy,* 239 (2010) 233.
[6] L. Reimer, *Scanning ElectronMicroscopy:Physics of Image Formation and Microanalysis.* Springer Verlag, Berlin, 1998.
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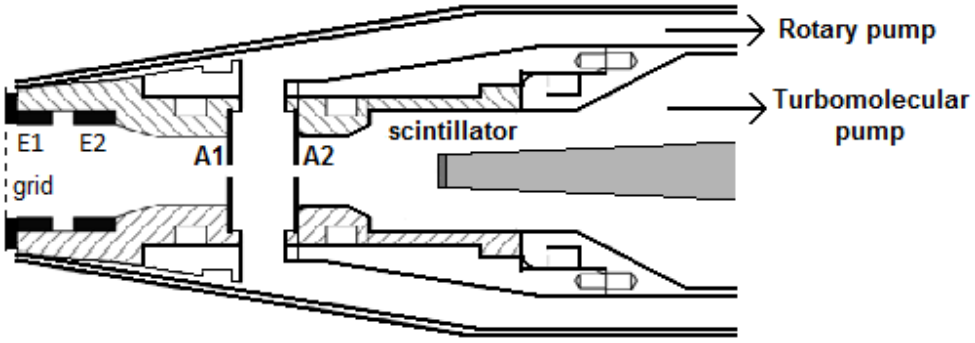

FIG. 1. Schematic drawing of scintillation secondary electron detector for VP SEM.

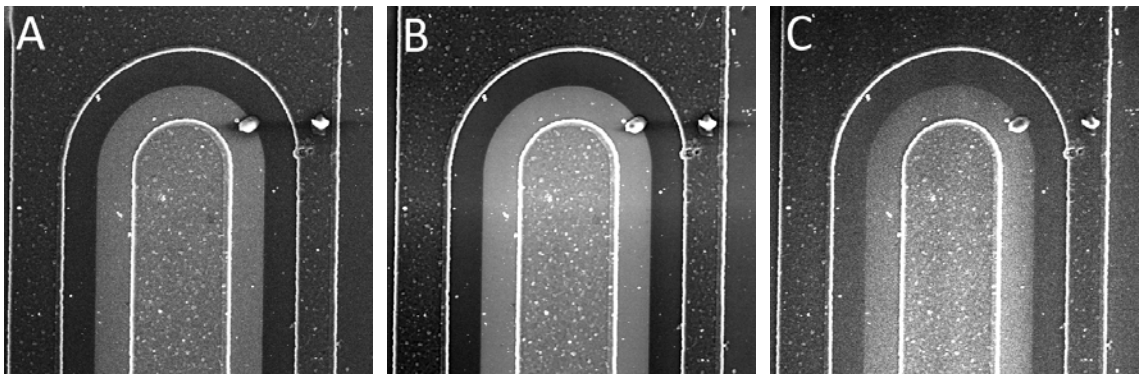

FIG. 2. Voltage contrast on PN junction of power NPN transistor at different pressures of water vapors in specimen chamber: A - 20 Pa, B - 100 Pa, C - 500 Pa. Reversed voltage of 10 V on emitter – base junction.

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