Scintillation secondary electron detector for variable pressure scanning electron microscope

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Detection of signal electrons at a higher pressure in the specimen chamber is commonly based on ionization and scintillation type of detectors. At the ionization detector secondary and backscattered electrons are amplified in the process of impact ionization of these electrons with atoms and molecules of gases in the specimen chamber. Electrons are subsequently detected by an electrode system of the detector. Voltage up to several hundred volts is added to the electrodes of the detector to give to secondary electrons and to electrons produced at ionization collisions sufficient energy needed for ionization of gases [1]. Last versions of this detector utilize also magnetic field and detect preferentially secondary electrons [2].

Scintillation detectors with the scintillator positioned directly in the specimen chamber are capable to detect backscattered electrons only. Detection of secondary electrons by a scintillation detector demands to add voltage up to 10 kV to the scintillator. Because of problems with electric discharges at higher pressures of gases in the specimen chamber the scintillator of the secondary electron detector has to be positioned in a special room with pressure maximally up to several Pa at pressures reaching one thousand Pa in the specimen chamber. Such detectors at which the scintillator is placed in a separately evaporated room were published by Slowko [3] and Jacka at all [4].

Scintillation secondary electron detector submitted in this paper is schematically pictured on Fig.1. This detector is based on a separation of the specimen chamber with pressure of gases up to 1000 Pa from the scintillator room by two pressure limiting apertures C1, C2 with openings of about several hundred micrometers in diameter. The space between the two apertures is evaporated by a rotary pump while the scintillator room is evaporated by a turbomolecular pump. This system of differential pumping ensures the pressure in the scintillator room lower than 3 Pa at the pressure of water vapors in the specimen chamber up to 1 000 Pa.

Voltages of several hundred volts are added to the apertures and so an electrostatic lens is created. Electrode system of the detector consists also from electrodes E1, E2 with voltages of several tens of volts. This system allows to a part of secondary electrons from the specimen chamber to pass through to the scintillator room. Trajectories of secondary electrons in the electrostatic field of the detector were simulated by the program Simion ver.7 for vacuum conditions in the detector. Optimal arrangement of electrodes and voltages on them at higher pressure of gases in the specimen chamber were find experimentally.

At the present state the detector is capable to operate in the pressure range from tens to 1000 Pa in the specimen chamber. Pictures of several samples obtained with this detector are on Fig. 2, 3 and 4.

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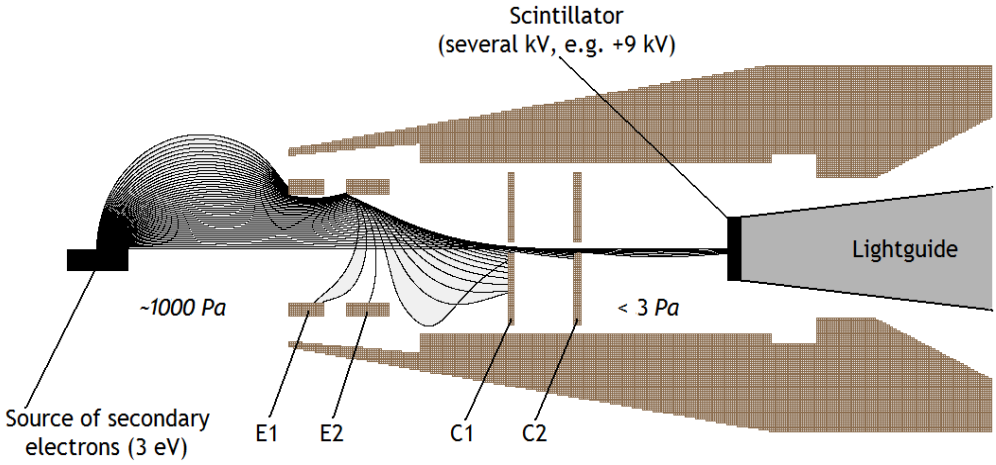

Figure 1. Scintillation secondary electron detector for variable pressure scanning electron microscope

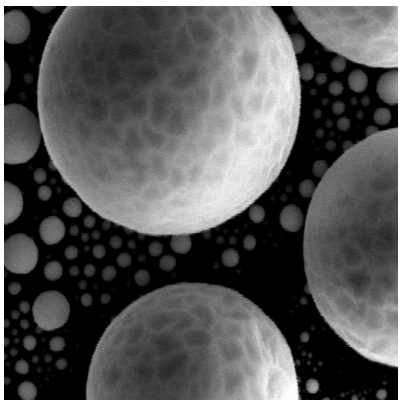

Figure 2. Tin spheres on carbon. Pressure of water vapors 420 Pa, magnification: 13000 x

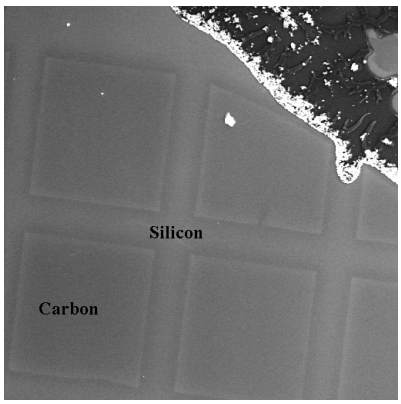

Figure 3. 3nm thick carbon layer on silicon substrate. Pressure of water vapors 150 Pa, magnification: 450 x

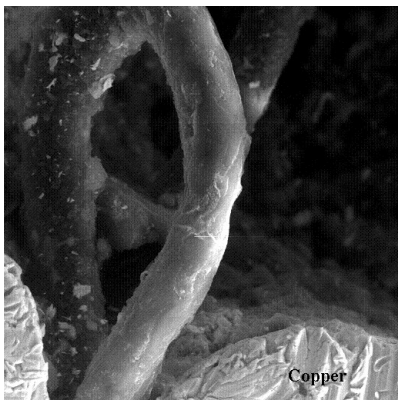

Figure 4. Cellulose fibre with copper. Pressure of water vapors 420 Pa, magnification: 3000 x