COMPARISON OF IMAGING WITH SE IONISATION AND BSE SCINTILLATION DETECTOR IN ESEM

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INTRODUCTION

Environmental scanning electron microscopy (ESEM) or low-vacuum scanning electron microscopy (LV SEM) enables the visualisation of samples in a gaseous environment at the pressure of the specimen chamber from 1 Pa to over 1000 Pa. Detection of signal electrons, namely secondary electrons (SE_S) cannot be realised in a gaseous environment of the specimen chamber in the same way as for the high vacuum SEM, because high voltage of the Everhart-Thornley detector is not compatible with the conductance of the low vacuum environment [1]. For this reason, gaseous ions which are ionised by SE_S from the specimen are used for the detection in ESEM. For the detection of the backscattered electrons (BSE_S), conventional scintillation detector is the best to use.

DETECTORS AND METHODS

The high pressure SEM of the own original construction equipped with the differential chamber and two pressure-limiting apertures located tightly under the pole piece has been used. So called combined detection system of the SE ionisation detector, the BSE scintillation detector and bottom pressure limiting aperture were vacuum tightly fixed on the bottom base of the differential chamber.

The detection system consists of the YAG single crystal scintillator [2], in the shape of a rectangular desk which is connected from the peripheral area to the light guide and PMT. There is a conical hole in the centre of the desk. This hole creates bottom pressure limiting aperture. Two annular electrodes with the different diameters are deposited on the bottom base of the YAG desk. The inner electrode is supplied with a positive voltage and collects ions as a collision result of a gas ionisation with SE_S emitted from the specimen. The outer electrode with the different voltage biased can suppress the influence of BSE_S on the SE image, recorded by the inner electrode. Both electrodes are transmitted for BSE_S having their energy higher than 2 keV. BSE_S are incident on the YAG single crystal, transferred to photons and detected by usual video path. By this way SE images and BSE images can be recorded simultaneously, either by ionisation detector or by scintillation detector.

RESULTS

The performance of both detectors was investigated using a biological specimen (part of a beetle′s head) at which no material contrast has been assumed because of the unique atomic number of specimen material.

The aim of the imaging was to find a pressure value of water vapour at which it is possible to record a useful image with the ionisation or scintillation detector at the

specimen temperature + 2°C. From Fig.1 can be seen that the scintillation detector based on YAG is able to create a useful signal up to the water vapour pressure 900 Pa. Signal of the ionisation detector is very low for pressures up to 200 Pa. The utility of the ionisation detector begins from the pressure approx. of 400 Pa. Accordingly high signal of the scintillation and ionisation detector can be recorded at the pressure of 600 Pa. A strong increase of the ion collisions appears at the pressure higher than 700 Pa. This is accompanied by a high contrast of the SE image, as shown in Fig. 1 for the pressure of 900 Pa.

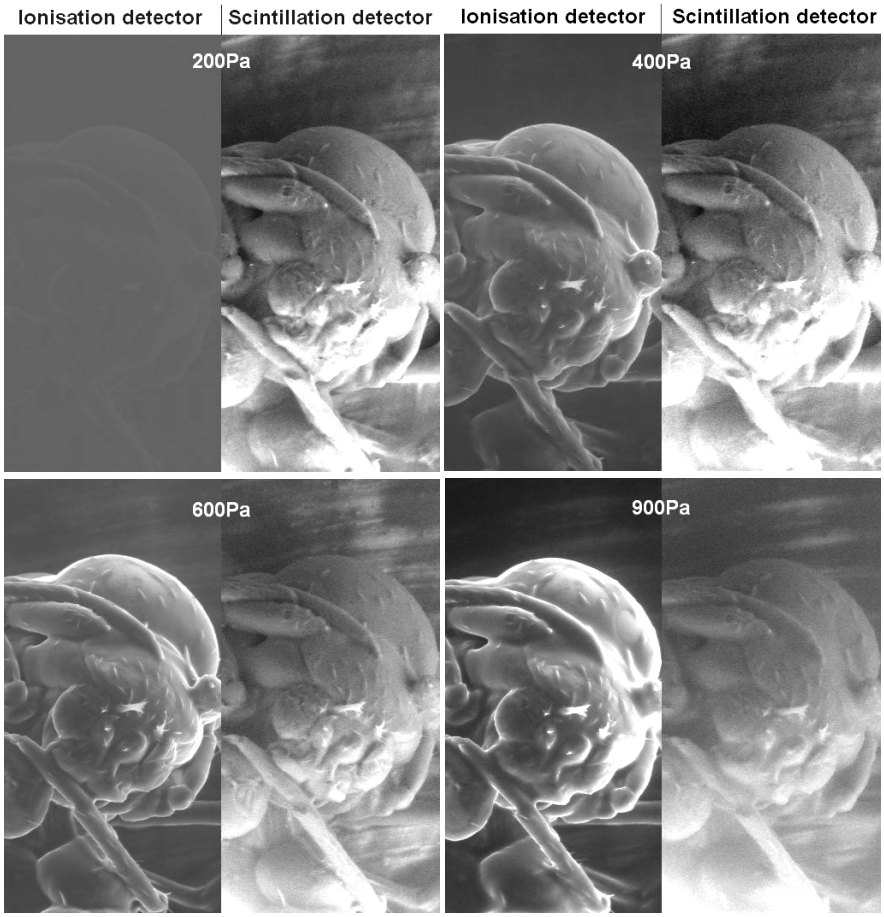

Fig.1 Imaging with ionisation and scintillation detector

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