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IT-4-P-1551 A simple way to obtain BSE image in STEM

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Backscattered electron (BSE) signal has been used to image small objects in a liquid phase. A thin film such as silicon nitride (SiN) film was used to seal the liquid solution, and imaging electron beam was incident through the film, and BSE signals were detected for imaging. Such a technique is usually based on SEM, thus the accelerating voltage available is up to about 30 kV. In this paper, we introduce a simple BSE detector that is easily incorporated into a scanning transmission electron microscope (STEM) sample holder, and present some results for BSE imaging using STEM electron beam up to 200 kV.

Fig. 1 is a schematic representation of our BSE detector. The BSE detector is consisted of p-type silicon (Si) and Schottky contact. A dimple was made from one side, and a through-hole with a diameter of about 200µm was created at the bottom of the dimple. A thin Schottky electrode was made on this side. On the other side, an ohmic electrode was made. TEM grids were used to hold particle objects, and the grid was placed just below the detector. This was conveniently done with a silver paste. Observation experiments were performed using Hitachi H-8000 STEM (accelerating voltage 75 - 200 kV). The beam current was about 1.5 nA.

We used two types of samples. One was latex (Φ90 nm) and Au (Φ60 nm) particles on a carbon film coated grid. The other was Au (Φ60 nm) particles confined between two SiN membrane window grids (fig.2). The Au particles of this sample were in air atmosphere.

Figs. 3(a) and 3(b) are dark-field (DF) STEM and BSE images, respectively, of the latex and Au sample taken at 75 kV. Both latex and Au particles are visible in the BSE image, and they are distinguishable according to their intensity. Au particles appear brighter than latex particle. The detector current at bright Au particles was about 130 nA. On the other hand, for the STEM image, the difference of the intensities is not so noticeable, and it is difficult to distinguish latex and Au particles. Fig. 4 shows a BSE image of Au particles confined between the two SiN membrane window grids, taken at 200 kV. These particles were located on the upper membrane. In spite of the presence of 100 nm thick membrane, we can see each particle clearly, owing to the usage of a high accelerating voltage of 200 kV. The detector current at bright Au particles was about 8 nA. The low current is mostly due to the low backscattering probability as compared with 75 kV. And partially because of the fact that the BSEs at 200 kV are distributed higher angle than at 75 kV.

Our BSE detector was conveniently fixed to the sample grid with a silver paste. But it was able to remove the detector from the sample grid with tweezers. So, the detector was reusable until breakage which may happen by mistake.

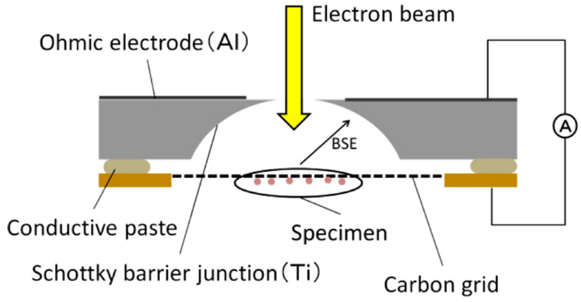

Fig. 1: Schematic representation of the BSE detector.

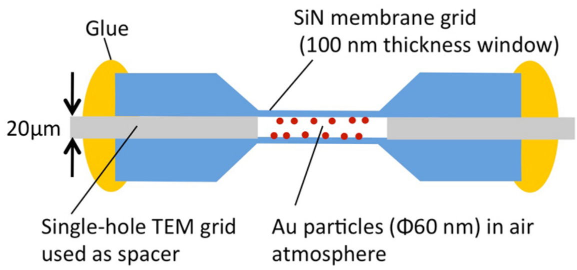

Fig. 2: Au (Φ60 nm) particles were confined between two SiN membrane window grids. Au particles were in air atmosphere. This was fixed to the detector with a silver paste for BSE observation of Au particles.

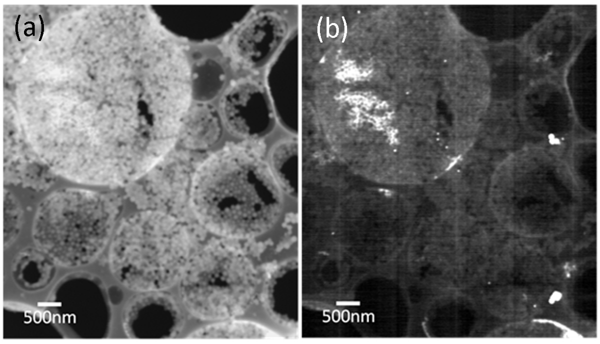

Fig. 3: Latex and Au sample taken at 75 kV. (a) Dark-field (DF) STEM and (b) BSE images, respectively.

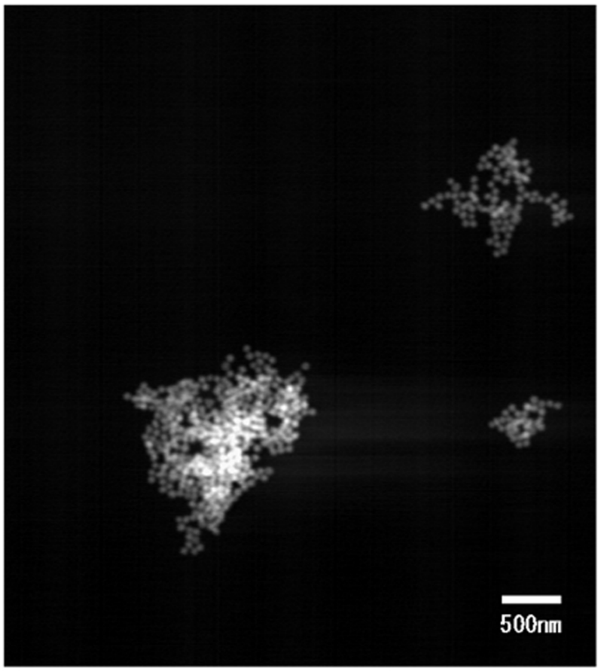

Fig. 4: BSE image of Au particles confined between the two SiN membrane window grids taken at 200 kV.