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Low Energy Secondary Electron Imaging of Nanosheets Using Inverted Fountain Detector

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The low energy secondary electrons (LE-SEs) are sensitive to the surface potential and may be used to characterize the p-n junctions in semiconductor devices. We have developed a low-pass secondary electron detector (LPSED) named "Fountain Detector (FD)". [1] This detector contains a bias grid above and microchannel plate (MCP) below the specimen. Since a negative voltage (-V1) is applied to the bias grid, the low energy electrons below –V1 emitted from the specimen are reflected by this bias grid, go downwards, and detected by MCP. Thus, FD acts as the LPSED. Fig. 1(a) shows the schematic of a FD. The bias grid is sandwiched by ground grids to avoid the deflection of electron trajectories due to the stray field of negative bias. The flat bias grid may be replaced by a parabolic or spherical grid to improve the energy resolution and collection efficiency. [2]

Now, in this work, we are trying to apply this FD for the detection of LE-SEs emitted from nanosheets, such as graphene, Si_3N_4 nanoribbon etc. To detect LE-SEs emitted downwards we designed inverted type FD (InvFD) as shown in Fig. 1(b).

The preliminary experiments have been performed so far and we found that the background electrons still have serious influence on the signals. Nevertheless, we can discuss the rough tendencies of these SEs emitted downwards. Fig. 2(a) shows the schematics of specimen. The graphene lies on the punched Si_3N_4 nanosheet which is supported by the Cu square grid. Fig. 2(b) shows the SE image taken by the Everhart-Thornley (ET) detector. Although the image is very noisy because the SEs pass through the hole of MCP are very few, Cu mesh is brighter than others. The InvFD images are shown in Fig. 2(c) and (d), which are taken with V1 =0 and 50 V, respectively. In both images, graphene is the brightest and Si_3N_4 is the second. No signal has detected from Cu mesh. It is rather difficult to distinguish the difference of these images. The LP-SE signals are calculated by the image subtraction.

In this presentation, the transmitted SE signals are plotted at the several points of graphene and Si_3N_4 against the bias voltage (Fig. 3(a)). Then the signals are differentiated as shown in Fig. 3(b). These curves may roughly represent the energy spectra of transmitted SE signals.
The details will be discussed at the presentation.

References

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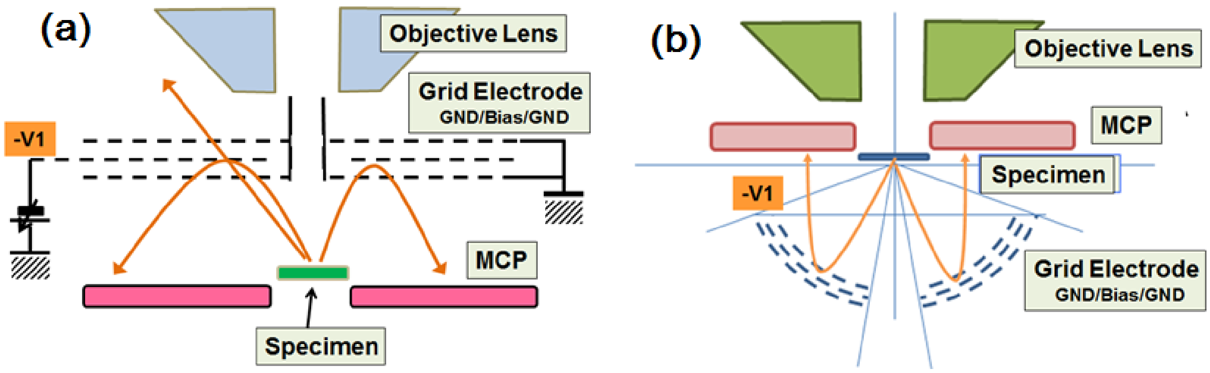

Figure 1. Schematics of (a) Fountain Detector and (b) Inverted Fountain Detector.

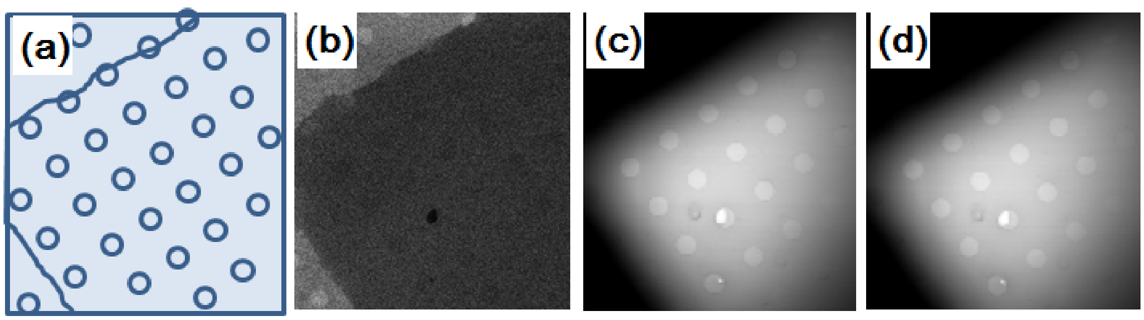

Figure 2. (a) Schematics of the specimen, (b) ET image, and (c,d) InvFD images. [V1 = (c) 0, (d) 50 V]. Accel. Voltage : 3 kV

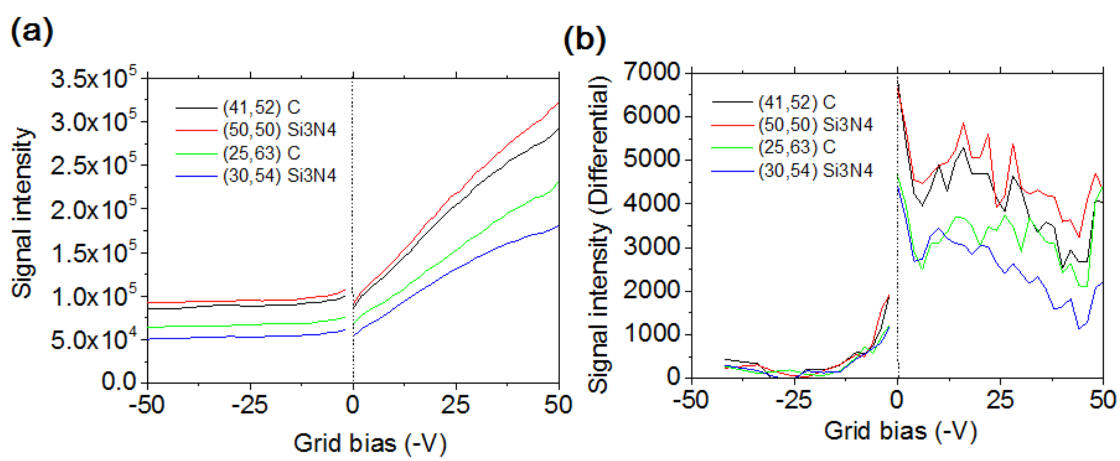

Figure 3. (a) InvFD signals vs bias voltage and (b) their differentiate.

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