A Simulation Study of Proximity Effects in the CD SEM

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Critical dimension scanning electron microscope (CD SEM) is one of the most versatile techniques used for in-line semiconductor devices measurements to monitor and improve yield and process[1]. CD SEM measurements depends on secondary electron (SE) and backscattered electron (BSE) signal intensities to derive edge positions.
Shrinking feature sizes and complex three-dimensional device structures place increasing challenges on CD SEM. As features become smaller, the main problems encountered are measuring dense lines with small confined spaces[2]. The proximity effects induced by neighboring features make an influence on detected signal intensities, and lead to measurement bias. The challenges to correct the proximity effects in the CD SEM are the fact that there are many factors influencing the proximity effects.

In this study, Nebula Monte Carlo electron simulator has been used to investigate proximity effects for varying primary electron beam landing energy, aspect ratio, spot size, top-rounding and bottom corner footing. Figure 1(a) and Figure 1(b) schematically depict the modeled PMMA structure on SiO_2 substrate and SE signal intensities with various electron energies of 500 eV, 800 eV and 1000 eV. Figure 2(a) and Figure 2(b) show the modeled silicon structures with high aspect ratio and BSE signal intensities with different electron energies of 15 KeV, 20 KeV and 25 KeV.

Modeling and simulation results show how proximity effects impact on signal intensities, measurement accuracy and the corresponding sensitivities, which indicates possible methods to compensate the negative effects. More results and details of our study will be presented at the conference.

[1] N. G. Orji *et al.*, *Nat Electron* **1**, 532-547 (2018).
[2] B. Bunday *et al., Proc. SPIE* **9050**, 90500T (2014).

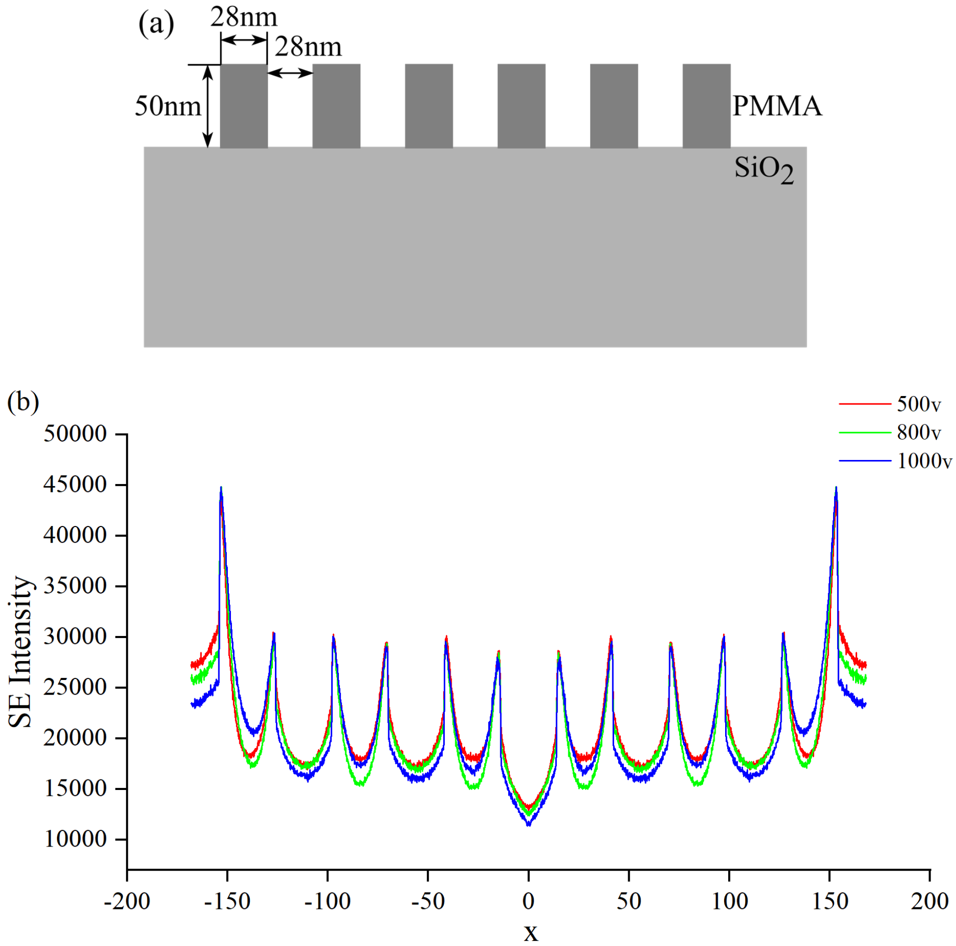

Figure 1: (a) PMMA structure on SiO_2 substrate, (b) SE signal intensities with various electron energies of 500 eV, 800 eV and 1000 eV.

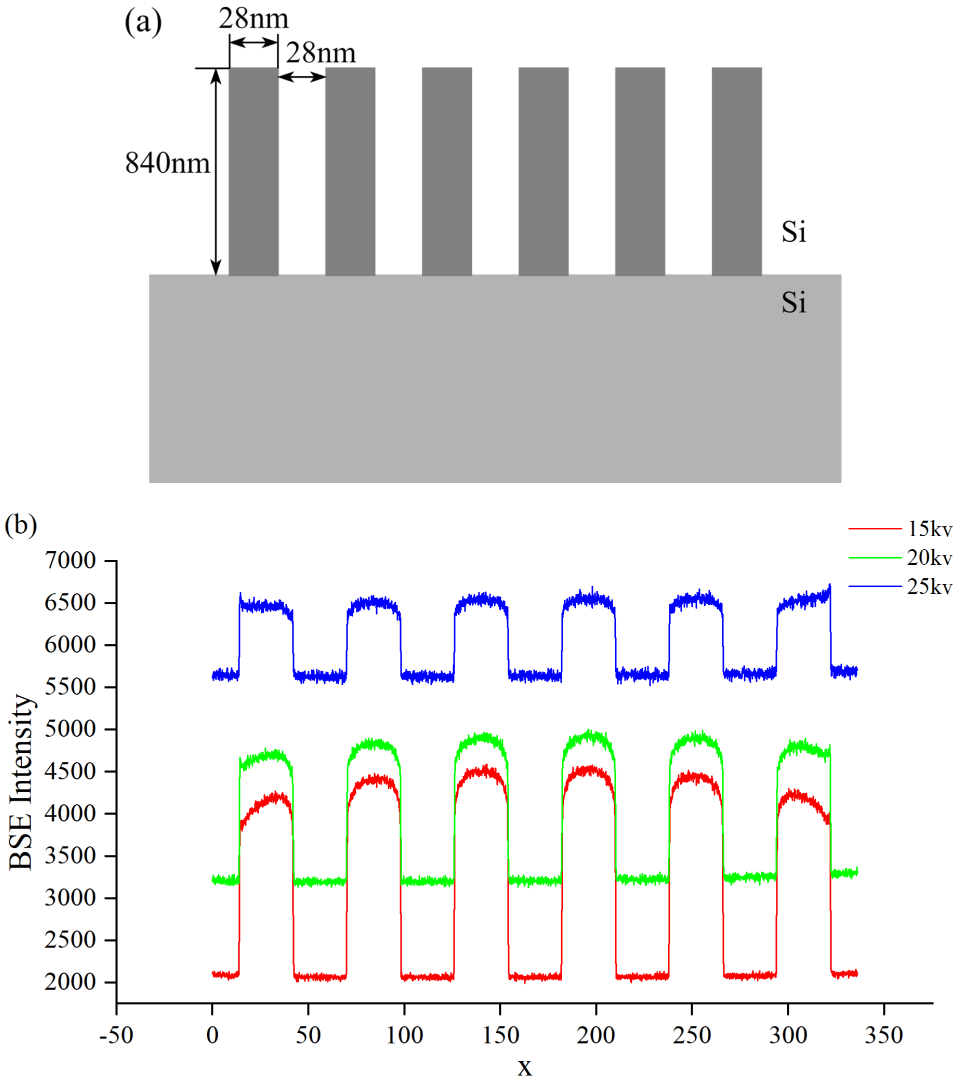

Figure 2: (a) silicon structures with high aspect ratio, (b) BSE signal intensities with different electron energies of 15 KeV, 20 KeV and 25 KeV.