Inspection method for contact/via-holes using a low-energy electron microcolumn

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Further scaling of semiconductor devices is limited by the increasing number of defects in contact- or via-holes, that occur as the aspect ratio increases. Inspection of the bottom of a hole to check for complete clearance becomes problematical for aspect ratios greater than about 5. Such inspection of the contact/via-holes is extremely important as any residue in the hole will result in device failure. At present, contact/via-holes are inspected from the top using an SEM, but, this method is ineffective for holes of diameter <~100nm. Smaller holes should be observed in cross section to ensure clearance; a method that is not suitable for manufacturing.

To resolve the problem, we propose a novel method of inspecting small contact/via-holes using a low voltage Microcolumn, where the specimen current image is very sensitive to residues. Simply by measuring the sample electron current when the beam is place over the hole, the presence of a no residual thin film at the bottom can be detected.

This inspection method is been demonstrated with a patterned SiO_2 on a Si substrate as shown in Figure 1(a), where this image was obtained at an electron energy of 200eV and probe current of 1nA. Figure 2 (a) and 2 (b) are preliminary results for currents measured at the through-holes in the SiO_2/Si sample and clearly show that the SiO_2 layer and the Si substrate may be distinguished.

Additional experiments with sub-micrometer-through holes patterns are in progress using this low energy electron beam column. The inspection method and test results will be discussed in detail.

[1] H. S. Kim, D. W. Kim, Y. C. Kim, S. Ahn, & S. J. Ahn, *J. Korean. Phys. Soc*., submitted.

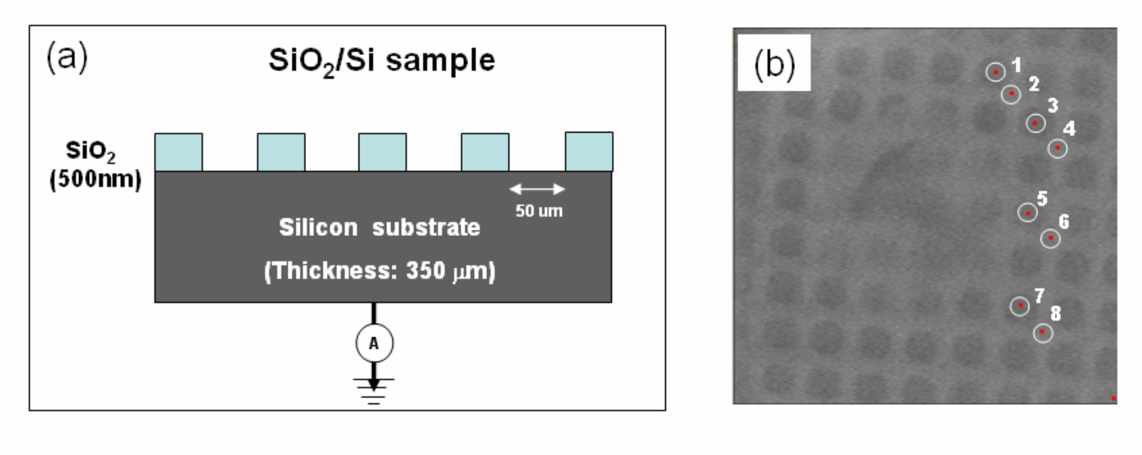

Fig. 1. Cross-section schematic diagram of the SiO_2/Si sample structure, with SiO_2 thickness of 500 nm. (b) Sample current image using the low-energy e-beam Microcolumn of 200 eV.

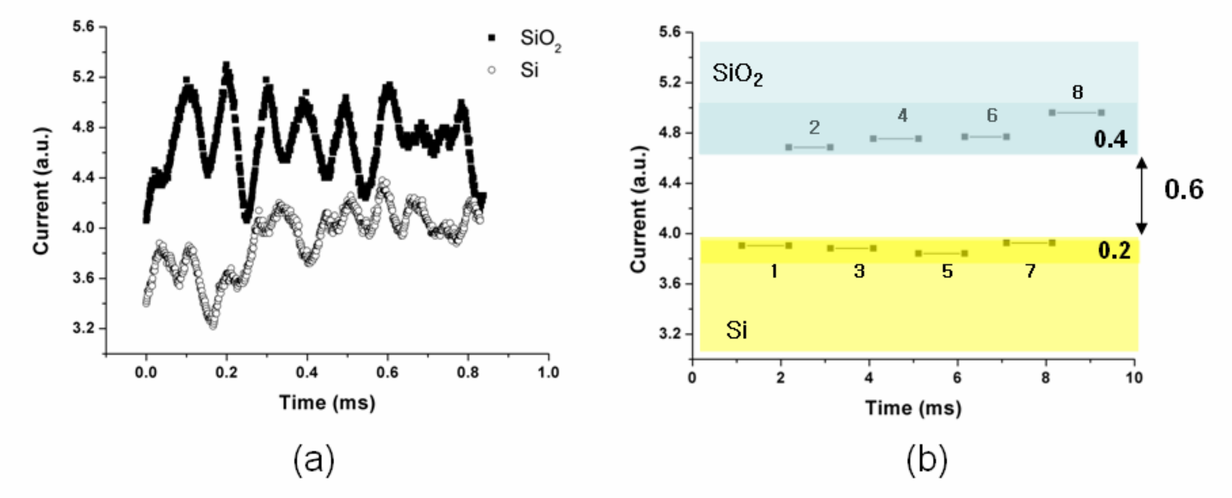

Fig. 2. (a) Time dependent sample current measurement taken from separate SiO_2 and Si areas. (b) The analysis result of data (a) shows an obvious difference between the measured current at the silicon compared to on the SiO_2 layer. Current values averaged over a time interval of 1 ms for the locations specified in Figure 1(b).