PHYSICAL ELECTRONICS

PHI TRIFT I-IV:
ADJUSTABLE HEIGHT SAMPLE HOLDER

INTRODUCTION

The PHI TRIFT series (TRIFT I-IV) analyzer has a superior capability to measure secondary ions with high mass resolution within a large depth of field. However, the back mounting of samples within the currently available sample holders makes it difficult to observe the concave portion of high aspect ratio samples. To solve this problem, a sample holder with an adjustable height capability has been developed. This application note discusses the design and use of this new sample holder.

DESIGN OF THE ADJUSTABLE HEIGHT SAMPLE HOLDER

Figure 1 shows the schematic design of the conventional and the newly designed sample holders. With the conventional sample holder, it is very difficult to align the bottom of a high aspect ratio sample with the optimum front surface of the sample holder. The new sample holder utilizes a set screw underneath the bottom of the inner sample holder that allows the vertical adjustment of the inner sample holder. The focal plane of the optical microscope is then set at the front surface of the outer sample holder. The vertical position of the desired analysis position can then be adjusted to the focal plane of the optical microscope using the set screw. After adjusting the sample height, the inner sample holder is fixed in position with the stop screw.

SILICON WAFER RESULTS

The variation in the ion intensity, mass resolution and TOF-SIMS image were recorded for various sample heights of a small section of a standard silicon wafer mounted on top of the inner sample holder. Figure 2 shows the variation in the (a) intensity and (b) mass resolution of the $^{28}Si^{+}$ ion peak with varying sample heights. The height of the focal plane is defined as *dz*=0 and vertical adjustment further from the TRIFT extraction electrode is reported as a positive *dz*. These results indicate that ion intensity and mass resolution remain constant within the range of -300 to +300 µm and -500 to +100 µm, respectively.

APPLICATION (BALL GRID ARRAY SUBSTRATE)

The newly designed sample holder has been used to characterize the distribution of defects, scratches, stains, and contamination on various kinds of samples. Figures 3 shows the optical microscope (OM) images, TOF-SIMS images and mass spectra obtained from an area in between 500 µm diameter solder balls on a BGA substrate at three different sample heights (*dz*=0, +200 µm and +500 µm). The analysis area was 100 µm x 100 µm. At *dz*=0 µm, micron size defects and scratches on the sample surface are observed in both the OM and TOF-SIMS images (Figure 3(a)).

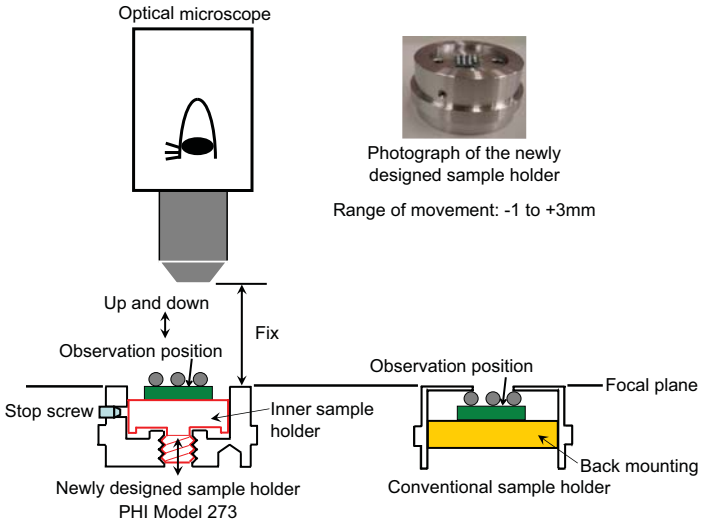

Figure 1: Schematic illustration of a conventional and a newly designed sample holder.

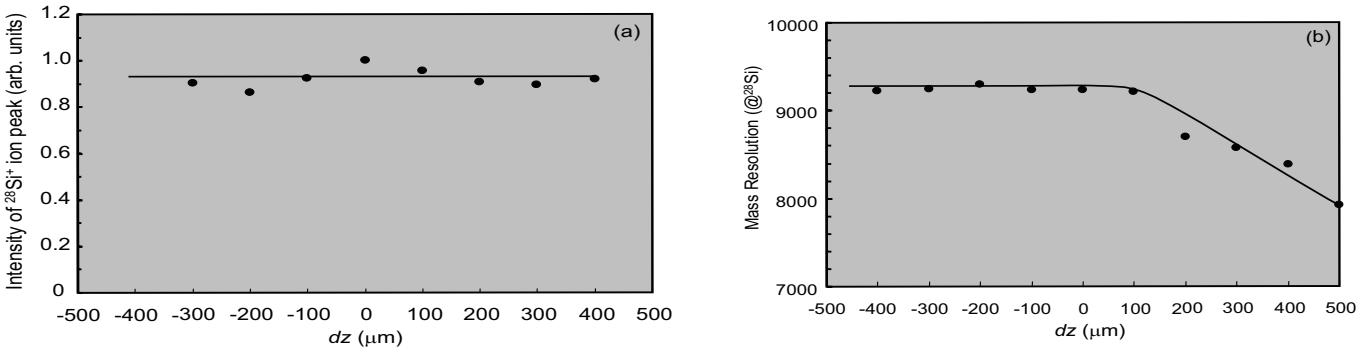

Figure 2: Variation in the (a) intensity and (b) mass resolution of $^{28}Si^+$ ion peak with varying sample heights.

However, at *dz*=+200 μm, the faint, blurry OM image is defocused, although the defects and cracks are clearly observed in TOF-SIMS image (Figure 3(b)). These results indicate that the focal depth of field of the TRIFT system is greater than that of the optical microscope. It should be noted that no change of the peak intensities are observed between the two mass spectra at *dz*=0 and at *dz*=200 μm. Secondary ions are not detected at *dz*=+500 μm, which corresponds to the vertical displacement that would result from mounting the sample in a conventional sample holder. (Figure 3(c)).

SUMMARY

The present data reveals that measurements for many samples with complex shapes can be performed by adjusting the sample height within the range of almost ±100 μm from a best value. It should be noted that the distance between the extraction electrode and focal plane is approximately 2 mm with an extraction potential of 3 kV. Therefore, to measure the concave portion of a high aspect ratio or rough sample, the sample should be aligned so as to not contact the extraction electrode.

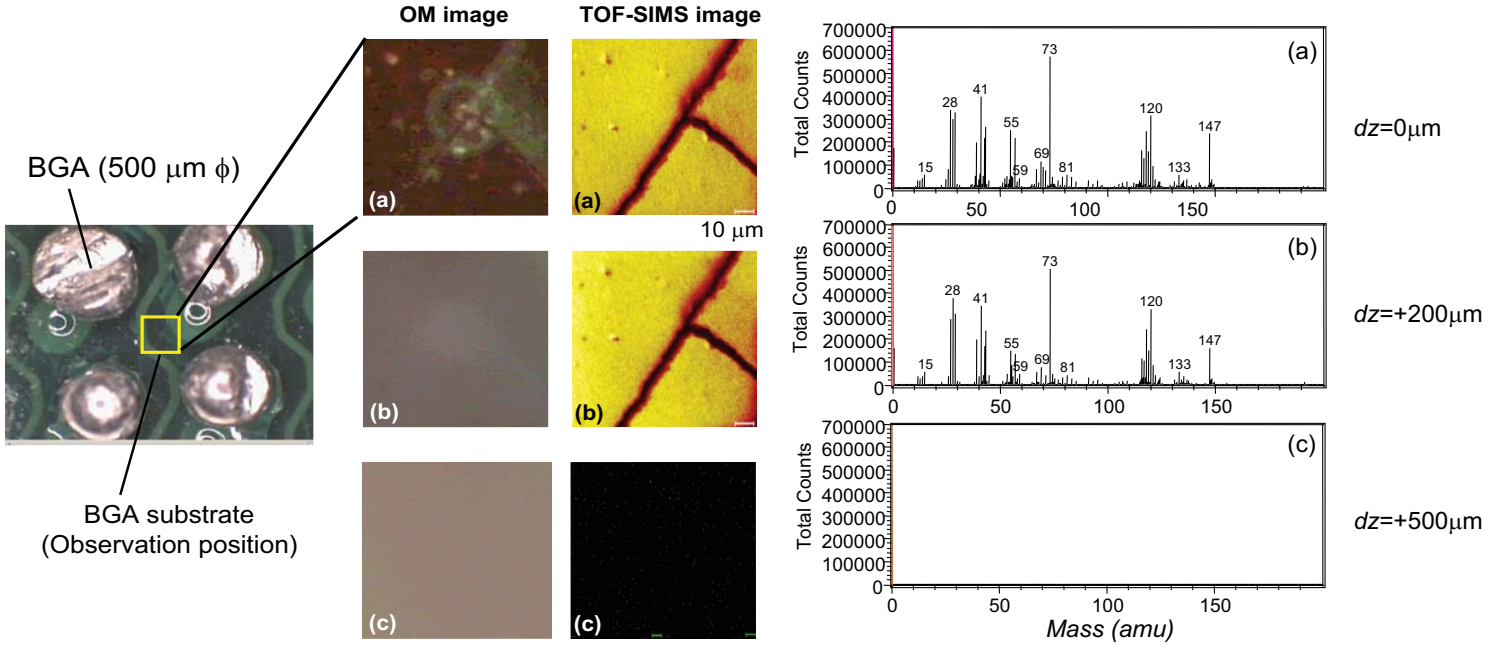

Figure 3: OM image, TOF-SIMS image and mass spectrum obtained from (a) dz=0 μm, (b) dz=+200 μm and (c) dz=+500 μm.

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