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# Spatially nano-meter difference method for improvement in sensitivity of small particle detection - Yudai Ito

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1. Research background and purpose

Small particles on the semiconductor substrate can cause significant yield degradation. Detection of small particles is one of the key problems for the semiconductor manufacturing process. As miniaturization of semiconductor device progressing, the particle problem becomes more serious in general, and we develop new detection techniques that can detect smaller particles, without competition for shortening of light wave length. Light scattering method is widely used for particle detection. Intensity of scattered light from small particles is proportional to the sixth power of particle size. As particle size decreasing, the intensity of scattered light decreases rapidly. Therefore there is demand for highly sensitive technique to detect the weak scattered light signal.

We have proposed spatially nano-meter difference method as a technique to enhance sensitivity of the light scattering method. This technique reduces the noise by differential processing, the detection sensitivity is enhanced and furthermore are applied to the distributed particles on a Si wafer.

2. Spatially nano-meter differential method

Wafer placed on the precision stage was irradiated with laser, where the area image sensor measured scattered light intensity from particles as the usual method likely. Stage was moved again in scales of nanometers, and then scattered light signal was measured repeatedly. The differential brightness at the same pixel of the image sensor has been obtained. These procedures of differential treatment were repeated several times, and integrate the images. This integration process eliminates in-phase noise.

3. Experimental Method and Results

Polystyrene latex particles that size 50 or 100nm were sprayed on a silicon wafer as the sample. The samples were irradiated with Ar laser that have 488nm wave length, and Scattered light intensity was measured by the CCD camera. Sample on the precision stage was moved by 10nm, and scattered light images were obtained each position. In all five scattered light image was obtained. Figure 1 shows the scattered light image from 100nm particle before differential treatment. Figure 2 shows after that. You can see that the background noise is eliminated by the differential treatment. Figure 3 and Figure 4 show experimental result of 50nm polystyrene latex particles. Comparing the before and after differences, the ratio S / N (S: the maximum value of the signal - average value of the noise N: 3σ of the noise) improved nearly doubles from 1.9 to 3.9. The above results show that spatially nano-meter difference method is effective to reduce noise in light scattering method.

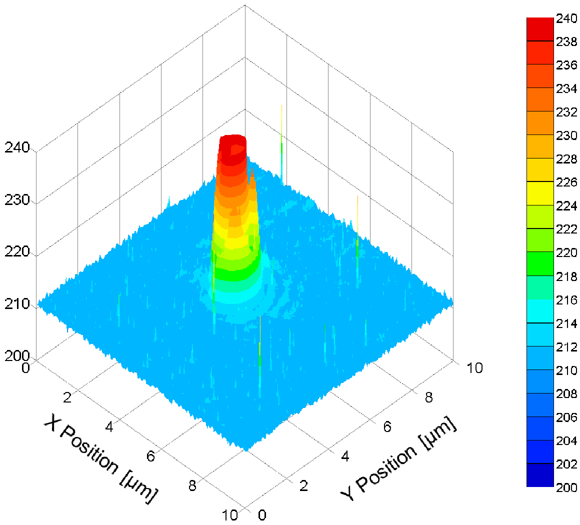



Figure 1 Scattered light image of the 100nm particles (before differential treatment )

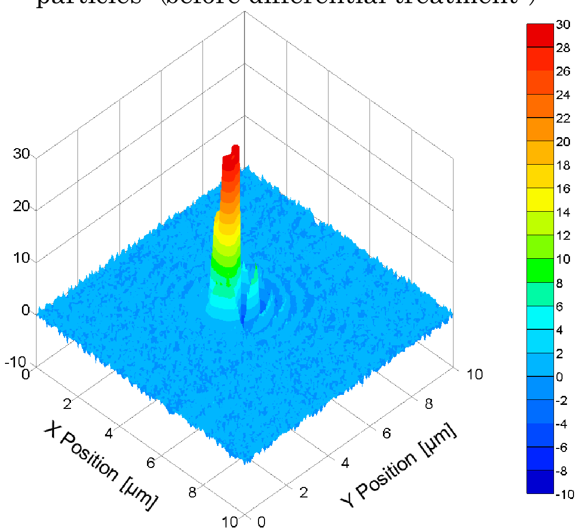
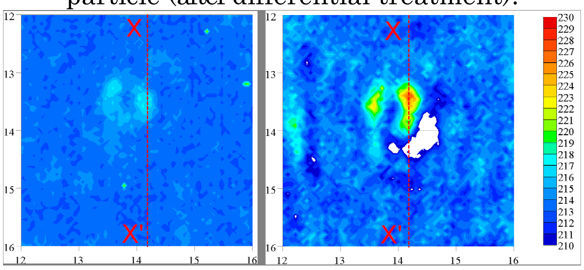



Figure 2, Scattered light image of the 100nm particle (after differential treatment).




(a) (b)

Figure 3, Scattered light image of the 50nm particle ((a): before differential treatment, (b): after differential treatment).

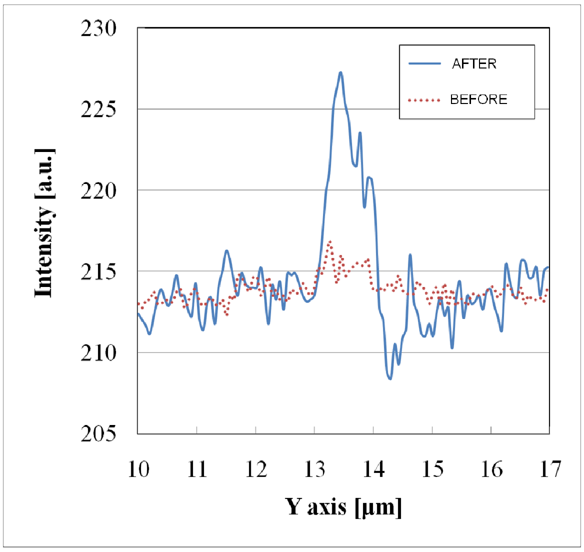



Figure 4, Line Profile of X-X'.