Determination of reasonable control parameters for scanning electronic microscope(SEM) measurement of nano powder

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ABSTRACT

Scanning electron microscopy has become a powerful tool in nanomaterial analysis because of its high resolution. However, it is very difficult to measure the resolution limit due to the influence of the sample and the control constants. [1] In the case of samples with low heat resistance such as biological specimens and nonconductive samples, the acceleration voltage is lowered. [2] The image quality of the scanning electron microscope is increased by increasing the acceleration voltage for specimens with high heat resistance such as metal materials and conductivity [3] Here, a reasonable control constant for improving the image quality in the image measurement of the scanning electron microscope with respect to the nano powder was determined.

1. Apparatus, sample preparation and experimental method

1) Equipment and sample preparation

A Quanta 200 type scanning electron microscope was used as the image measuring device. SCD005 type cathode scattering device and CEA035 type C deposition device were used as sample covering devices. The coating material used Au and C fibers with high purity.

The sample was prepared by applying nano ZnO powder to a conductive band and drying at 100 ° C for 1 hour. The sample was coated with C-Au composite coating method. First, C was deposited to a thickness of 2 nm and Au was dispersed to a thickness of 2.4 nm.

2) Experimental method

Experiments were carried out to investigate the minimum resolution distance of the acquired image according to the control parameters (U) and electron beam diameter (d) of the scanning electron microscope, the distance (W) from the end of the objective lens to the focused point, We proceeded to determine a reasonable control constant with the smallest decomposition distance. The minimum resolution

distance was measured by the "analySIS" program, which is the smallest distance of the lip from the image.
U, d, and W were controlled by the "Microscope control" program.

2. Results and discussion

1) Effect of U and d on the minimum decomposition distance

The effect of d on the minimum decomposition distance of scanning electron microscopic images at accelerating voltages of 20 kV, 25 kV and 30 kV, respectively, at a working distance of 6 mm was investigated and the results are shown in Fig. The experimental point is approximated by a polynomial. The graph of the approximate function is shown by a solid line in the figure.

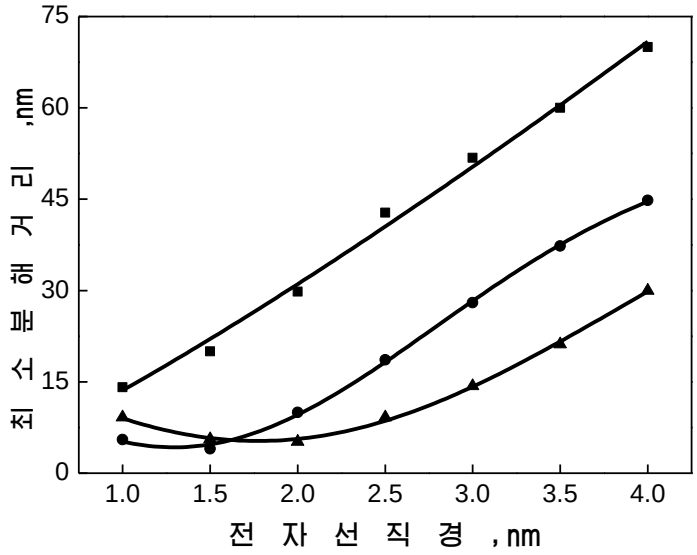

Figure 1. Effect of U and d on the minimum decomposition distance

As shown in the figure, when the acceleration voltage is 20 kV, 25 kV, 30 kV, the larger the electron beam diameter, the smaller the minimum resolution distance is. The minimum decomposition distance at the electron beam diameter of 1.5 nm is the smallest at 4.6 nm when the acceleration voltage is 25 kV. When the acceleration voltage is 30 kV, the minimum decomposition distance at the electron beam diameter of 2 nm is the smallest at 5.7 nm.

It can be seen that the integer value with the smallest minimum decomposition distance in the range of integer values examined in the experiment is an acceleration voltage of 25 kV and an electron beam diameter of 1.5 nm when W is 6 mm. The minimum resolution distance is 4.6 nm.

2) Effect of W on the minimum decomposition distance

The effect of W on the minimum resolution distance of the scanning electron microscope image is considered and the results are shown in Fig. The acceleration

voltage was 25 kV and the electron beam diameter was 1.5 nm. The experimental values are approximated by a third-order polynomial and the graph of the approximate function is shown in solid line in Fig.

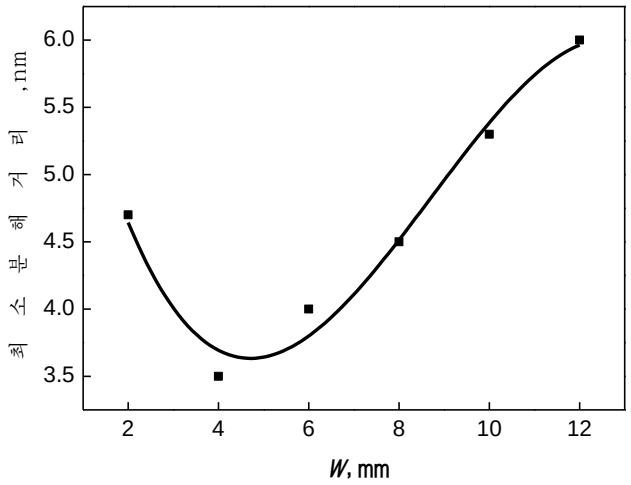

Figure 2. Influence of W on the minimum decomposition distance

As you can see from the figure, it can be seen that the minimum decomposition distance varies with the minimum value according to W. The reasonable control constants of the Quanta200 type scanning electron microscope with the smallest decomposition distance are U = 25kV, d = 1.5nm, W = 3.8mm ~ 4.4mm. The minimum resolution distance is 3.6 nm.

The minimum resolving distance of the image measured with the control constants determined by Nano SiO2 powder, Nano CaO powder, and Nano TiO powder is compared with the minimum resolving distance of the image measured from the standard control constant value. Table 1 shows the results. Standard control constants are U = 30kV, d = 2.5nm, W = 9mm ~ 10mm.

Table 1. Measurement results of minimum decomposition distance of several nano powders

Sample type / division	Nano SiO_2 powder	Nano CaO powder	Nano TiO_2 powder
Standard control integer value	**14.7 nm**	**14.5 nm**	14.5 nm
Improved steering constant value	**3.6 nm**	**3.5 nm**	3.5 nm
Before and after improvement The ratio of the minimum decomposition distance	**4.08**	**4.14**	4.14

As shown in the table, the control constants for enhancing the image quality of the nano powders examined in the experiment were determined to minimize the minimum decomposition distance from 14.5 nm to 14.7 nm to 3.5 nm to 3.6 nm. This is because the control constants for improving the image quality of the Quanta 200 type scanning electron microscope are determined and the image quality is increased four times or more as compared with the previous one.

A conclusion

A reasonable control constant for image quality improvement was determined by scanning electron microscopic image measurement of the nano powder.

For several nano powders, the quality of the image was improved four times or more.

references

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