技術情報 Technical Information

Beam size and X-ray emitting area

X-ray emitting area and electron scattering

The spatial resolution of X-ray imaging in EPMA is approximately 1 um.This results in blurred X-ray images at magnifications over 3000x (Figure 1 b).This is caused mainly by the X-ray emitting area being enlarged by scattering of accelerated electrons within the sample.The X-ray emitting area changes its size due to other factors including beam size, X-ray absorption, and X-ray excitation.

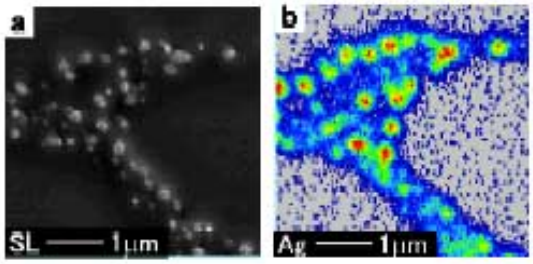

Figure 1 High magnification secondary electron image

(a) Secondary electron image

(b) X-ray imaging

Conditions:

Accelerating voltage 8 kV

Probe current 10 nA

Analytical range 5 μm×5μm

The electron beam is scattered within a sample.

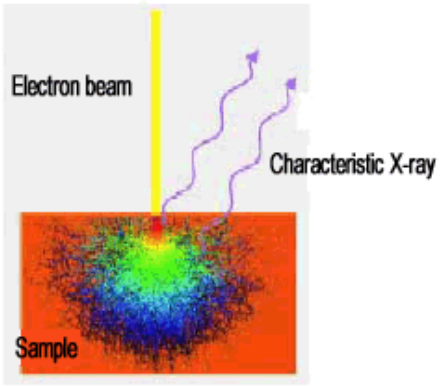

Figure 2 X-ray emitting area and electron scattering

The beam is spread, and so is the X-ray emitting area.

Effect of electron scattering on interface analysis

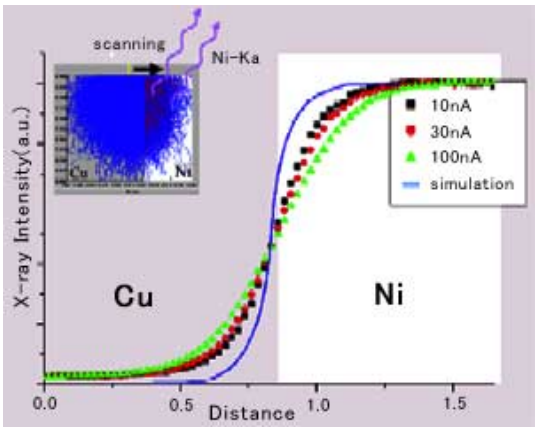

Figure 3 Line analysis of Cu-Ni interface
Ni-K was plotted with 3 different probe current levels, 10 nA, 30 nA, and 100 nA at an accelerating voltage of 15 kV (JXA-8100).The blue line shows the results of Monte Carlo simulation when the beam size is zero.

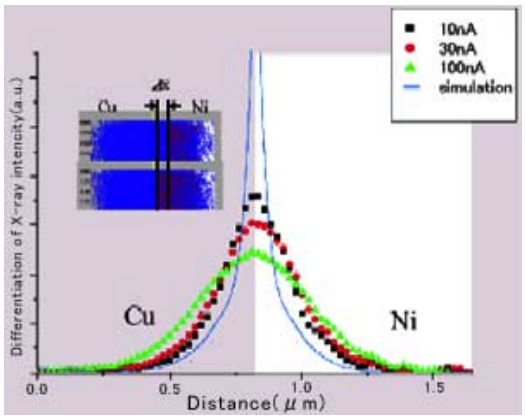

Figure 4 Derivative of line analysis of Cu-Ni interface
The graph in Figure 4 was differentiated by the Zavitzky-Golay method.Differential results correspond to the X-rays emitted at the X-axis of the graph.

The effect of the wider X-ray emitting area will be further intensified when the interface of different metals is analyzed.This was confirmed by line analysis of the Cu-Ni interface.Results of the line analysis and simulation are shown above.

Figure 3 shows the results of Ni-K line analysis by scanning the electron beam over the Ni-Cu interface.Due to the electron scattering within the sample, Ni-X was detected when the beam was projected on the Cu area.
Figure 3 also compares the results at different beam sizes by changing the probe current.As the probe current was increased, so was the beam size as shown in Figure 5.The results of line analysis show a broader resolution when the beam size was enlarged from 10 nA to 30 nA to 100 nA.
The effect of line analysis was also studied through Monte Carlo simulation when the beam size was zero.　Under these conditions, electron scattering within the sample resulted in broad interpretation of the interface.

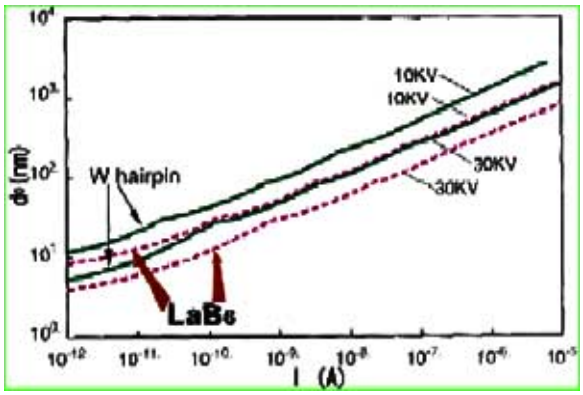

Figure 5 Beam size vs. probe current in JXA-8100/8200
Vertical axis: beam size; horizontal axis: probe current.The higher the probe current, the larger the beam size.