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The benefits associated with a 1 mm Beam Gas Path Length on the accuracy of x-ray analysis in the Variable Pressure SEM

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The scanning electron microscope (SEM) is extensively used to provide imaging and analysis of specimens, in combination with energy dispersive x-ray spectroscopy (EDS), in both high vacuum and variable pressure (low vacuum) modes. Variable pressure SEM is of increasing importance as the technique permits investigation of non conducting and hydrated specimens without coating.

Although specimen charging effects are minimised by introducing gas into the SEM chamber, the scattering of the primary electron beam with the gas molecules result in electron loss from the primary beam. Scattering into the beam skirt is a critical issue that influences both imaging and the microanalysis of non-conductors. The beam skirting effect is well known and the scattering, and other effects, can be reduced by several strategies [1-3]. Lower gas pressures and shorter beam gas path length (BGPL) values decrease the beam skirt. The scattered electrons generate x-rays away from the focussed beam and as the contribution from the electrons in the beam skirt increases, the spatial resolution and accuracy of the EDS analysis is compromised.

An experimental study of the effect of reducing the BGPL to 1 mm (from 2 mm) has been undertaken at a range of pressures (10 Pa to 3000 Pa) and with two gases (nitrogen and water vapour) in an Carl Zeiss EVO® MA15 electron microscope. This SEM was fitted with through the lens pumping and with both 1 mm and 2 mm BeamSleeve®. A 20 keV 1 nA electron bean was employed. The 1 mm BeamSleeve® has been designed so that backscattered electrons, secondary electrons, and x-rays are collected from the specimen, over a field of view of 0.5 mm, without reduction in intensity. The experimental method used the x-ray intensity from a 400 um diameter Mo aperture of 3 mm overall diameter to infer the scattered fraction [1].

Conclusion

The results presented in Figure 1 and Table 1 show that the scattered fraction is proportional to the beam gas path length. The use of water vapour is again shown to be beneficial. These benefits apply across the whole pressure range studied and represent a significant step in improving imaging and analysis in the variable pressure and environmental microscopes.

References

[1] S. Bean, V. Kugler, Microscopy and Microanalysis 2006
[2] S. Bean, V. Kugler, Microscopy and Microanalysis 2007
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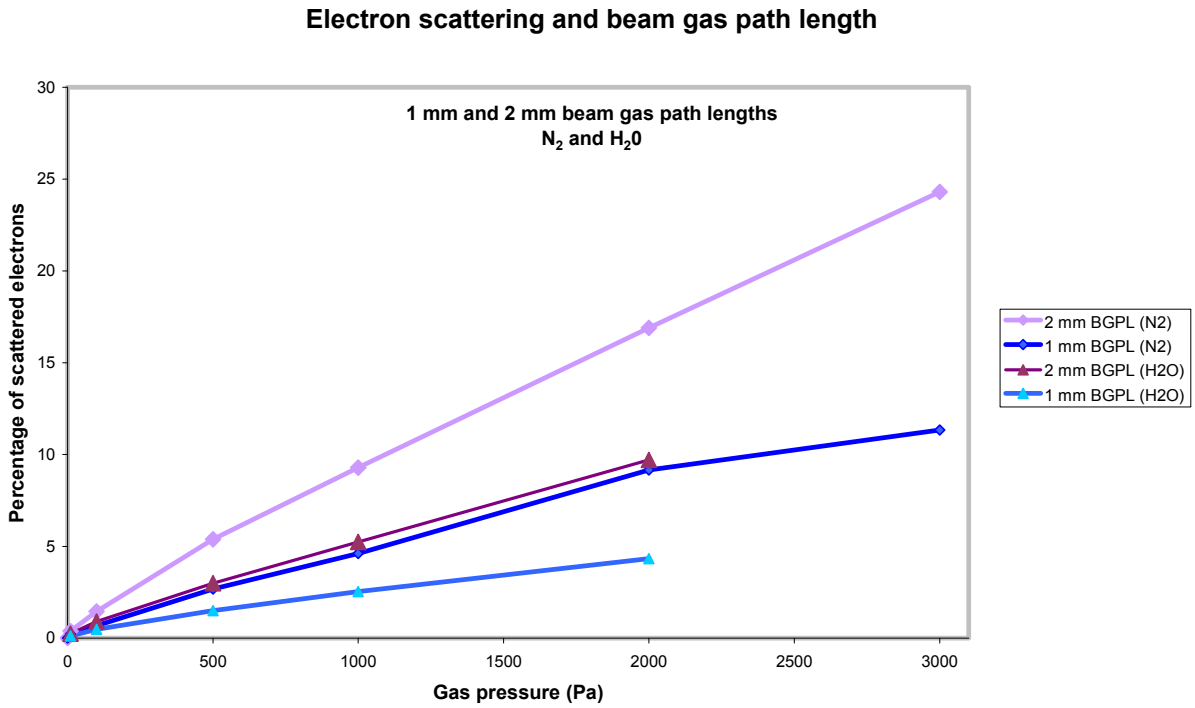

Figure 1. The scattered fraction determined for 20 keV electrons as function of gas pressure and gas type and beam gas path length.

	nitrogen		water vapour	
Pressure (Pa)	1mm BGPL	2 mm BGPL	1mm BGPL	2 mm BGPL
10	0.224	0.388	0.132	0.25
100	0.681	1.46	0.482	0.904
500	2.68	5.38	1.5	2.99
1000	4.62	9.29	2.54	5.24
2000	9.16	16.9	4.34	9.71
3000	11.34	24.3		

Table 1. The scattered fraction determined for 20 keV electrons as function of gas pressure and gas type and beam gas path length.

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