DOI: 10.1017/S1431927605502022
Microsc Microanal 11(Suppl 2), 2005

Parallel Beam Wavelength X-Ray Spectroscopy – An Evaluation of Current Performance

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Introduction:
Parallel Beam WDS spectrometers were introduced to provide high efficiency WDS capability with compact design. This paper discusses the merits and also the problems with such spectrometers in applying them as analytical tools for SEM's.

The parallel beam spectrometer uses an x-ray optic positioned close to the sample to convert a divergent beam of x-rays from a point source to a parallel beam of x-rays directed at a Bragg diffractor. It uses the principles of total x-ray reflection at small incidence angles to accomplish this. The optics used can be grading incidence devices or polycapillaries. The cones are useful in the low energy region of the x-ray spectrum, while the poly capillaries can be used to 10 Kev and above. Because the x-ray beam is parallel, flat diffracting crystals can be used to analyze the energy spectrum of the beam. The detector used is a large area proportional counter using P-10 gas; an argon-methane mixture.

Application to Field Emission SEM's:
Field emission SEM's offer superior imaging performance at low kV, so using a PBS spectrometer is desirable. However, proportional counters are notorious for leaking P-10 gas, which could poison the ion pumps in the SEM. A leak free proportional detector system was developed to resolve this problem to enable the PBS to operate within a high vacuum environment,

Sample Height and Optic positioning requirements:
Samples must be place in the focus of the WDS spectrometer. Conventional vertical spectrometers must position the sample within a few microns of the focus, as well as the PBS systems have similar requirements. Conventional horizontal spectrometers have the advantage of having a much less severe positioning requirement. With an automated z-axis stage, a routine can be applied which steps the stage in the z axis to find the optimum position by maximizing count rate.

The optics must also be aligned. In a conventional spectrometer, the Rowland circle must intersect the position of the beam striking the sample. The PBS optics must be placed at the proper focal length, and be aligned with the column. The focal spot gets smaller as energy increases, so the positioning and stability of positioning is critical for the polycapillary type optic. To position this optic precisely, a piezoelectric stage was developed for this optic. This resulted in a completely stable platform for this optic.

The useful energy range of these systems must be compared. The Grazing Incidence Optic is useful from 80ev to 2400ev, while the polycapillary optic and the conventional spectrometer can be used to greater than 10 keV.

References
[1] David O'Hara, Microsc Microanal 9(Suppl 2), 2003
[2] United States Patent 5,682,415 – Collimator for X-Ray Spectroscopy – October 28th 1997

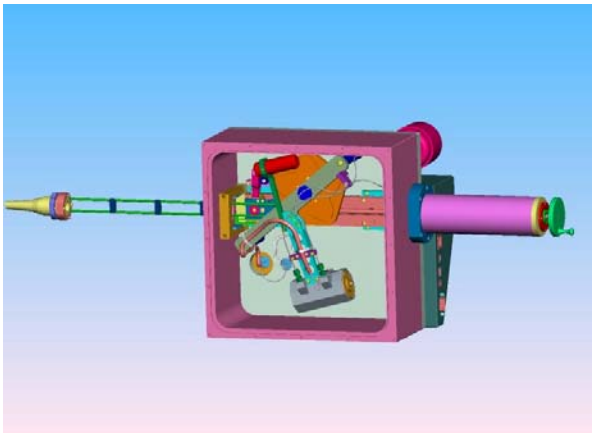

Figure 1: Schematic of Parallel Beam X-Ray Spectrometer

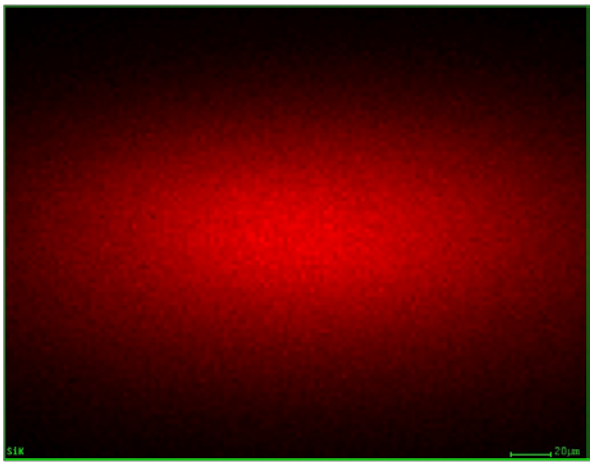

Figure 2: X-Ray Map of Si showing focal area of capillary optic

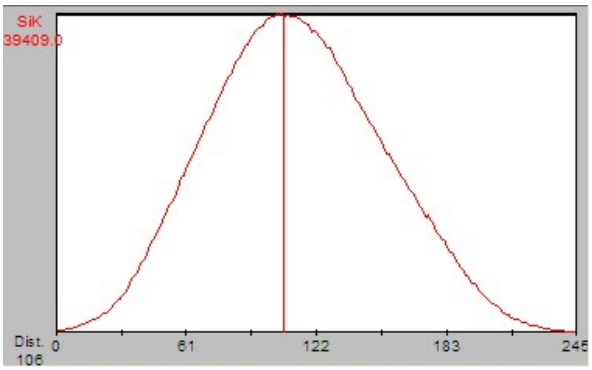

Figure 3: Vertical line scan through Si X-Ray Map

https://doi.org/10.1017/S1431927605502022 Published online by Cambridge University Press