Abstract Title: Microanalysis by EPMA with a Field Emitter Source

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XRay microanalysis by EPMA has in recent years evolved in three main directions which each provide special challenges for both analysis protocol and hardware design.
First, with improved hardware and analysis techniques it has become possible in many cases to reach some 10's ppm detection limits at high spatial resolution using LaB_6 sources. Analytical challenges of this type can be met only with high spectrometer reproducibility, excellent Peak to Background ratio high energy resolution and electron columns capable of providing 100's nA beam current closely regulated for several minutes collection time.
Second, the entry of EPMA as an accepted metrology technique in-fab in the semiconductor industry for quantification of thin films and implants has required the development of a specialized Low Energy XRay Emission Spectrometry (LEXES) involving absorption and emission models for many <5kV XRay lines not normally used for quantitative microanalysis. However, due to the extremely low concentrations of some of the target species, EPMA instruments of this type operate at 10's µA of current and beam diameters >10µm.
Third, there has been considerable interest in extending EPMA capabilities to ever-smaller activation volumes by using a field emission (FE) source, many of which can provide beam diameters <100nm also at low accelerating voltage. Effective use of such beam diameters for proper quantitative microanalysis requires improvements both to the hardware and to the quantification paradigm itself. Further, an effective general purpose FE-EPMA must also be able to operate at more conventional column conditions and high current modes in order to meet low detection limits as described in the first section above. Examples acquired with the CAMECA SX Five FE instrument will be discussed.
Analytical Resolution (AR) in EPMA does not directly correspond to beam diameter, but is governed mainly by a combination of accelerating voltage and average atomic density of the matrix as may be understood by Monte Carlo modeling. To achieve AR in the 100nm range for many substrates requires impact energies of only a few kV, and for many atomic species this energy is insufficient to excite the conventional higher-energy K lines and one must instead quantify using lower-energy L and M lines. In this energy range (see LEXES) it may be necessary to deploy more sophisticated XRay emission models in order to achieve effective quantification. Practical examples illustrating the SX Five FE analytical capabilities will be shown.