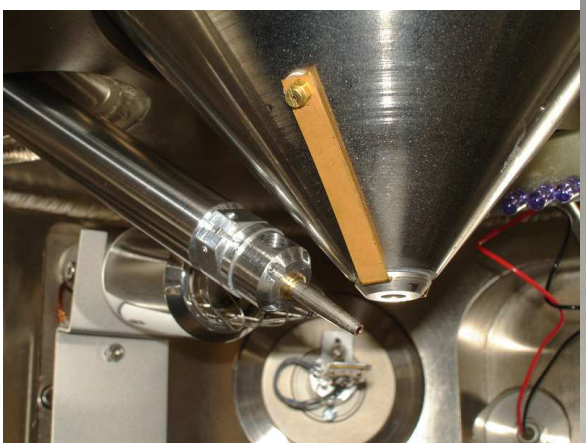
# Applications of LoMAX™ X-Ray Optic for EDS

## Introduction

LoMAX™ is an x-ray optic for use with Energy Dispersive Spectrometers (EDS) used in electron beam micro-analysis. It is essentially a conical-shaped mirror that selectively captures lower energy x-rays (< 1 KeV) and directs them towards the EDS detector. This substantially increases the number of low energy x-rays emitted by the sample that reach the detector, which in turn increases sensitivity to low energies and light elements. Therefore, analysis can be readily performed on light elements (or low energies emitted by heavy elements) that could not otherwise be accomplished.

LoMAX is installed by the user by simply sliding it over the end of the EDS detector. There is no interference with higher energies. In short, this is analogous to installing a more powerful lens on an optical microscope in order to see smaller details and features.



LoMAX installed on EDS detector in SEM chamber

Lomax optic, electron trap, ring clamp, adaptor

## Bulk Analysis

Although modern EDS used in electron beam micro-analysis can detect x-ray energies below 1 KeV, they are not very sensitive to such low energies. This energy region includes K lines from Be, B, C, N, O and F along with many L lines of transition

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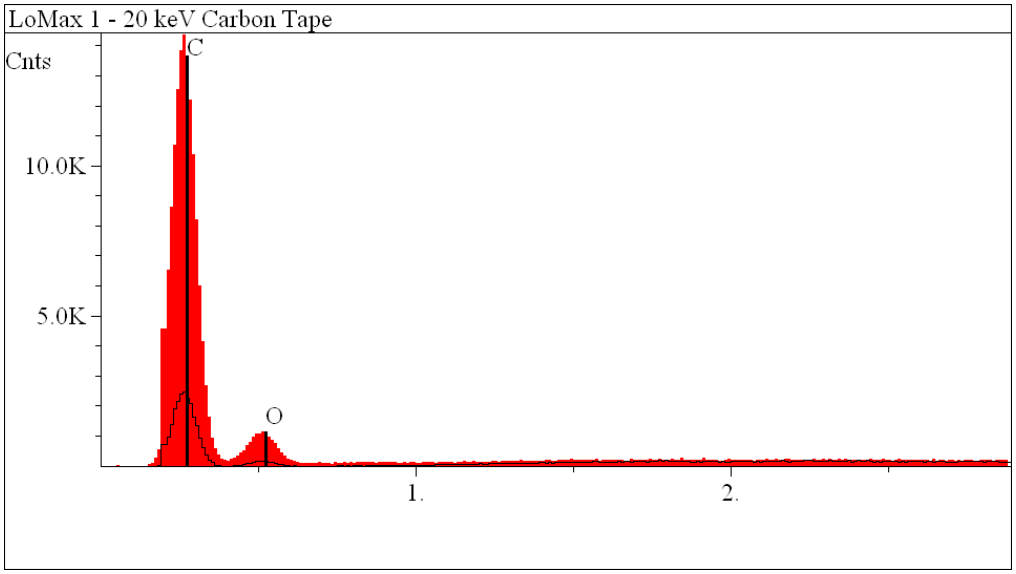
elements and some low energy M lines of heavy elements. The L and M lines have their corresponding K and L lines at higher energy, respectively, so they can be detected in bulk samples with EDS. However, the K lines of the low Z elements cannot be otherwise detected; one must look at sub-1 KeV energies for them.

These light elements can be important for forensics applications, and here are just a few of many possible examples. Beryllium is used as a hardener in copper in the range of 1-4% and cannot be detected via conventional EDS methods. Boron is used in various glasses so that the origin of a tiny glass chip can be determined by its presence. Carbon is used in various types of steel and the amount can be used to determine the type of steel. Nitrides are used for tool coatings and nitrogen in such a situation is very difficult to see with conventional EDS.

LoMAX gives considerable flux gain for these low energy lines so that a good analysis can be achieved. Any conceivable solid sample evidence with these elements present is a candidate for greatly improved analysis using LoMAX.



Overlapping spectra of carbon tape at 20KV, with (red) and without (line) LoMAX

## Thin Films

In many cases, a sample has a thin film or coating that must be analyzed and the use of high electron beam energy causes the bulk substrate material to emit x-rays that interfere with the analysis. By using low electron beam energy (lower KV), the thin film can be probed while mostly excluding the underlying substrate material. However, this means that one must rely on the low energy lines, many of which are below 1 KeV where conventional EDS does not work well. The range of electrons in thin films is such a

strong function of beam energy that this can easily be used to get a fast measurement of the film thickness. Using LoMAX also allows for more effective depth profiling, in general. LoMAX allows fast and accurate thin film analysis using these low energy L and M lines.

## Fine Particles

Using LoMAX for low energy analysis with low electron beam energies (lower KV) also allows for analysis of smaller volumes in the sample. For example, in most combustion processes, heavy elements preferentially condense on very fine particles so that analysis of these particles can be used to identify the source of the materials being combusted. If a high energy electron beam is used, the beam spreads beyond the individual particles so that the analysis may be uncertain for a given particle. For this reason, fine particle analysis should be done at low beam voltage to confine the analysis area to the desired location. These low voltages mean that the higher energy K or L lines cannot be used so one must rely on the low energy lines where conventional EDS does not work well. Therefore, using LoMAX for analysis of fine particles will improve reliability and sensitivity of the analysis of fine particles.

## Conclusions

Analysis of material evidence – bulk, thin film, or fine particles – can be greatly improved by using LoMAX in conjunction with EDS. Analyses that were out of reach with EDS, or marginal at best, can now be performed with reliability. The value and usefulness of the EDS equipment, and the effectiveness of the lab itself, are the main benefits. Technical details and data about LoMAX are highlighted in the March 2008 Microscopy Today article, attached with this document.

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