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Optimising cathodoluminescence collection conditions and examples of applications

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A Cathodoluminescence (CL) system has been developed at CSIRO Minerals that allows the simultaneous collection of x-ray, backscatter and multi-channel CL data on JEOL 8900/8200 microprobes[1]. This system offers significant benefits over traditional CL, X-ray and backscattered secondary collection techniques in that direct comparison with the elemental concentrations at the same pixel or over the same region is now possible. In addition, all data is collected under the same conditions. This minimises the effects of electron beam induced changes to the surface, such as, charge trapping which can result in changes to both CL and x-ray yields and surface contamination which results in enhanced absorption of x-rays, in particular soft x-rays.

A number of modifications have made in order to improve the capturing and processing of the CL data. One of the first improvements made was to fit a Peltier cooling device to stabilise the temperature of the charge coupled device (CCD). Spectra acquired from a CCD have a ‘dark noise’ background, which is dependent upon temperature, and CL maps acquired without the cooling device can show variations in room temperature that lead to background banding or artefacts in the image. The removal of background drift which is due to thermal instability has enabled us to implement automatic background subtraction at every pixel. A further modification has been to allow the collection of CL maps in beam scan mode, as well as stage scan mode. In beam scan mode finer steps can be taken and higher spatial resolution images achieved. At low voltage resolutions of down to 20 nm have been recently achieved in beam scan mode[2].

The handling of very large data sets generated during mapping, by the integrated system, has forced the implementation of new data handling strategies within Chimage[3]. In particular the capability of selecting a number of channels which are averaged together when the dataset is opened into dynamic memory. Typically, five channels are averaged together for first pass inspection of data and this significantly reduces the amount of data loaded into the computer memory whilst retaining the high-resolution data for later inspection. For data visualisation several modes of displaying, including pan chromatic, and selectable frequency ranges are now implemented. The latter mode allows subtle changes in “constant” chemical features to be revealed by selecting a frequency range in CL as one of the inputs to a three-colour map; the other two inputs are x-rays.

To guarantee reproducible soft x-ray and CL levels surface preparation of polished mounts must be considered. Extensive investigation of fine polishing has revealed that steps must be taken to remove all amorphous surface layers. Combined with this we have investigated the absorption of light through the conductive carbon coat that is applied to the surface using a carbon arc sputter coater. The variation in transmission with frequency across the visible spectrum has been found to vary from 45 % at 400 nm to 70 % at 900 for carbon, Fig. 1. Carbon coat thicknesses of between 10 – 15 nm have found to be sufficient to minimise charging and are now routinely applied to surfaces. If the absorption of the CL signal through the carbon film is taken into account, as well as detector response and the transmission of light through the optics, then a correction for these contributions can be performed and true CL output at the surface calculated.

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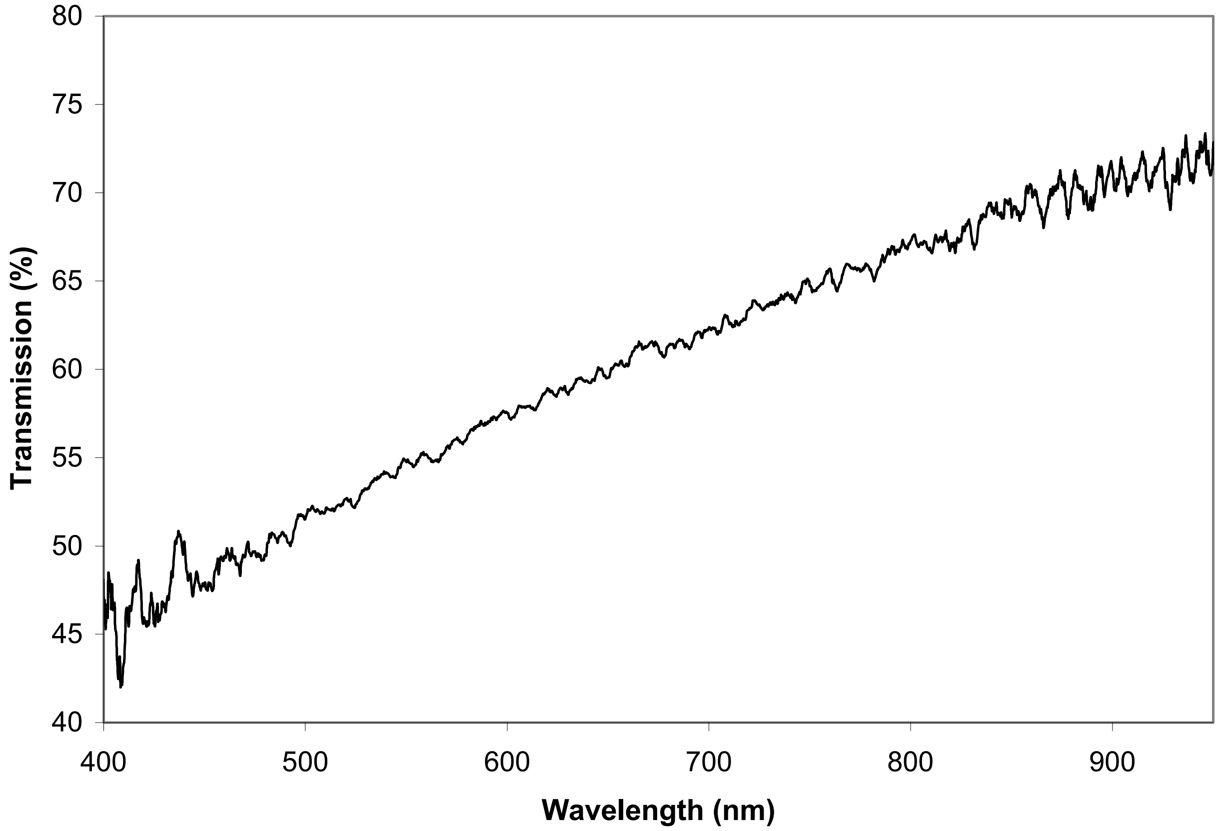

Figure 1. Transmission of light through a 15 nm carbon film, applied by a carbon arc.

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