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CATHODOLUMINESCENCE IN SEM AND EPMA – APPLICATIONS IN GEOLOGY AND MATERIAL SCIENCES

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ABSTRACT

Cathodoluminescence (CL) is the release of light when electrons strike a crystalline solid. It allows for characterisation of a material's optical properties on a centimetre- to nanometre-scale [1]. In this study, we use CL in a scanning electron microscope (SEM) and an electron microprobe (EPMA) as CL is more sensitive, and so shows more zonation than other SEM modes, to understand the growth in naturally occurring gem-quality diamonds.

CL images may be used to explore the growth history of naturally occurring diamonds [2]. In fibrous diamonds, many fluid inclusions are found within the borders of growth zones. In gem-quality diamonds, CL imaging helps locating the interfaces between growth periods, which may represent subtle changes in the chemistry of the fluid from which the diamond crystallised and/or the surrounding mantle rocks. CL helps to identify regions where there is a higher trapping probability of fluid inclusions (see Fig. 1) where the position of each inclusion may be related to the growth history of the diamond sample. In addition, CL images allow the identification of the twinning planes in twinned diamonds and reveal whether growth in twinned crystals is uniform.

Panchromatic CL images, where the variation of intensity of all the emitting light is mapped [3], are used in this study to understand the growth patterns of naturally occurring fibrous and gem-quality diamonds. Monochromatic analysis, where images are produced from light of a single wavelength, and single point spectroscopy, which measures a spectrum of the light emitted from a sample at a single point, are used in this study, along with hyperspectral imaging where a full spectrum is recorded at each point of a map [3]. In Fig. 1, some sharp peaks are observed between 350 and 850 nm on top of the broad bands typical of mantle diamonds. The advantages of hyperspectral imaging are that we can map wavelength shifts, apply multivariate statistical analysis to the multidimensional dataset and combine analysis with that of other SEM modes measured simultaneously [3].

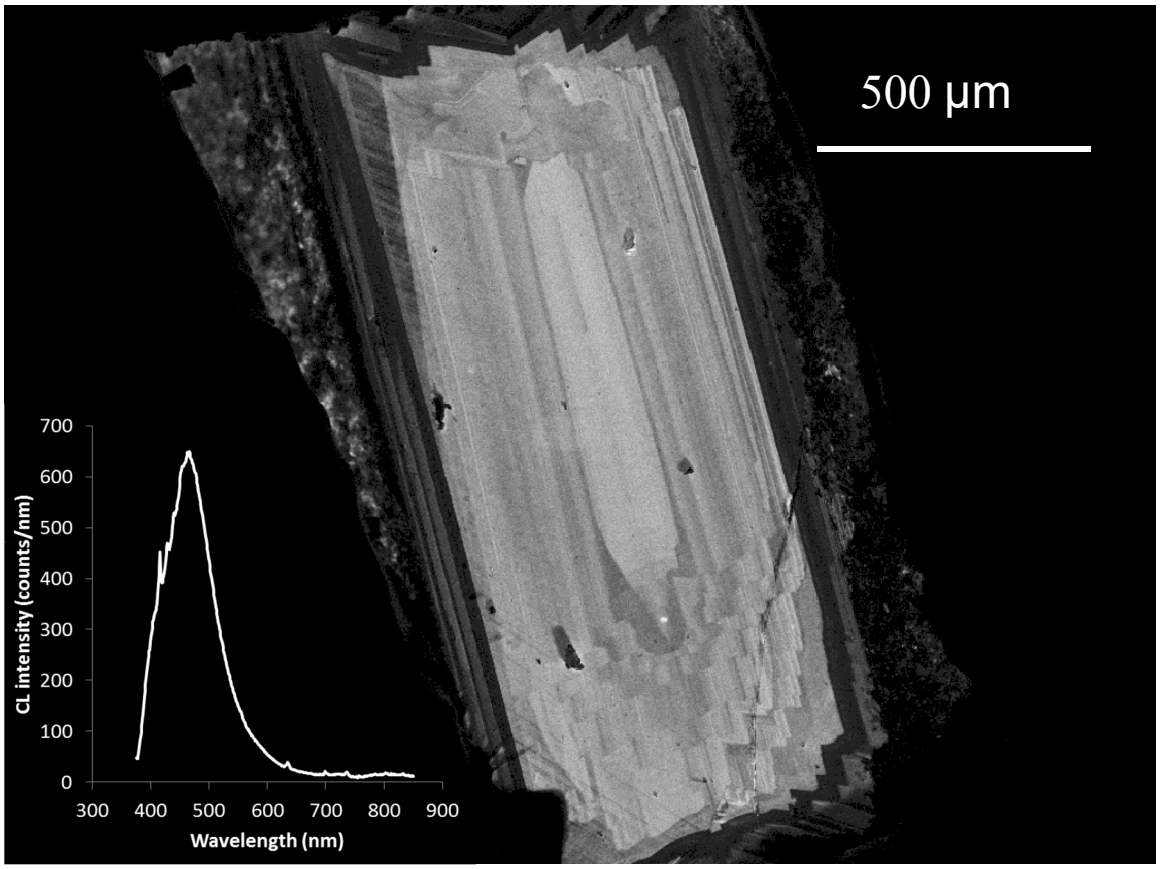

Figure 1. CL micrograph of a gem-quality twinned monocrystalline diamond acquired with a panchromatic CL detector reveals the staged growth of the diamond. Inset shows a typical CL spectrum acquired from a similar sample.

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