Imaging diamond: using birefringence & infrared to map strain and impurities

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Birefringence is an anomalous optical property that has commonly been observed in diamond, but until recently has rarely been quantified. With the development of the MetriPol system [1] an automated microscope technique is now available that allows rapid quantitative birefringence analysis of diamond. This technique has some advantages over 2D Raman mapping of diamond's pressure sensitive 1332 cm^{-1} band [2] (Fig. 1). This method of imaging diamond can be used to investigate all of the documented causes of stress and strain within diamond [3].

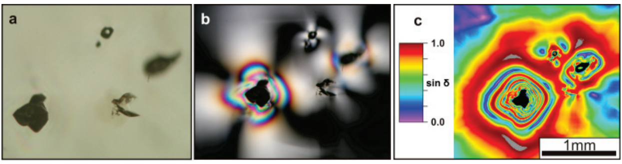

Fig. 1: Series of images of four coesite inclusions in a diamond from Finsch mine (South Africa): (a) plane-polarised transmitted light; (b) cross-polarised light; (c) MetriPol |sin(δ)| false colour image.

Since the original classification of diamonds based on their absorption in the one-phonon region of the mid-infrared (IR) range was first introduced, IR analysis has become the principle tool for classifying diamonds based upon the concentration and aggregation state of nitrogen.

Recent technological developments in the field of spectroscopy allow detailed μ-FTIR analysis to be automated and performed rapidly. The Nicolet iN10 microscope allows spectra to be collected with greater efficiency than is possible with conventional μ-FTIR spectrometer-microscope systems. Combining this with a computer controlled *x-y* stage allows the automated measuring of several thousand spectra in only a few hours. IR maps of diamond plates can now be recorded with minimal effort, but this has created the need for an automated technique to process the large datasets of IR spectra and to obtain quantitative data from them. A new computational method achieving this has been accomplished which generates false colour images that can define nitrogen concentrations, aggregation states, as well as hydrogen and platelet defects.

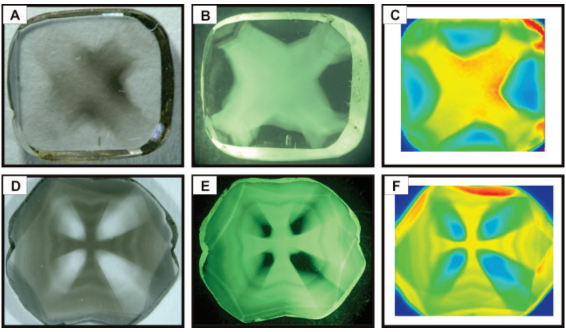

Fig. 2: Images of two diamond crystals showing 'maltese-cross' style growth zonations. Images A and D are under plane-polarised light, B and E are taken under UV, and C and E are false-colour images of the relative intensity of the 3107cm^{-1} (hydrogen) peak taken from IR maps.

[1] Glazer, A.M. et al. (1996) *Proc. R. Soc. London*, **452**, 2751-2765. [2] Howell, D. et al. (2010) *Contrib. Mineral. Petrol.* (in press). [3] Lang, A.R. (1967) *Nature*, **213**, 248-251.