GATAN

Experiment Brief

Monarc Cathodoluminescence Detector

Title

High-speed, hyperspectral (spectrum) imaging for all with the Monarc detector

Gatan instrument used

The Monarc™ system's revolutionary design enables spatial and spectral (color) information available in the cathodoluminescence (CL) signal to be captured with unprecedented speed to dramatically expand one's ability to understand mineralogical processes.

Background

CL microscopy—the analysis of light emitted by a mineral or gemstone when excited by an electron source—has proven to be a very effective microanalysis tool used to understand our geological history. This technique is finding extensive use in determining mineral provenance, including geochronology and metamorphic alteration studies and, more recently, thermobaromtery for petrographic applications.

Many CL detectors only collect spatial information in the form of unfiltered (black and white) images. In recent years, color CL imaging has largely displaced unfiltered imaging since it is easier to interpret and provides more information. However, color imaging provides very limited spectral information, which prevents the identification of trace elements, their valence and structural position, or quantitative analysis. For several years, it has been clear that hyperspectral imaging (spectrum imaging) offers many benefits because it collects all spatial and spectral information in a single data set (spectrum image or hyperspectral data cube). Yet due to the slow acquisition speeds, adoption of CL spectrum imaging in the geosciences has remained low.

Materials and Methods

Traditionally, a scanning electron microscope (SEM) scans the electron beam across a sample to collect wavelength-resolved spectra (spectrum images) on a point-by-point basis. For many applications, the resulting spectrum images exceeded spectral resolution requirements, but had limited spatial resolution due to the prolonged acquisition times. The Monarc detector provides a brand-new acquisition standard: Collects a series of (aligned) wavelength-filtered maps using ultra-fast detectors to build the hyperspectral data cube. This approach enables high-spatial sampling while greatly reducing acquisition times

In Figure 1, we compare two hyperspectral images of a polished zircon grain captured using the wavelength-filtered spectrum imaging and traditional wavelength-resolved modes on the Monarc detector. A comparison of the extracted spectra demonstrates that despite the limited wavelength sampling in the wavelength-filtered approach (42 channels), you can detect all spectra features. However, the Monarc's unique detection method allows >70x higher spatial sampling, enabling observation of the fine banding structure.

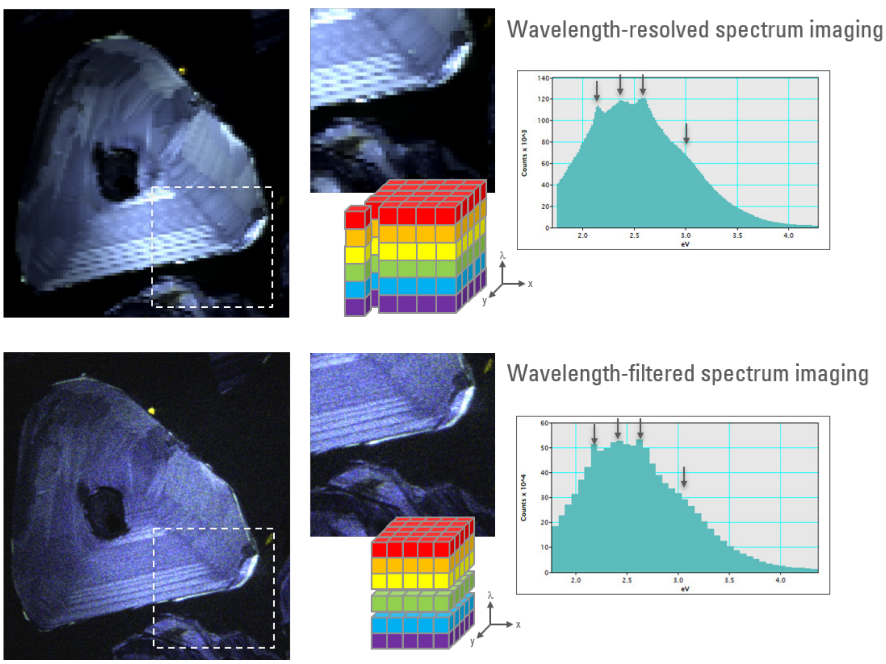

Figure 1. True-color representations of spectrum images captured by wavelength-resolved and wavelength-filtered modes of the Monarc detector. Both data sets were captured in 150 s.

Summary

The new wavelength-filtered spectrum imaging mode of the Monarc detector enables hyperspectral data to be collected up to 100x faster (or with 100x higher spatial sampling) than with other CL detectors. With this significant advancement, hyperspectral imaging is expected to displace color and, black and white CL imaging modes as scientists gain an even greater understanding of mineralogical processes using CL microscopy.

GATAN

www.gatan.com

EB-MonarcGeo-FL1-CA-NOV19