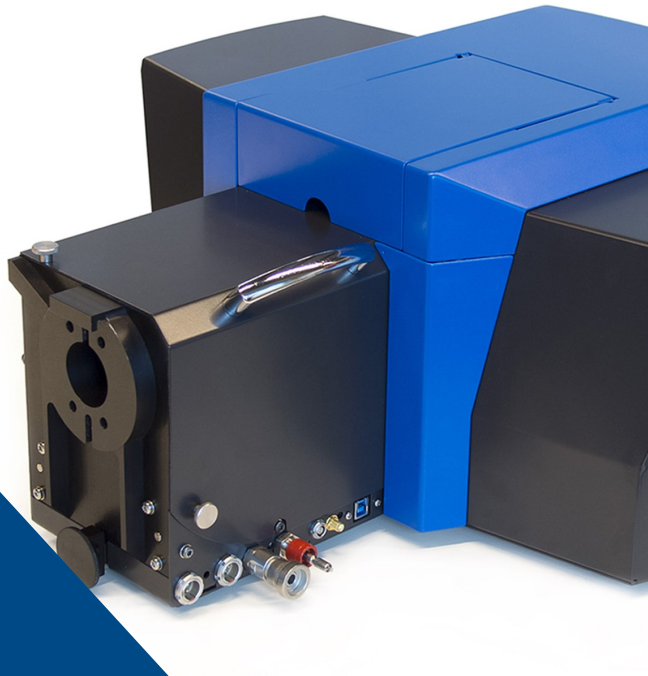

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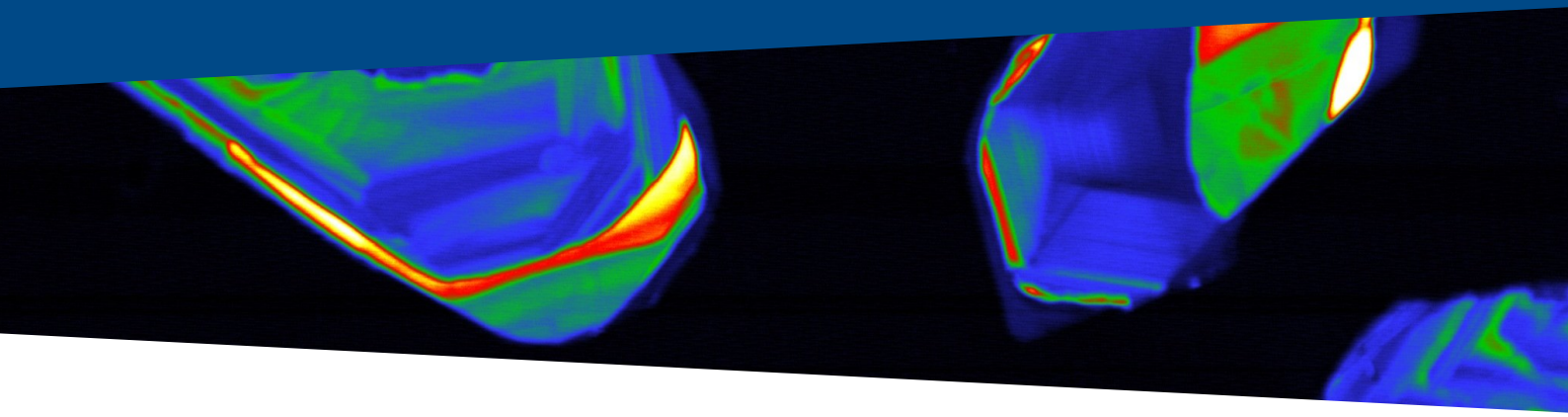
application note

Zircons

delmic

SPARC



application note

Zircons

Zircon ($ZrSiO_4$) is a ubiquitous mineral in the earth's crust. Because the material is chemically inert and hard, it is very resilient to weathering processes and can persist for a long time in a large variety of sedimentary, igneous, and metamorphic rocks. When zircon crystals are formed from a melt, conditions can vary over time which affects the zircon growth. Such changes in conditions lead to zonation in the zircon (zones of zircon which contain different amounts of trace elements, for instance). Similar to the growth rings in trees, these zones contain chronological information about the geological formation of the zircons.

Typically the zonation is subtle and does not, for instance, lead to large density differences, thus rendering it difficult to observe with regular scanning electron microscopy (SEM). Cathodoluminescence (CL) imaging, on the other hand, is highly sensitive to small concentration variations in trace elements such as rare-earth ions, as they have a strong and spectrally distinct CL response [1]. Interestingly, zircons often have high uranium and thorium content which can be used for radiometric dating.

CL can be used as a prescreening tool for high-resolution secondary-ion-mass spectrometry (SIMS) to image the zonation pattern and identify regions of interest for isotope analysis. These can then be interrogated with the more expensive and time-consuming SIMS technique. Such a combined analysis has been used to date zircons that are over 4.3 billion years old, which is the oldest native crustal rock from earth ever to be dated [2].

In Figure 1 we show a secondary electron image (a) and a panchromatic CL image collected with a photomultiplier tube (PMT) in the SPARC CL system (b). In both cases the zircon grains can clearly be distinguished from the background but the CL image shows significantly more structure within the grains. In (c) we show another CL image in which there is strong CL contrast within a single grain and the zonation is clearly visible. These results illustrate that the SPARC CL system provides an excellent platform to quickly reveal zonation patterns in such minerals and that it can also be used as an effective screening tool for advanced geological characterization techniques.

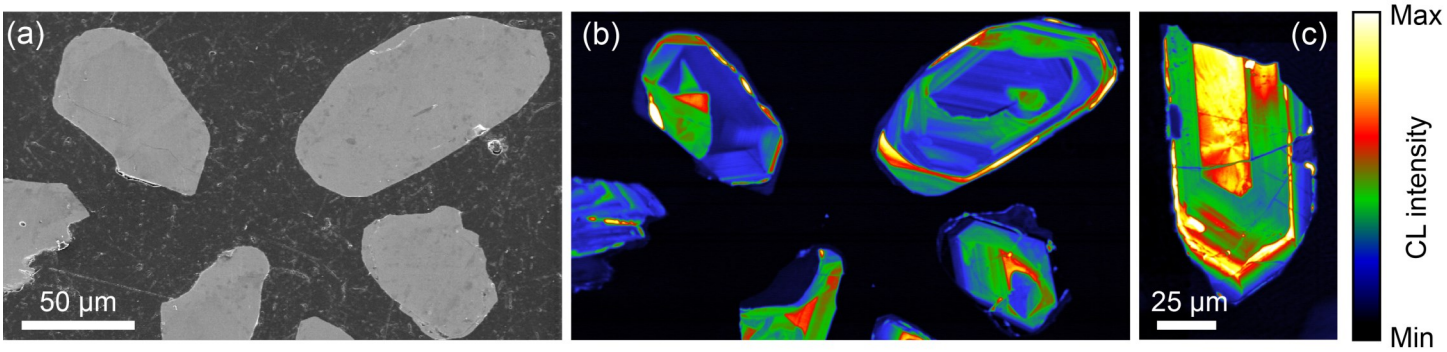


Figure 1 *(a) SEM image of some zircon grains. (b) Panchromatic PMT intensity image (grayscale) of the same area. (c) Close-up panchromatic PMT image of a single zircon grain. These measurements were taken at 10 kV acceleration voltage and 1 nA current with a 100 µs dwell time. CL images took ~1.5 minutes to collect. Samples courtesy of Prof. Jens Jahren (University of Oslo).*

References

1. Zircon, J.M. Hanchar and P.W.O Hoskin, Rev. Mineral. Geochem. 53 (2003)
2. S. A. Wilde et al., Nature **409** (2001) 175-178.

DELMIC B.V. is a company based in Delft, the Netherlands that produces correlative light and electron microscopy solutions. DELMIC's systems cater to a broad range of researchers in fields ranging from nanophotonics to cell biology.

The SPARC is a high-performance cathodoluminescence detection system produced by DELMIC. The system is designed to optimally collect and detect cathodoluminescence emission, enabling fast and sensitive material characterization at the nanoscale.

For questions regarding this note, contact our SPARC Application Specialist at: coenen@delmic.com

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delmic.com

Thijsseweg 11
2629 JA Delft
The Netherlands

+31 (0)15 744 0158
info@delmic.com