技術情報 Technical Information

Cathode luminescence in EPMA

General

Cathodeluminescence (CL) is a technique used to study crystalline structure, trace impurities, lattice defects, and crystalline distortion.A cathodeluminescence device can be installed on a JXA-8800 electron probe micro analyzer (EPMA) that is also being used for secondary electron and backscattered electron imaging, and elemental analysis with WDS.Below are some examples of samples analyzed in this combined system.

Applications of CL

CL, which has been widely used for studies of minerals, is attracting increasing attention as a powerful tool for analyzing other types of materials such as commercial optical devices that use blue-color light-emitting diodes and laser diodes.

Samples	CL applications
Semiconductor optic devices	Properties, emission wavelength, micro defects, impurity distribution
Optical fibers	Index of refraction gradient, ultra micro defect distribution
Fluorescent materials	Emission wavelength, identifying light emitting spots, light emitting particle distribution
Ceramics	Grain boundary of sintered compact, defect analysis
Minerals, rocks	Trace impurity distribution, structural non-uniformities, stress distribution
Steel materials	Analysis of oxides and other impurities
Biological samples	Imaging of light emitting stains

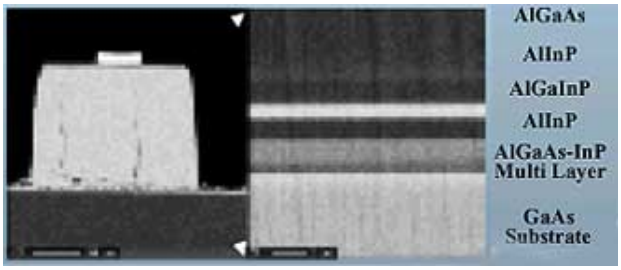
Examples

1. Optical devices

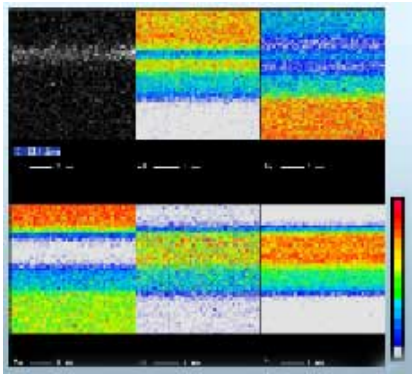
1-1 Red LED

A cross section of a commercial high brightness red LED was analyzed.The area analysis shows that the sample is a multi layered semiconductor compound containing Ga, In, P, Al, and As.The CL image demonstrates that the AlGaInP layer emits red light at a wavelength of 642.5 nm.

Electron Probe Micro Analyzer



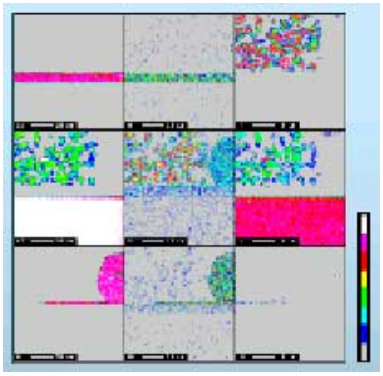
BE composition image



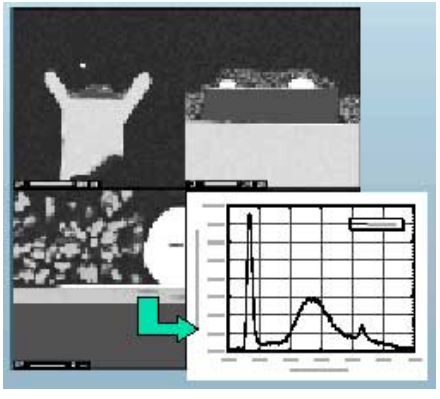
CL image (642.5 nm) and color elemental maps

1-2 White LED

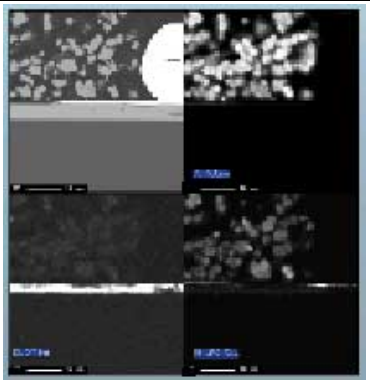
A cross section of a commercial white LED was analyzed.The white LED, a GaN blue LED coated with a fluorescent layer to emit olive green light such as YAG, excites YAG with blue light emitted from GaN, creating white by combining blue and olive green.Results of CL area analysis suggest that 560 nm, 457, 5 nm, and 370 nm were olive green light emitted from YAG, blue light emitted from the GaN top active layer, and light emitted from the GaN layer n-doped respectively.



Color elemental maps of white LED



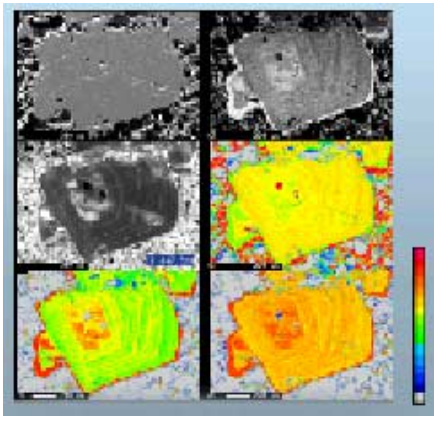
BE composition image and CLD spectrum of GaN



CL images of different wavelengths at cross section

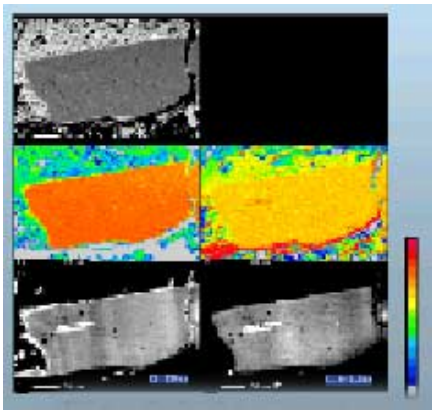
2. Mineral samples

To the right are the SE, BE, 487.5 nm CL images and X-ray maps of Si, Ca, and Al of a plagioclase in a volcanic rock.The layering structure in the plagioclase suggests that it was cycling through a magma of varying compositions (or temperature) while the plagioclase crystal was growing.The brightest portions of the CL contrast roughly correspond to areas richest in Ca and Al.

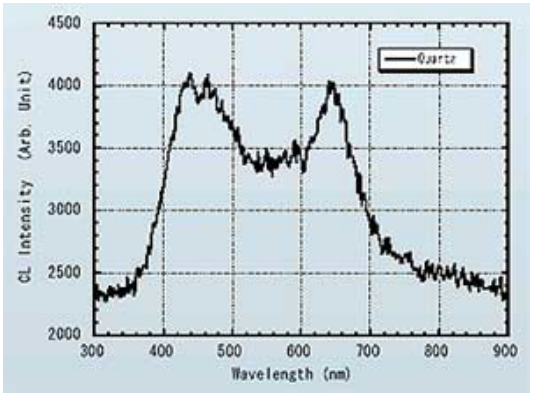


CLD image and color elemental maps

Quartz in the same sample was also analyzed.Since the CL spectrum of the quartz showed peaks at 430 nm and 642.6 nm, CL maps were collected at both peak positions, in addition to element maps.The CL images at the peak positions produced different patterns, demonstrating that they did not correspond with each other.Using the pattern in the 430 nm CL image as a reference, qualitative analyses were tried at several spots of different intensities, but were unable to identify any other elements other than Si and O.



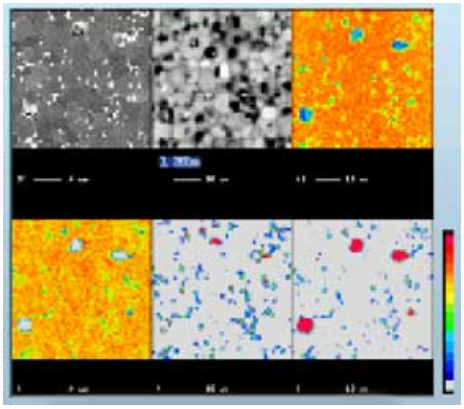
CL image and color elemental maps



CL spectrum of quarz

3. Ceramic samples

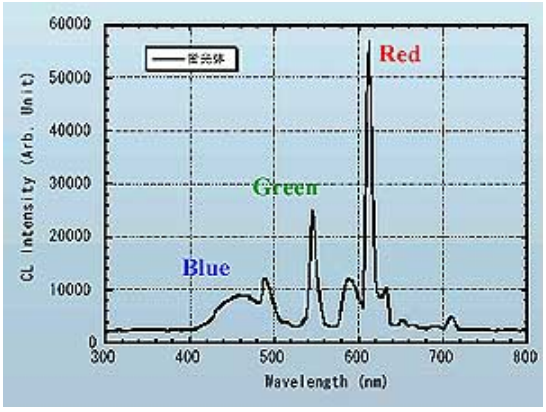
The sample to the right is a commercial AIN sintered compact widely used as an insulating heat sink. Displayed are the BE image, the CL image of the 360 nm peak position, and X-ray images of AI, N, Y, and O.Since the depth of analysis in the CL image is the same in the X-ray, channeling and grain boundary contrasts are unlikely to appear in the BE image. However, the sample shows a contrast apparently reflecting the crystalline grain boundary.It also shows dark and bright spots in grains that do not correspond to distributions of AI, N, Y, and O.



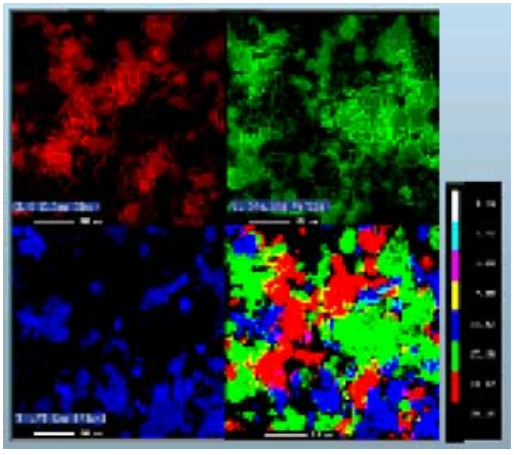
CL images and color maps of AIN sintered compact substrate

4. Fluorescent samples

CL has traditionally been used for analysis of fluorescent materials.The fluorescent material from the walls of a commercial fluorescent light was collected and attached to a conductive tape for analysis to show the distribution of particle representing the red, green, and blue wavelengths of light.In the CL spectrum of the fluorescent material, peaks at 612.5 nm, 545 nm, and 457.5 nm respectively correspond to the red, green, and blue particles.CL maps were acquired from these peaks, and combined into a composite map showing the distribution of the three colors.The data visually demonstrates the particle distributions and the percent area occupied by each color in the field of view, suggesting the effectiveness of CL for product inspection.



CL spectrum of fluorescent material



CL images of red, green, and blue and the composite map