Cross sectional cathodoluminescence study for structured materials

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Advanced luminescence materials often possess complex structures. Hetero-structures are essential to enhance the light emission from III-V compound semiconductor lasers and GaN based LEDs. Core-shell structures are adopted to improve light emission from phosphor nanoparticles and semiconductor nanowires. Although cathodoluminescence is versatile to image the luminescence distribution in such optical materials and devices, it is difficult to elucidate the origin causing such distribution. To overcome such difficulty, we propose the combination of cross sectional specimen preparation and 3D cathodoluminescene (CL) mapping.

As for the specimen preparation, nanoparticles or nanowires can be fixed in epoxy resin and their cross sections are easily fabricated by cross sectional polisher (CP) using Ar ion bombardment. In case of heterostructures, we propose angle polishing to enlarge the depth scale to clarify the property of each stacked layer. The 3D CL mapping is performed by accumulating CL spectrum of each pixel point and combined the spectra into 3D image. According to the development of CL system and image software, 100 x 100 pixels data are processed in a few hours.

Fig. 1 shows an example of 3D spectral imaging. The inset shows the cross sectional panchromatic CL image of Eu-doped $CaAlSiN_3$ (CASN) ceramic plates, which are used for red phosphor for laser illumination device [1]. The 3D spectral image clearly shows the difference of emission property between core and shell part. In this case, the shell part is less luminescent and peak is blue shifted rather than the core part due to some distorted structure. Thus, some improvement of the shell part would be necessary to increase the emission property.

This demonstration clearly shows the advantage of this technique for the development of luminescent materials and devices.

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[1] Li S, Zhu Q, Le Wang D, Cho Y, Liu X, Hirosaki N, Nishimura T, Sekiguchi T, Huang Z, Xie R J, J. Mater. Chem. C 4 (2016) 8197

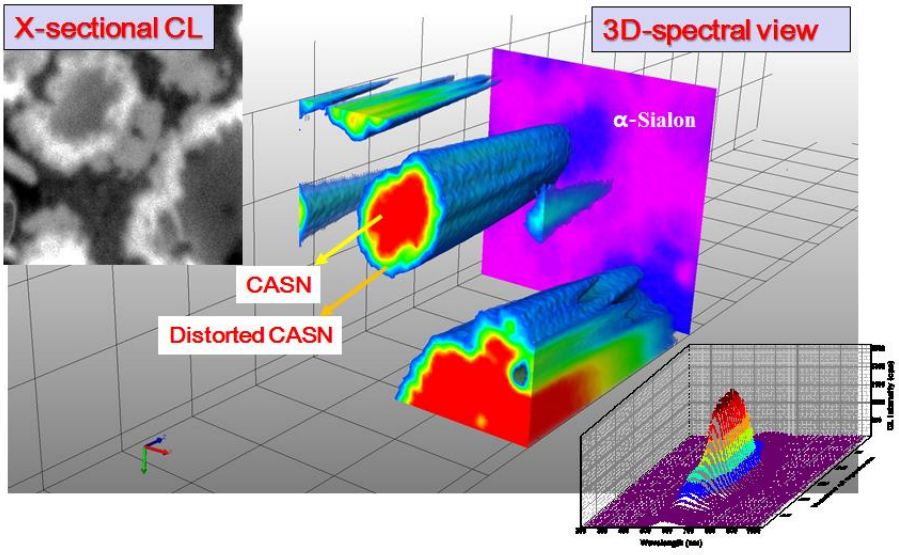

Fig. 1. X-sectional CL image and 3D-spectral representation.