Emission Imaging of a LaB_6 Emitter

Gerald G. Magera
Applied Physics Technologies, Inc 1600 NE Miller St, McMinnville, OR 97128
email: bmagera@a-p-tech.com, voice: (503) 434-5550

Victor Katsap, Chising Lai
NuFlare Technology, 10 Corporate Park Dr., Ste C, Hopewell Jnctn, NY 12533
e-mail: katsap@nuflare.com Tel: (845) 896 0692

Oxide cathode emissive imaging had been used routinely in CRT's as described in[1]. We used a similar approach, running LaB_6(100) cathode in a triode gun, in temperature-limited mode, and using a magnetic lens to image the emitting surface, or tip, onto the target plane with magnification of ~3.4X (Fig. 1).
In target plane, the magnified tip image, size ~250 μm, was digitally scanned over a 10 μm DIA pinhole with variable pitch. The amplified pinhole current was used as a video signal over 256x256 X-Y scan. The scan magnification was variable from 1X to 16X. A formed image was displayed on a standard PC monitor, and the image also could be saved as a 2D file for post-processing.
Typically, we would start with a low scan magnification to get a classic LaB_6(100) Maltese cross image. In Maltese cross, bright center spot is emission from LaB_6(100) tip, and 4 satellite spots are emission from 4 (110) planes located on the conical sidewall of the LaB_6 crystal.
Focusing on the area of interest, or center spot, and adjusting the scan magnification to 16X with pitch ~1 μm, we obtained a LaB_6(100) tip image with ~2 μm resolution.
This image files can be converted to a matrix with user-defined gray scale.
Case in point, LaB_6(100) cathode emission image showed apparent 4-fold symmetry (Fig. 2).
While we should expect 4-fold symmetry from a (100) crystal plane, details of this image are remarkably similar to those in high-resolution FIM image[2] of a (100) crystalline plane (Fig. 3).

Barring artifacts, our emission image rendered (100) crystalline plane structure in great detail.

Cathode whose image shown in Fig. 2 had been tested long-term, and a new set of emission images were taken at the end-of-life (Fig. 4).
Post-mortem optical and electron microscopy inspection confirmed crystal tip profile obtained via emission imaging (Fig. 5).

LaB_6(100) cathode emission imaging can be used during routine cathode tests for *in-situ* crystal evaluation.

Reference

1. H. Moss, Narrow angle electron guns and cathode ray tubes, Academic Press, NY, 1968.
2. G. A. Schwind, private communication.

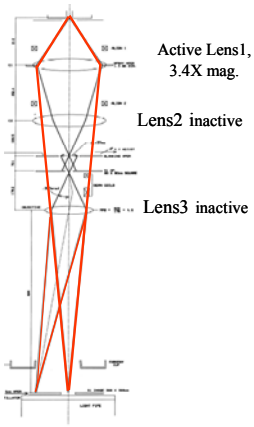

Figure 1. Tip image is focused by a magnetic lens onto target plane.

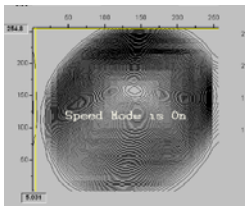

Figure 2. $LaB_6(100)$ cathode tip emission image in 64 shades of gray. The 4-fold symmetry is visible.

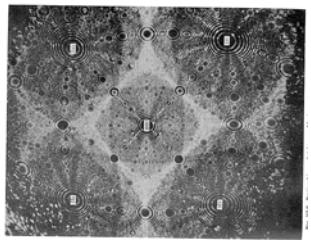

Figure 3. Focused ion microscope image of (100) crystalline plane, courtesy of G. A. Schwind

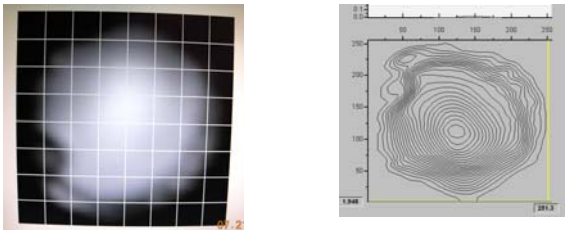

Figure 4. $LaB_6(100)$ tip analog (l) image and digital (r, inverted) image at the end of cathode life. Uneven crystal loss was suspected

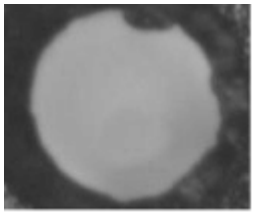

Figure 5. $LaB_6(100)$ tip microscopic image in good agreement with emission image shown in Fig. 4.