EFFICIENCY OF CATHODOLUMINESCENT PHOSPHORS FOR A FIELD-EMISSION LIGHT SOURCE APPLICATION

Nikolai N. Chubun, Andrei G. Chakhovskoi, Charles E. Hunt
Department of Electrical and Computer Engineering,
University of California at Davis, CA, 95616, USA

The use of field emission cathodes to illuminate cathodoluminescent phosphors until recently was restricted only to flat panel displays [1]. Other prospective applications of field-emission cathodes include pixel-size CRTs for giant outdoors displays, LCD backlighting, specialized and general-purpose lighting applications [2-5]. Due to practically 100% efficiency of a field-emission cathode, the general efficiency of the light source will be determined by the phosphor efficiency. Unfortunately, commercially available CRT phosphors operate at very high acceleration voltages, typically 10-30 KV, which imposes significant challenges for design and geometry of filed emission devices. Operation of filed emitters can be achieved at considerably lower voltages, however the light efficiency of standard CRT phosphors reduces significantly at lower acceleration energies. In this paper we are reporting results of wide investigation of a viable selection of modern cathodoluminescent phosphors for filed emission light source applications *.

The standard test procedure included phosphor settling with surface density up to 4 mg/cm^2 on a glass slide, lacquering with destructible organic sacrificial film, and aluminizing with thin reflecting film for unidirectional light emission. We tested each phosphor screen in the vacuum chamber at the accelerating voltages from 4 to 14 kV. The lower accelerating voltage was determined by electrons ability to penetrate through aluminum film, and the upper voltage was limited by the power source. The lighting application requires phosphor brightness from 5,000 up to 30,000 cd/m^2. The corresponding current density during the tests varied from 4 to 40 μA/cm^2. As the result, the thermo loading for phosphors was considerably more demanding in comparison to conventional CRT level. An equilibrium temperature of phosphor layer was found to be in the range of 100-150° C.

The efficiency of the color phosphors was experimentally compared within the range up to 90 Lm/W for green, up to 30 Lm/Watt for blue, and up to 35 Lm/Wt for red color at 14 kV. Color spectra and CIE coordinates were also measured. The selection of appropriate CRT phosphors will determine the future success of the filed emission light sources.

References:

1. C. Hunt, A. Chakhovskoi, JVST-B, 15(2), 1997, p 516
2. N. Chubun et al, IVMC 1995, Portland, USA, p.384
3. S. Uemura, T. Nagasako et al, SID 1999, Anaheim, USA, p 1052
4. J.M. Bonard, ITM-FEECM, July 2001, Moscow, Russia, p 25
5. S.H.Lim, H.S.Kim et al, SID 2002, Boston, USA, p 356

Corresponding author: N. N. Chubun, e-mail: nchubun@ece.ucdavis.edu

* Samples of commercial P-22 type CRT phosphors were obtained from manufacturers and are listed by manufacturers corporate name: *Kasei* - Kasei Optronix LTD, Japan; *Sylvania* - Osram Sylvania, USA; *Platan* – Platan Co, Russia; *Saratov* – Volga R&D Co, Russia.

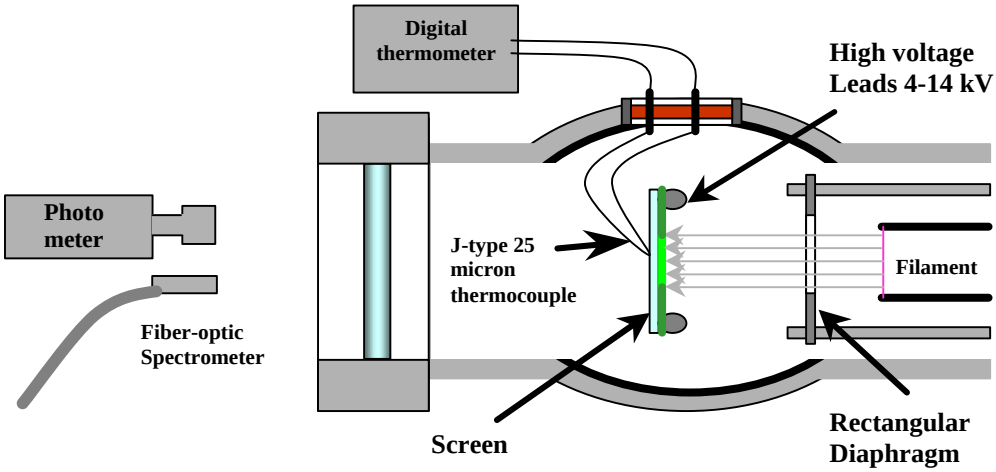
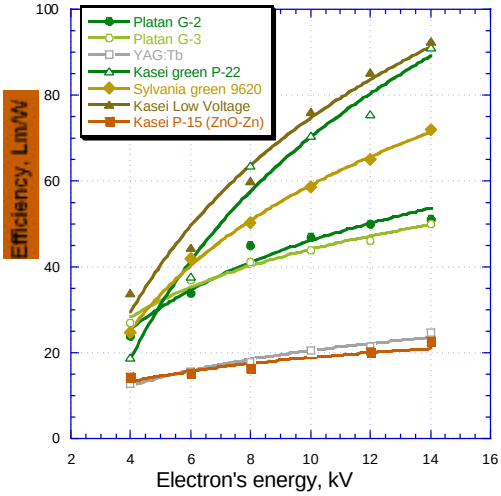


Fig. 1. Test setup for the phosphor measurements



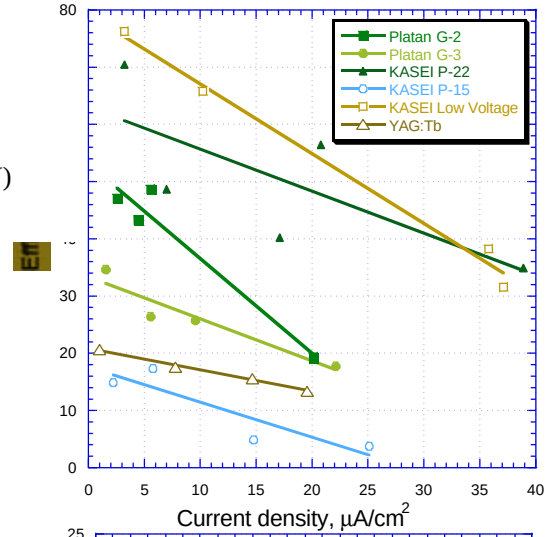
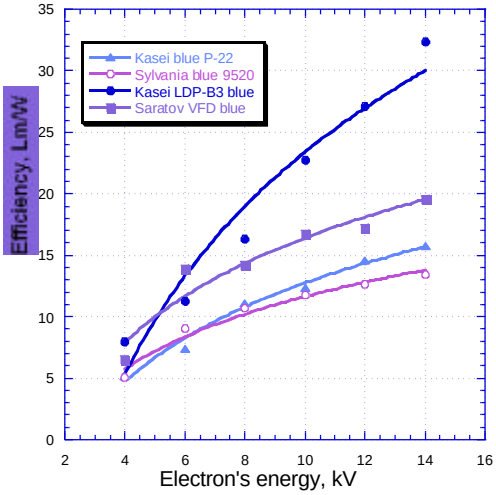


Fig. 2. Efficiency of green phosphors at low (left) and high (right, at 10 kV) current density



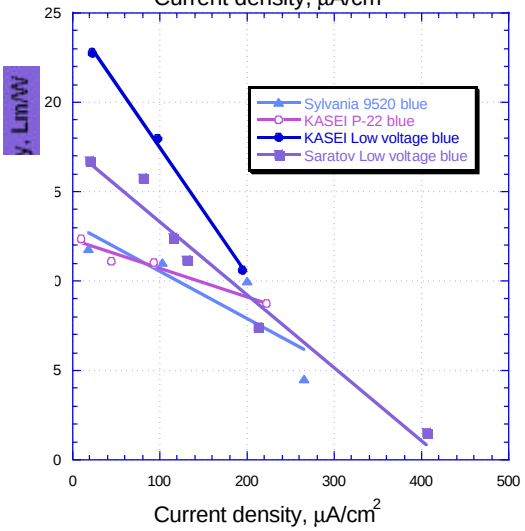
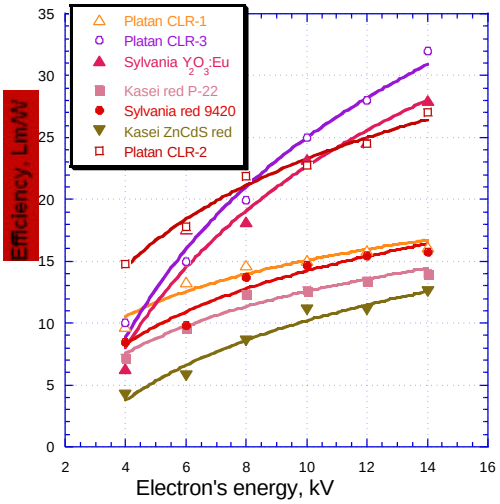


Fig. 3. Efficiency of blue phosphors at low (left) and high (right, at 10 kV) current density



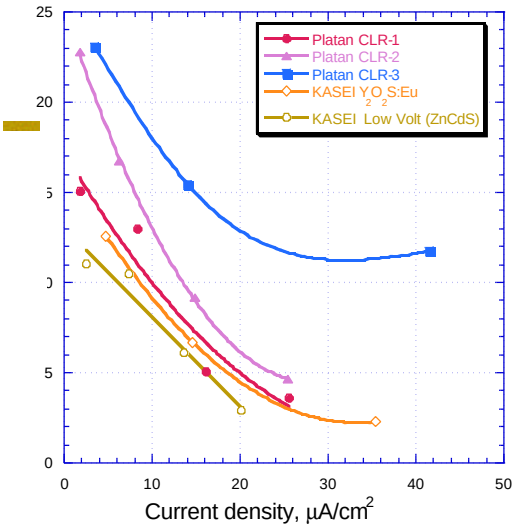


Fig. 4. Efficiency of red phosphors at low (left) and high (right, at 10kV) current density