UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Electrical Engineering and Computer Sciences

EE290D — Handout #53
Spring 1999 — T.-J. King

HOMEWORK ASSIGNMENT #6
Due Thursday, May 6 at 5 PM (outside 567 Cory)

<u>Problem 1</u>: Inorganic Electroluminescent Displays

a) What are the advantages of TFEL displays over LCD displays?

b) Explain briefly the following requirements for the dielectric layers in an ACTFEL device:
- i) high dielectric constant
- ii) high breakdown electric field
- iii) minimal pinhole density

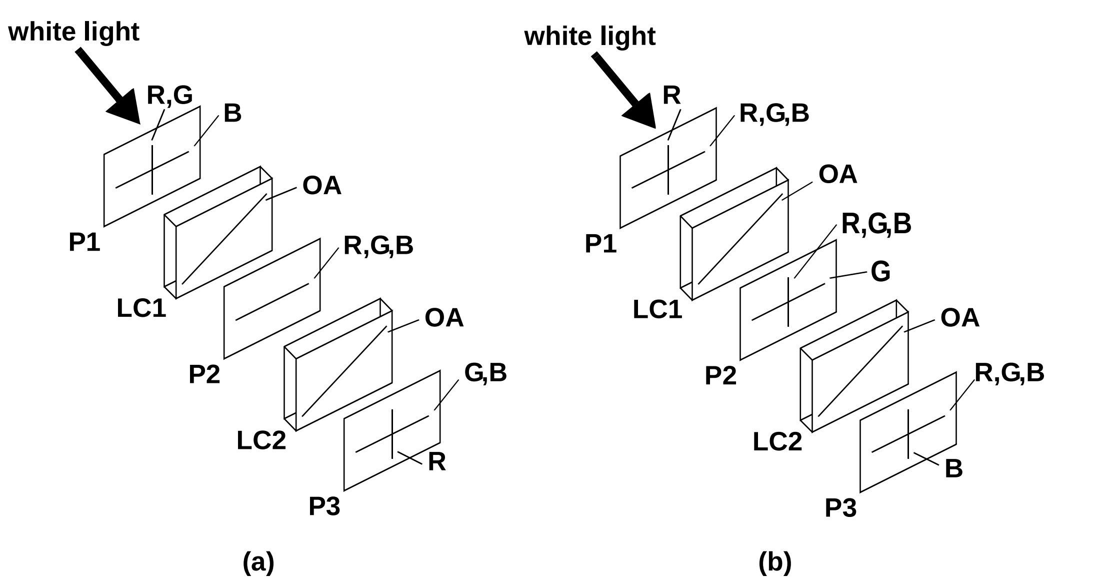
c) Why does the luminance of an ACTFEL display increase with the frequency of operation?

d) Why is low-voltage operation desirable? How can the operating voltage of an ACTFEL display be reduced?

<u>Problem 2</u>: Color TFEL Displays

a) Describe 3 approaches to achieving a full-color TFEL display. What is the main advantage and main disadvantage of each approach?

b) In the notes for Lecture #21 (Handout #46), the operation of a liquid-crystal color shutter is described. The shutter consists of three polarizers and two LC cells, as illustrated in Figure P2a in more detail. The LC cells are fast-switching "pi cells" [ref. P. Bos *et al*., *SID Digest of Technical Papers*, p. 30, 1983]. In the off state, a pi-cell acts as a half-wave retarder for normally incident light, so that the direction of polarization of incoming light changes by 90^o. In the driven state, light passes through the pi-cell unaffected.



<u>Figure P2</u>: Examples of liquid crystal shutter filters, used to create full-color images from monochrome white displays. The polarization axes for the R, G, and B components of the white light are indicated for each polarizer. The optic axes of the LC cells are labelled "OA".

(a) Shutter used in AMEL diplays. Note that polarizer P2 is a neutral polarizer, while polarizers P1 and P3 are pleochroic. (Cyan = Blue + Green (i.e. no Red); Yellow = Green + Red (i.e. no Blue))

(b) Example of shutter employing only pleochroic polarizers. Each polarizer transmits only one

Indicate in the table below how the R, G, and B components of the white light source are transmitted by operation of LC1 and LC2, for the light shutter in Figure P2b. This table has been filled out for the light shutter in Figure P2a, as an example.

		LC1	LC2
Figure P5a	R	OFF	OFF
	G	OFF	ON
	B	ON	ON
Figure P5b	R		
	G		
	B		

Problem 3: Organic Display Technology

a) What are the advantages of OLED displays over LCD displays?

b) Low-voltage operation of OLEDs is important because of cost and power-consumption considerations. Describe at least 2 approaches to reducing OLED driving voltage (the voltage required to achieve a given current density, *e.g.* 1 mA/cm^2).

c) How is the color of the light emitted by an OLED "tuned"?

d) What is the primary advantage of using polymer materials vs. small-molecule materials?

Problem 4: Organic Display Operation

Consider the organic light-emitting diode technology used in Pioneer's monochrome dot-matrix display (refer to the second paper in Handout#50, Figures 5 and 7). Recall that 4π lumens of luminous flux corresponds to 1 candela of luminous intensity.

a) For the dot-matrix display (256 x 64 dots, 240 μm x 300 μm each, passively addressed) described, what is the peak operating brightness (in cd/m^2) of a dot (pixel) which is required to achieve a display luminance of 100 cd/m^2? What is the luminous efficiency (in lm/W) of the display at this luminance? Estimate the power consumption of this display. (Consider only the power required to generate light.)

b) Estimate the power consumption of a 5-inch-diagonal quarter-VGA-resolution (320 x 240) monochrome dot-matrix display operating at a brightness of 100 cd/m^2. Assume a pixel aperture ratio of 95%.

c) What are the benefits of using active-matrix addressing in OLED displays? What is the main disadvantage?

d) In an active-matrix 10-inch-diagonal VGA OLED display employing 2 (p-channel) TFTs per pixel, how much current does the TFT in series with the OLED need to supply, for a pixel luminance of 100 cd/m^2? Assume the pixels are square, and that the pixel aperture ratio is 80%.