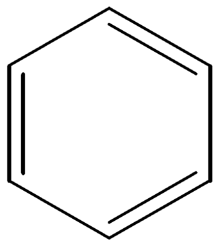
18 - OLED & OPV

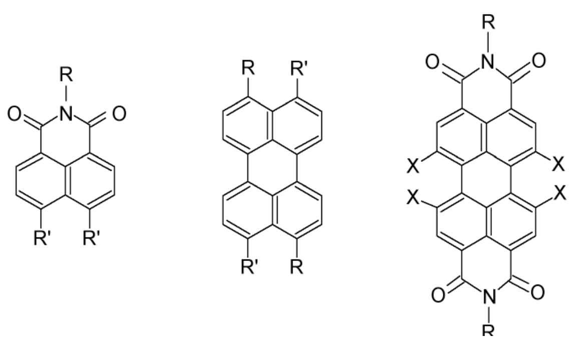
Name:____________________________

In-Class Problems

(1) For benzene (shown below), which has conjugated bonding, draw a molecular 'stick and ball' diagram like we had in lecure, and label where you have single bonds (with a '1') and where we have double bonds (with a '2) and ensure that every Carbon has 4 shared covalent bonds to give it 8 total valence electrons.



(2) Three fluorescent dyes are shown below. One is blue, one is green, one is red.



(a) which one of the above molecules is the product shown in the data sheet shown at right?

(b) obtain two acrylic sheets from Prof. Heikenfeld, one is doped with green fluorescent dye, the other with red fluorescent dye. You will notice that the edges appear to glow more than the large-area surfaces…. WHY?

Hint, this has to do with light out-coupling…

(c) the acrylic sheet as a refractive index of ~1.5. Calculate the total light outcoupling percentage for the sheet (what is not outcoupled, is trapped inside by total internal reflection!). OLEDs use plastic

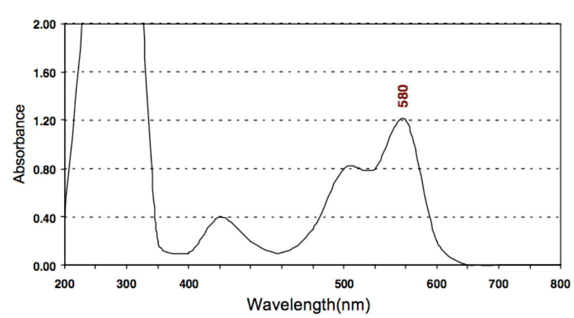
LUMOGEN® F Red 300

0.02% GPPS

Type of Dye		Perylene
Color Index		-----------
Fastness to Weathering (PMMA) *0.02% in PMMA injection-molded plaques of 2 mm thickness Residual fluorescence(%) after 80 days accelerated exposure in Xenotest 1200		>95*
Heat Stability (0.02%)	(PC) (PMMA)	300°C 300°C
Melting Point		>300°
Specific Gravity		1.40 cm^3

Max (nm) Absorption in ethylene dichloride dichloride	Max (nm) Absorption in PMMA	Fluorescence (nm) in ethylene dichloride	Max Quantum Yield
578	578	613	0.98

LUMOGEN® F RED 300
Spectral curve run in Acetone



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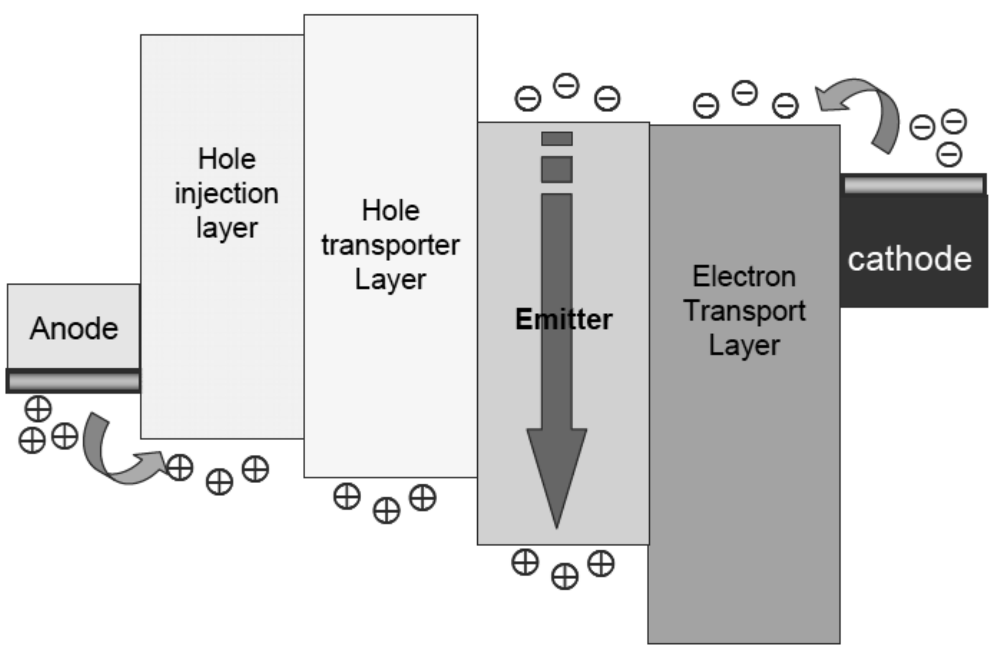
materials which have similar refractive indices (roughly). You may neglect Fresnel reflection. Equations are in lecture 17 on LEDs….

(d) GaP has a refractive index of 3.4. What is its outcoupling? You will see that for inorganic semiconductors, which have higher refractive indices, you need to pay close attention to outcoupling! You may neglect Fresnel reflection again.

(3) Check all statements below that are true for ORGANIC light emitters and detectors:

__ they potentially are lower cost (made of 'plastic', and simple printing/spraying on long rolls of material)
__ they are ideal for making thinner, lighter, more flexible/foldable/rollable, and shatterproof devices
__ they have lower mobilties and likely will always be inferior to inorganic semiconductors for solar cells, LEDs, etc.
__ they degrade faster than inorganic semiconductors and are sensitive to heat, moisture, sunlight fading, etc.

(4) For the more advanced OLED device shown below….



(a) why do we have a hole injection layer? ….. 1 reason

(b) why did we add a hole transport layer? …. 2 reasons

(c) why did we add an electron transport layer ? …. 1 reason

(d) why don't we need an 'electron injection layer'? …. 1 reason

(e) what is the ONE parameter you need for the metals, that you would look up, before you determined if they could inject electrons or holes?

(f) if the anode is transparent, what type of electrode material do you have to use?

(g) if the anode is transparent (e.g. transmits all light >400 nm), then what must the bandgap energy of the material be?

(5) You create a super high resolution and large OLED display with 9 million pixels. You may assume the display is monochrome (is single color, no RGB sub-pixels which would cause you to require 3X more electrodes).

(a) What is the minimum number of external control electrodes needed if you directly wired your display inputs to each pixel? That means you are <u>not</u> using matrix addressing…

(b) What is the minimum number of external control electrodes needed if you use active-matrix transistors to provide input to each pixel?

(c) How many TOTAL number of transistors (thin film transistors) on glass will you need to fabricate to drive the OLED display? Careful, OLEDs are more complex to drive than LCDs….

(6) Lets do some very important review before the final! Circle or underline the right answer!

(a) Exists at 300K for a diode in thermal equilibrium (with no voltage applied to it).

DRIFT DIFFUSION BOTH NEITHER

(b) Reduces as you increase doping for a forward biased PN junction.

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(c) Is how carriers are transported across the base of a BJT.

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(d) Separates photogenerated carriers inside a solar cell so that they can be collected.

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(e) Drives the source to drain current in a MOSFET.

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(f) How a collector actually 'collects' current in a BJT.

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(g) A solar cell with no voltage and no light, drives current flow at thermal equilibrium (think before you answer).

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(h) A JFET would have an current-to-current amplification factor of infinity if it were not for this.

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(i) What drives current from the emitter to the base in a pnp BJT.

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(j) Requires particles that have electrical charge and electric field.

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(k) Requires a concentration gradient.

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(l) After taking this course, is now personally your favorite type of current.

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