

Organic LEDs - part 6

- Exciton Recombination Region in Organic LEDs
 - White OLED
 - Flexible OLEDs
 - Solvation Effect
 - Solid State Solvation
-

Handout: Bulovic, et al., Chem. Phys. Lett. 287, 455 (1998); 308, 317 (1999).



Exciton can transfer its energy to:

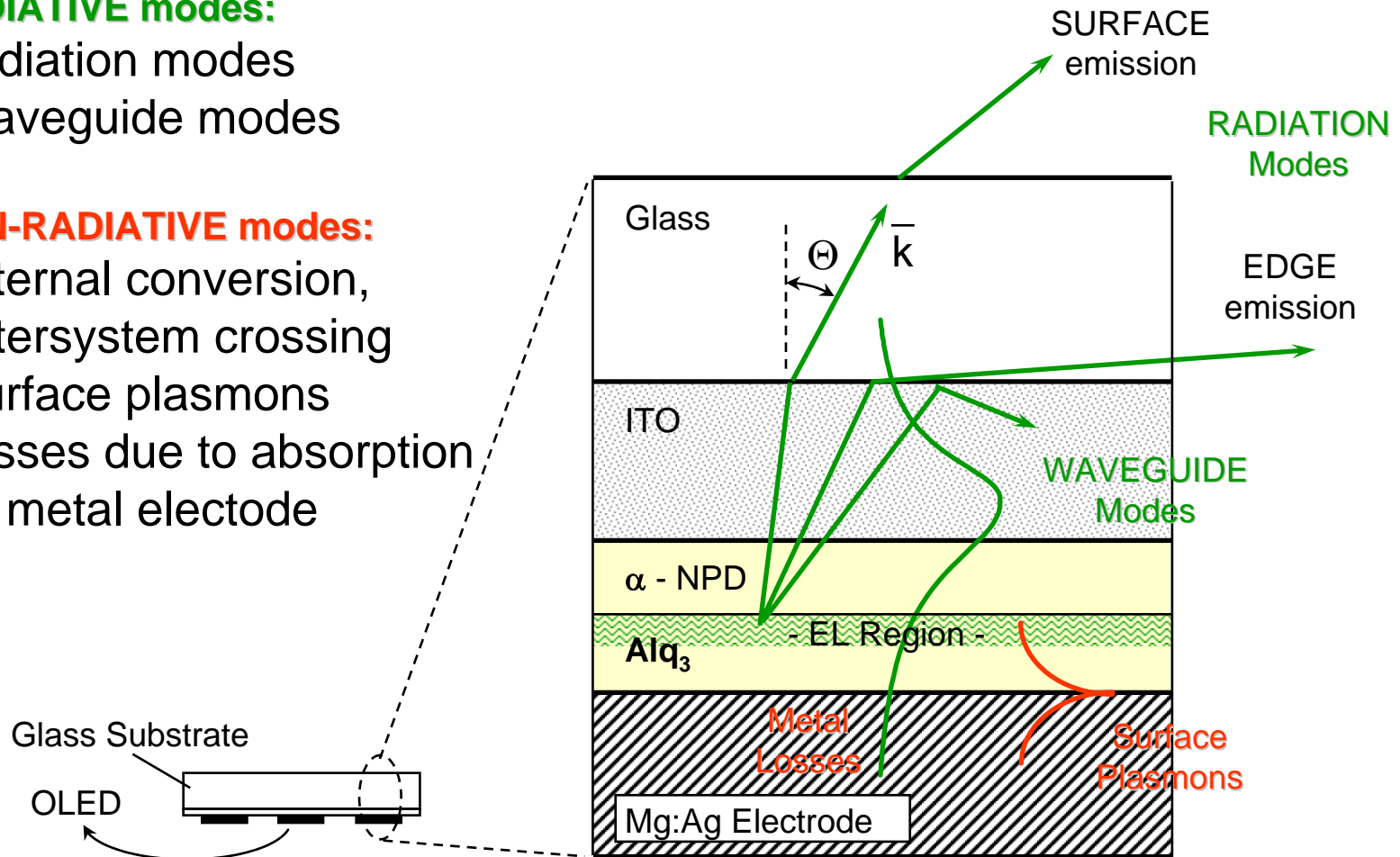
Bulović et al., Phys. Rev. B 58, 3730 (1998).

RADIATIVE modes:

- * radiation modes
- * waveguide modes

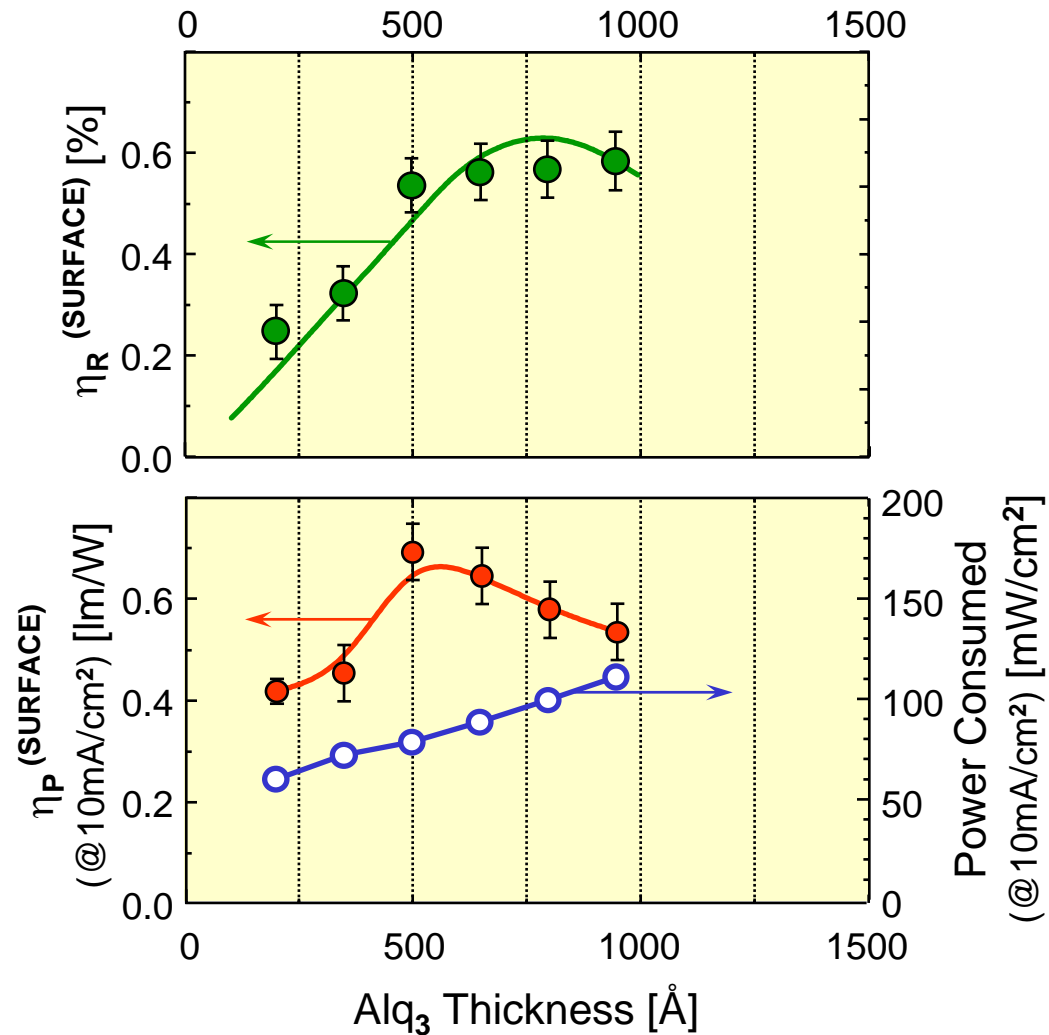
NON-RADIATIVE modes:

- * internal conversion, intersystem crossing
- * surface plasmons
- * losses due to absorption in metal electrode



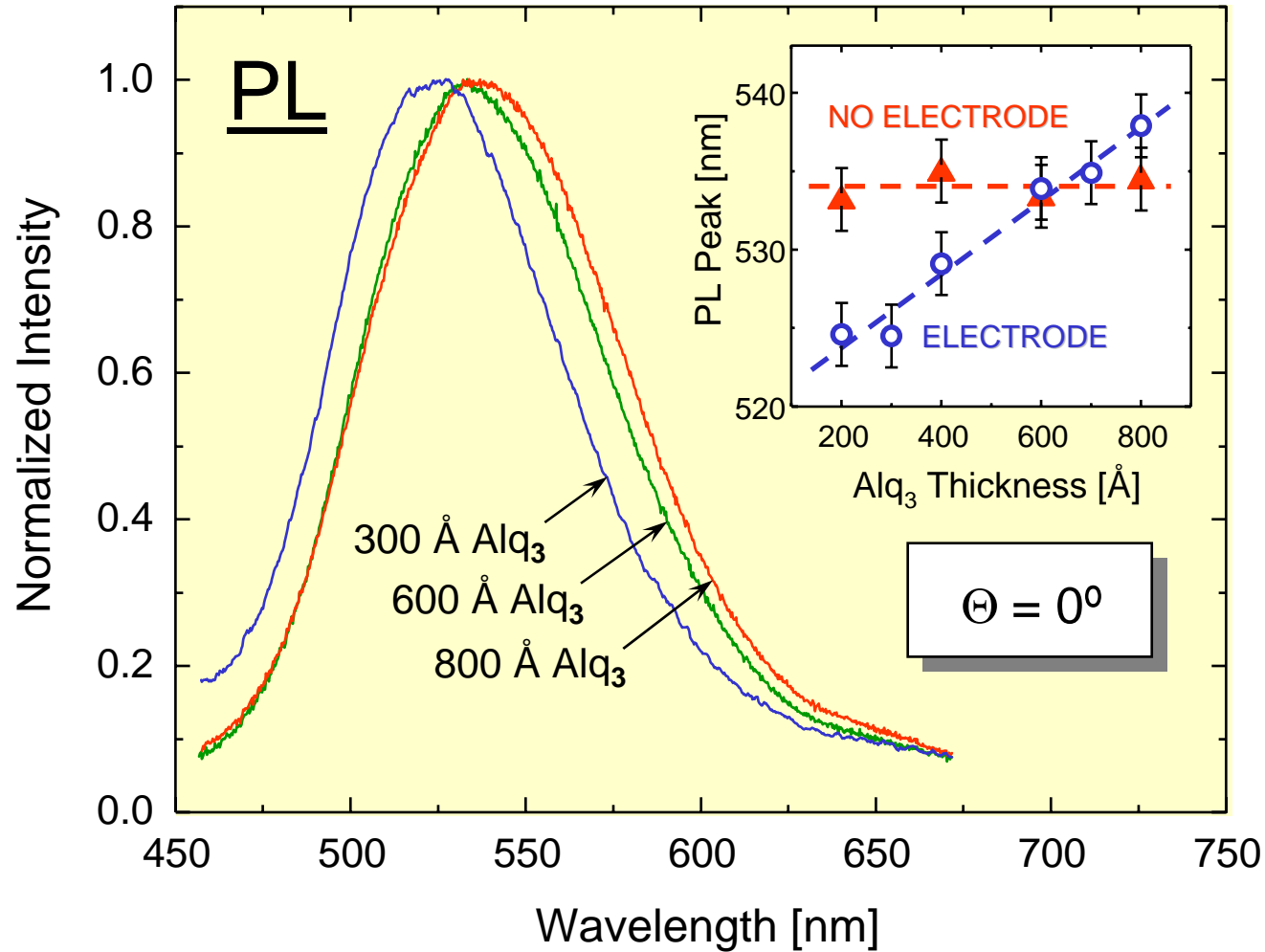
External EL Quantum and Power Efficiency (η_R and η_P)

for ITO/ 350Å NPD/ xÅ Alq / Mg:Ag / Ag



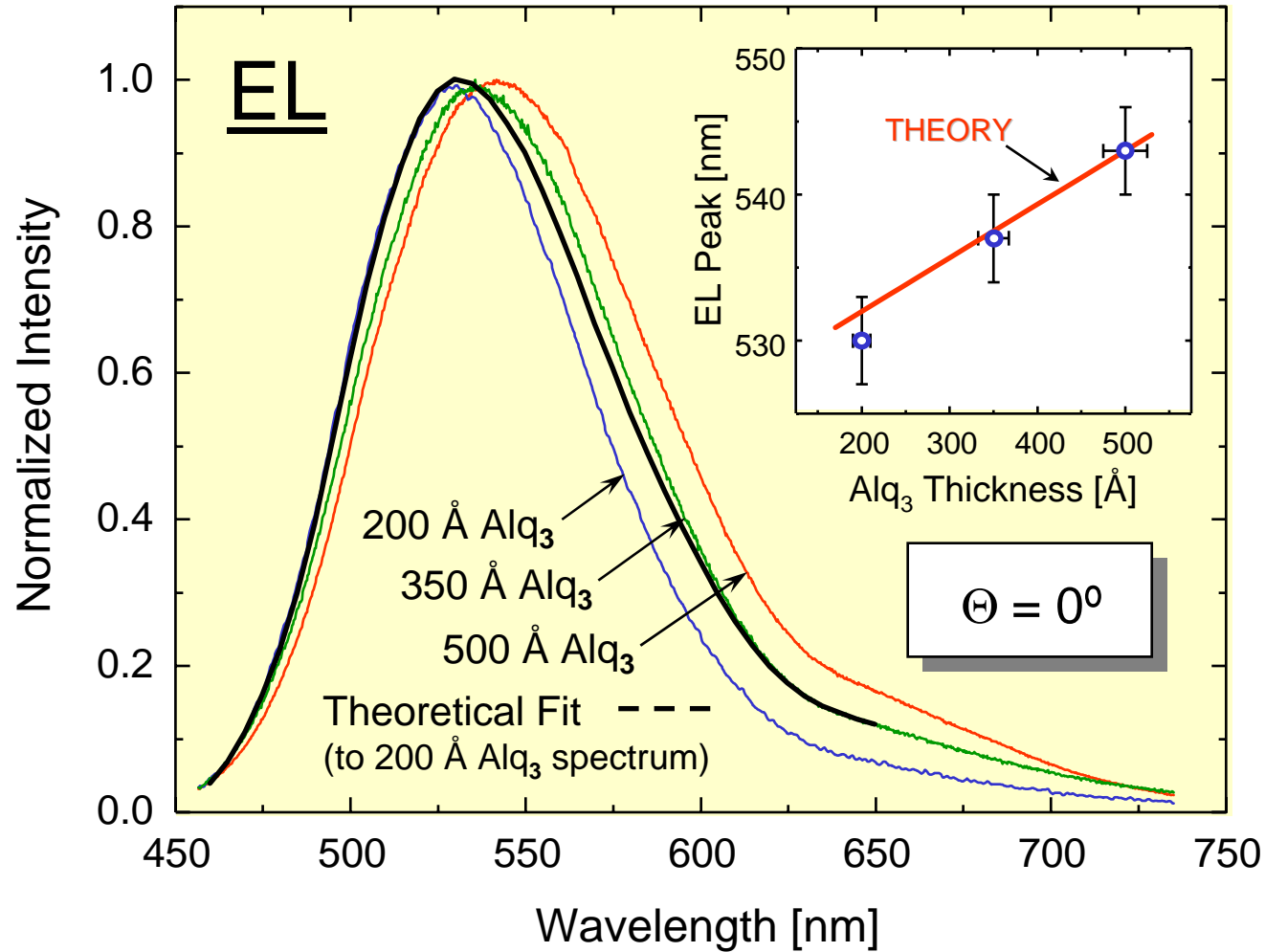
PL Dependence on Alq₃ Thickness

Bulović et al., Phys. Rev. B 58, 3730 (1998).



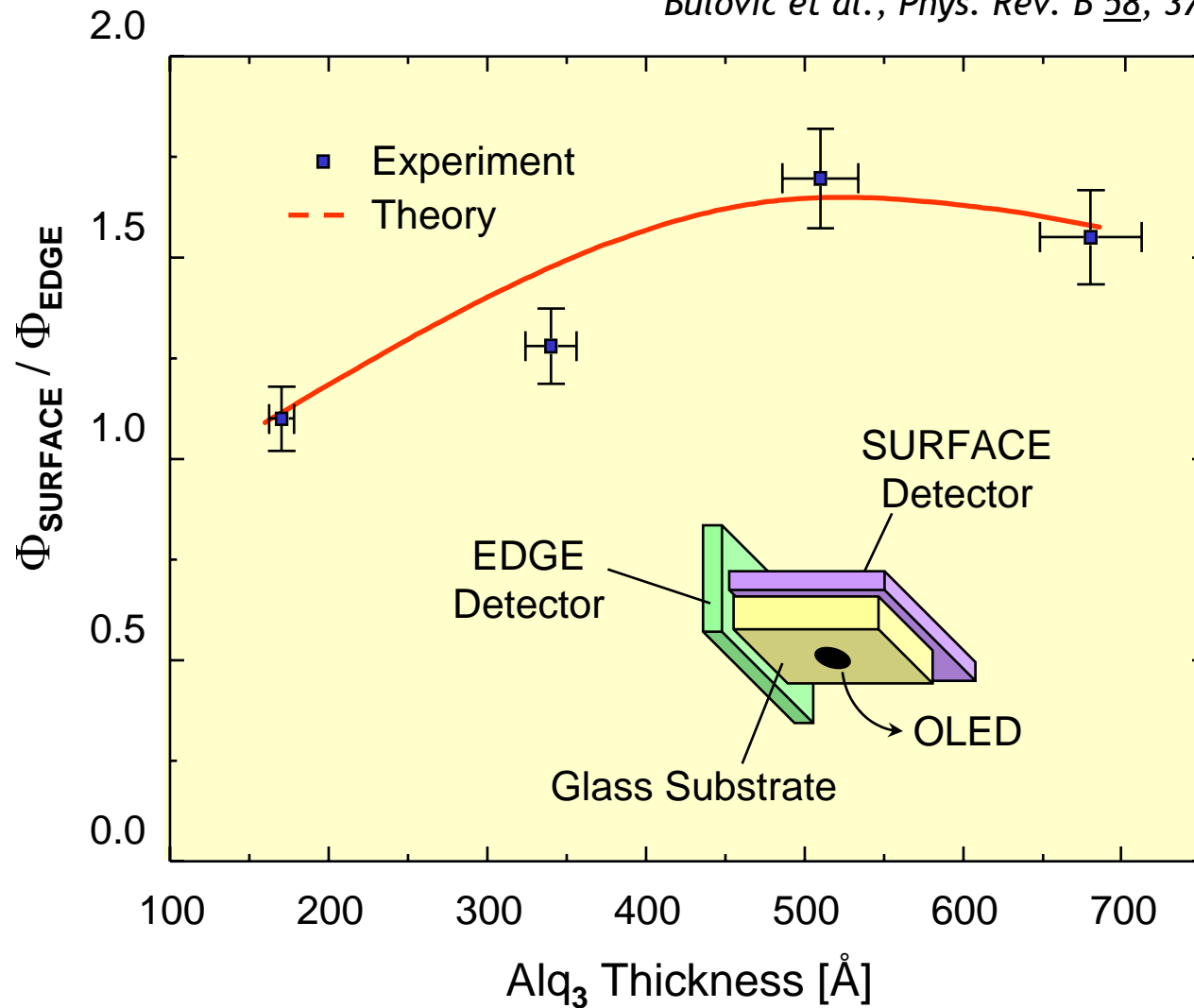
EL Dependence on Alq₃ Thickness

Bulović et al., Phys. Rev. B 58, 3730 (1998).



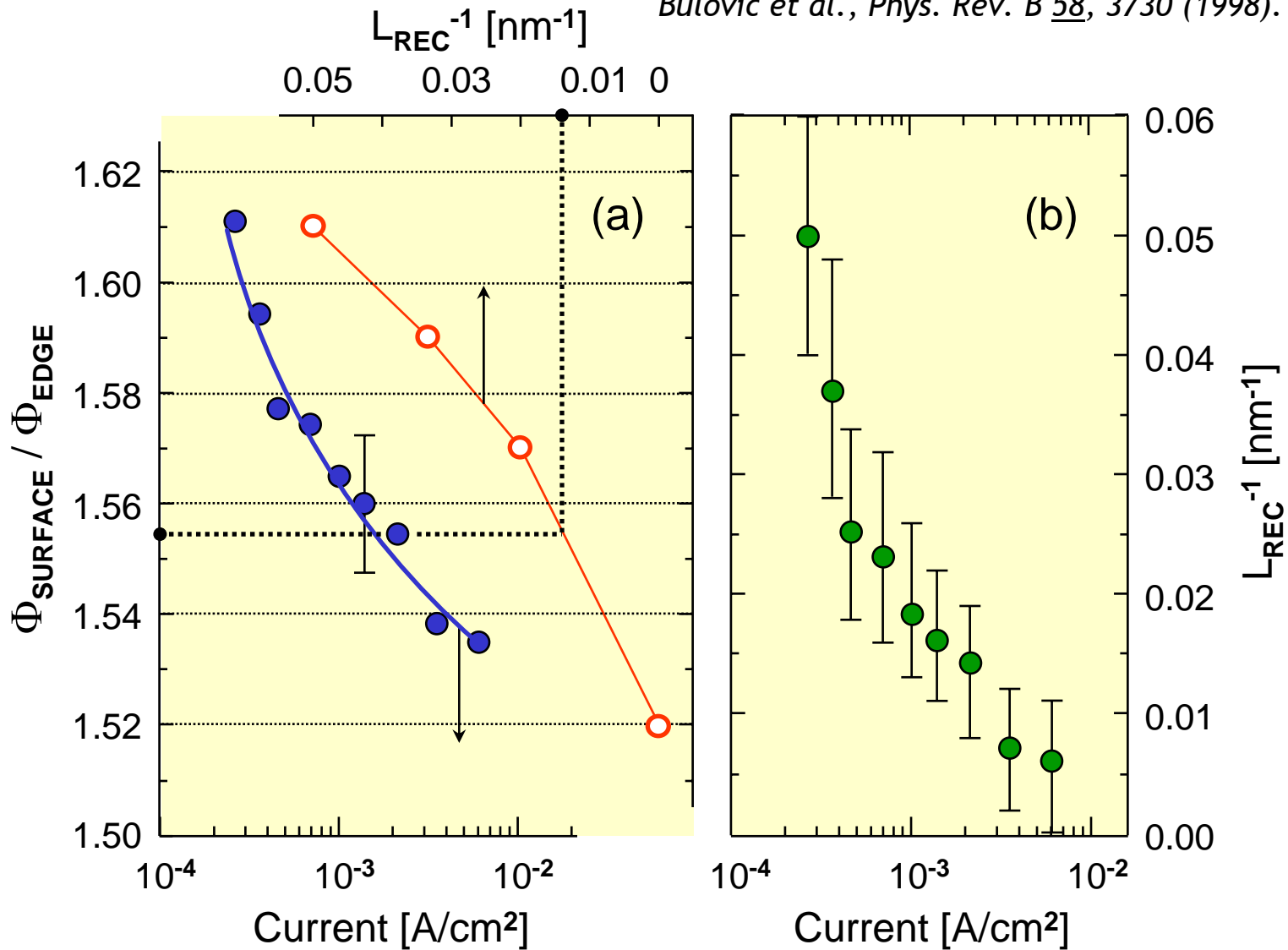
Top to Side EL Ratio - Dependence on Alq₃ Thickness

Bulović et al., Phys. Rev. B 58, 3730 (1998).

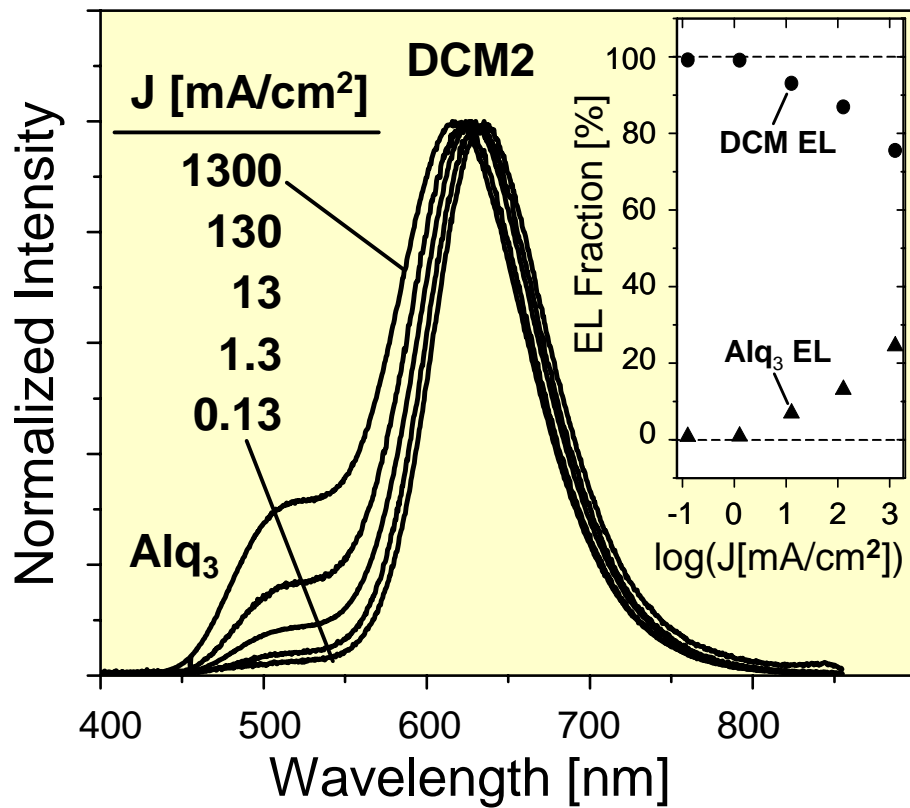
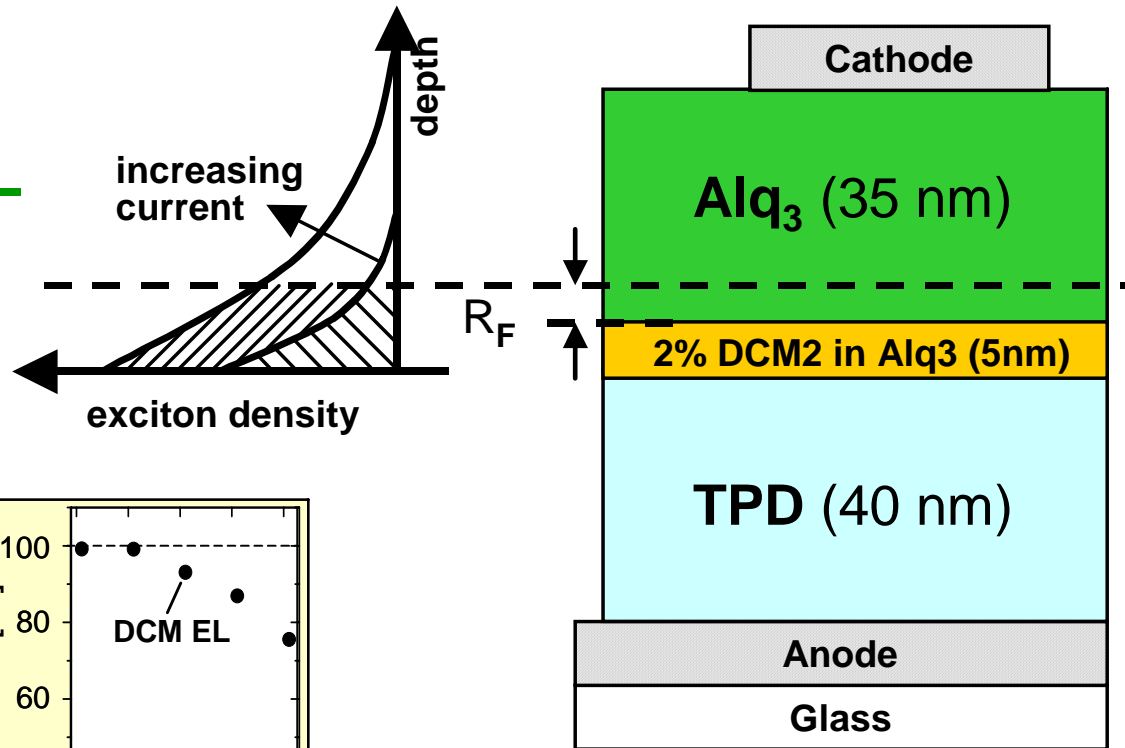


EL Recombination Region Dependence on Current

Bulović et al., Phys. Rev. B 58, 3730 (1998).

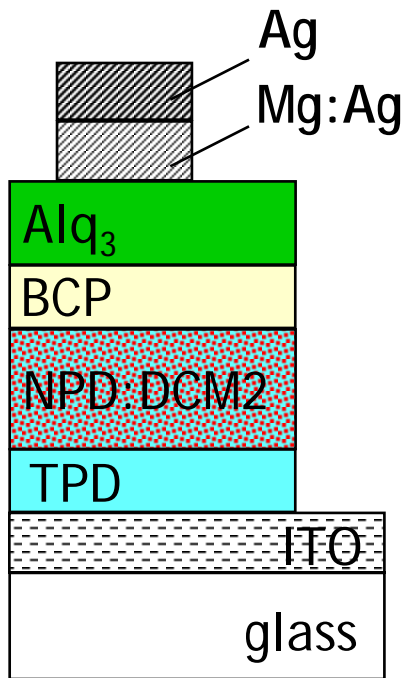


EL Recombination Region Dependence on Current

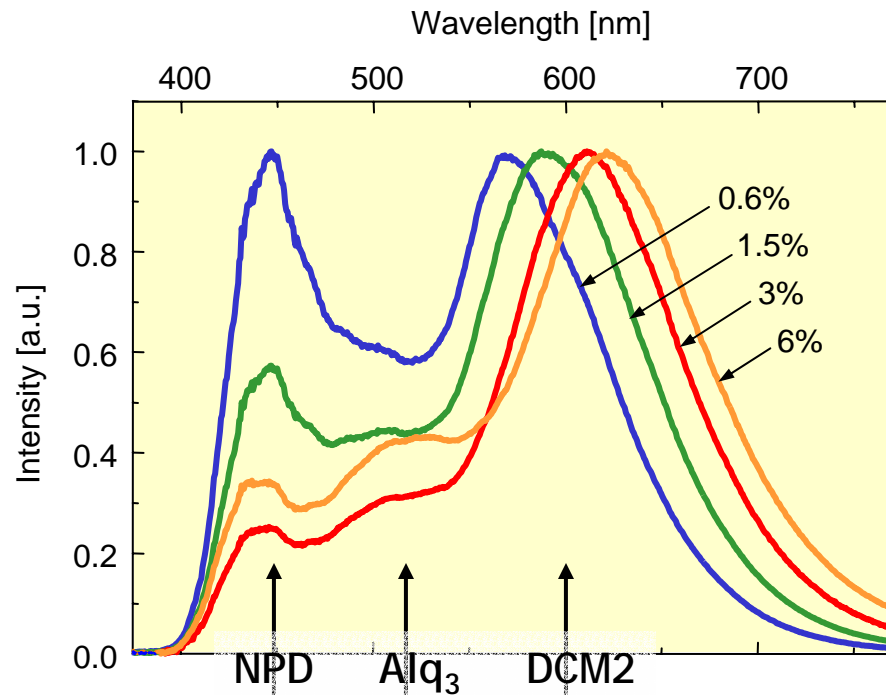


Coe et al., *Org. Elect.* (2003)

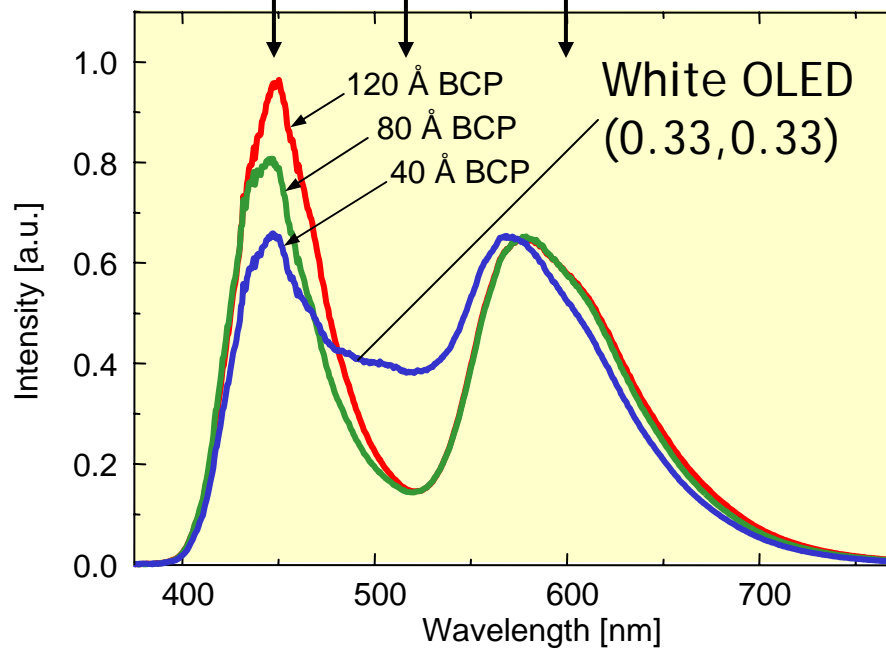
Tuning Emission of White OLEDs



BCP - exciton blocking layer



changing DCM2 in α -NPD concentration (with 40Å BCP)

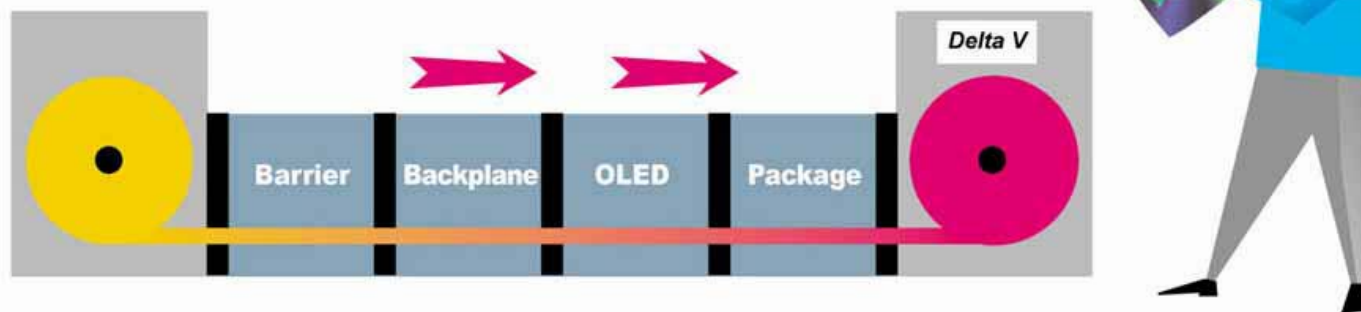


changing BCP layer thickness (with 0.6% DCM2)

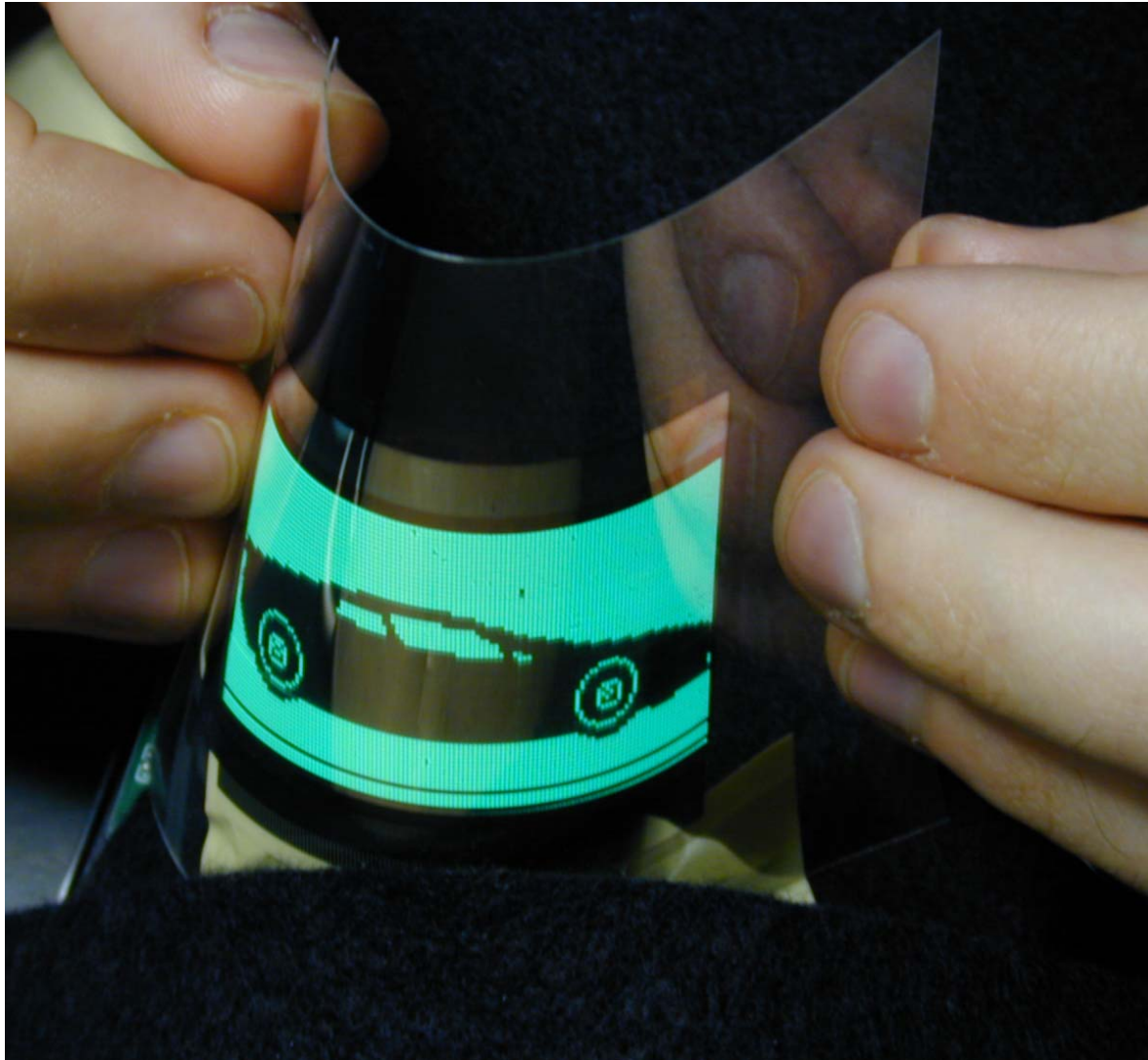
Flexible OLED (FOLED)

- Ultra lightweight
- Thin form factor
- Rugged
- Impact resistant
- Conformable

Manufacturing Paradigm Shift
Web-Based Processing



FOLED-based Pixelated, Monochrome Display



Source: UDC, Inc.

Transparent FOLED-based Pixel



Source: UDC, Inc.

Packaging of OLEDs - Multilayer Coatings

Barix is a coating composed of alternating layers of polymer and ceramic thin films that can be deposited on a plastic substrate or directly on an OLED display. The technology breakthrough that enables this to be used as the packaging material for flat panel displays is the creation of a barrier layer 10,000 times better than anything currently produced.

From Vitex, makers of barix coating

The PRESENT ...

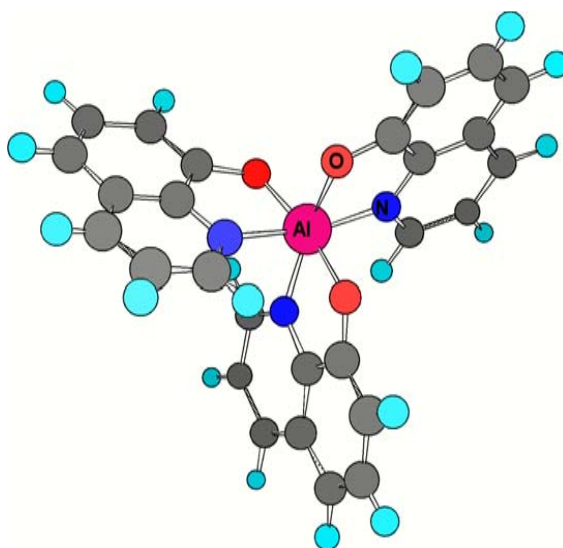


... and the nearby FUTURE ...



... of ORGANIC DISPLAY TECHNOLOGY

Luminescence of Molecules in Solid Matrices

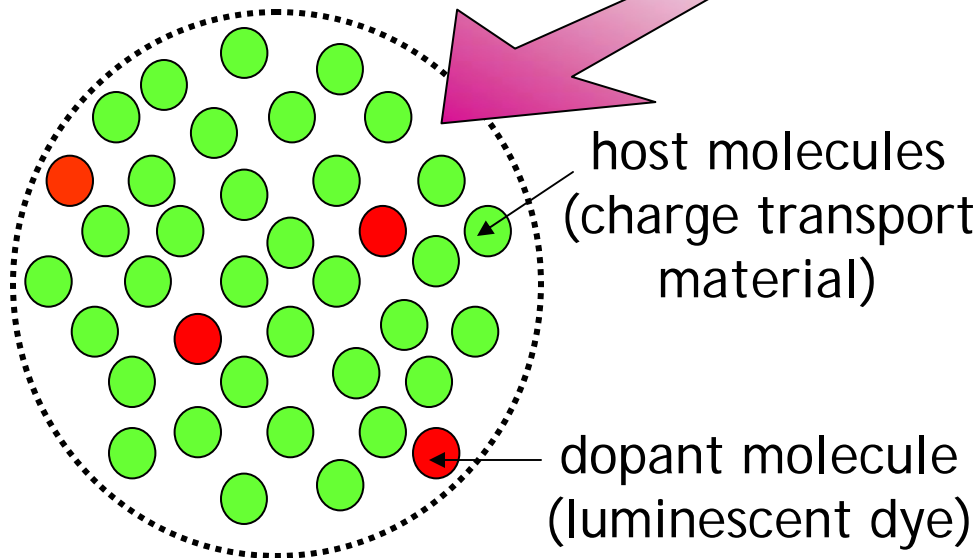
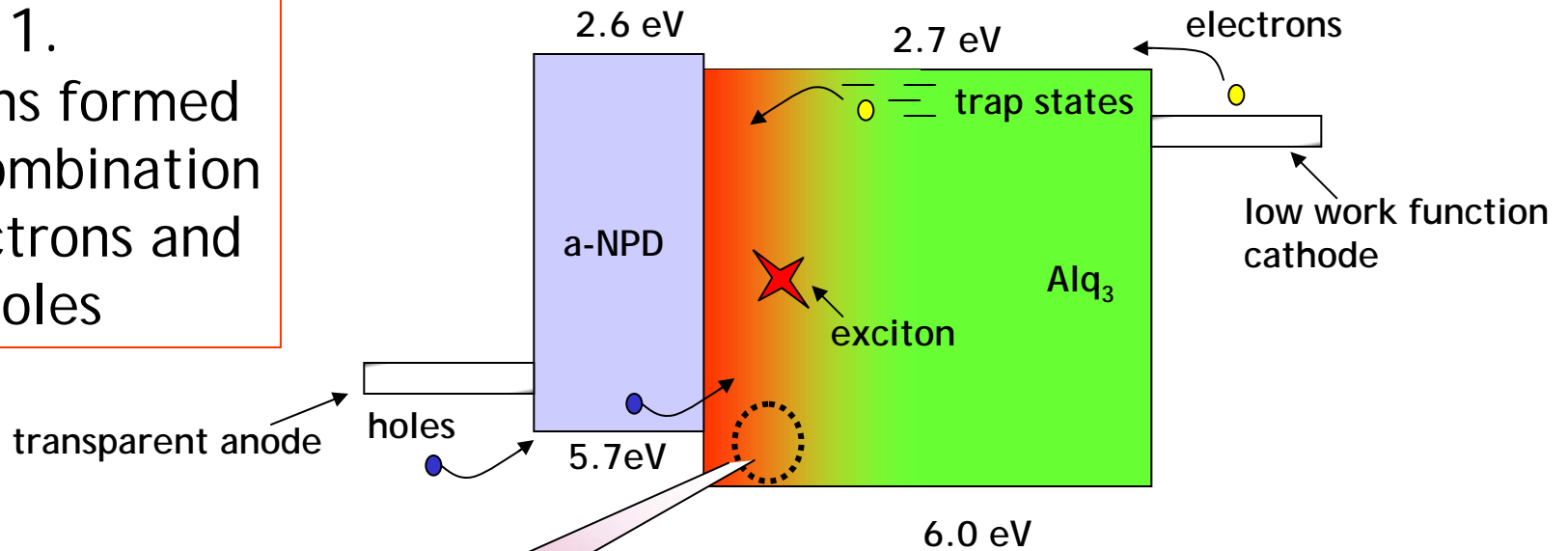


-
- Solid State Solvation (SSS) •
 - Time-Resolved SSS •
-



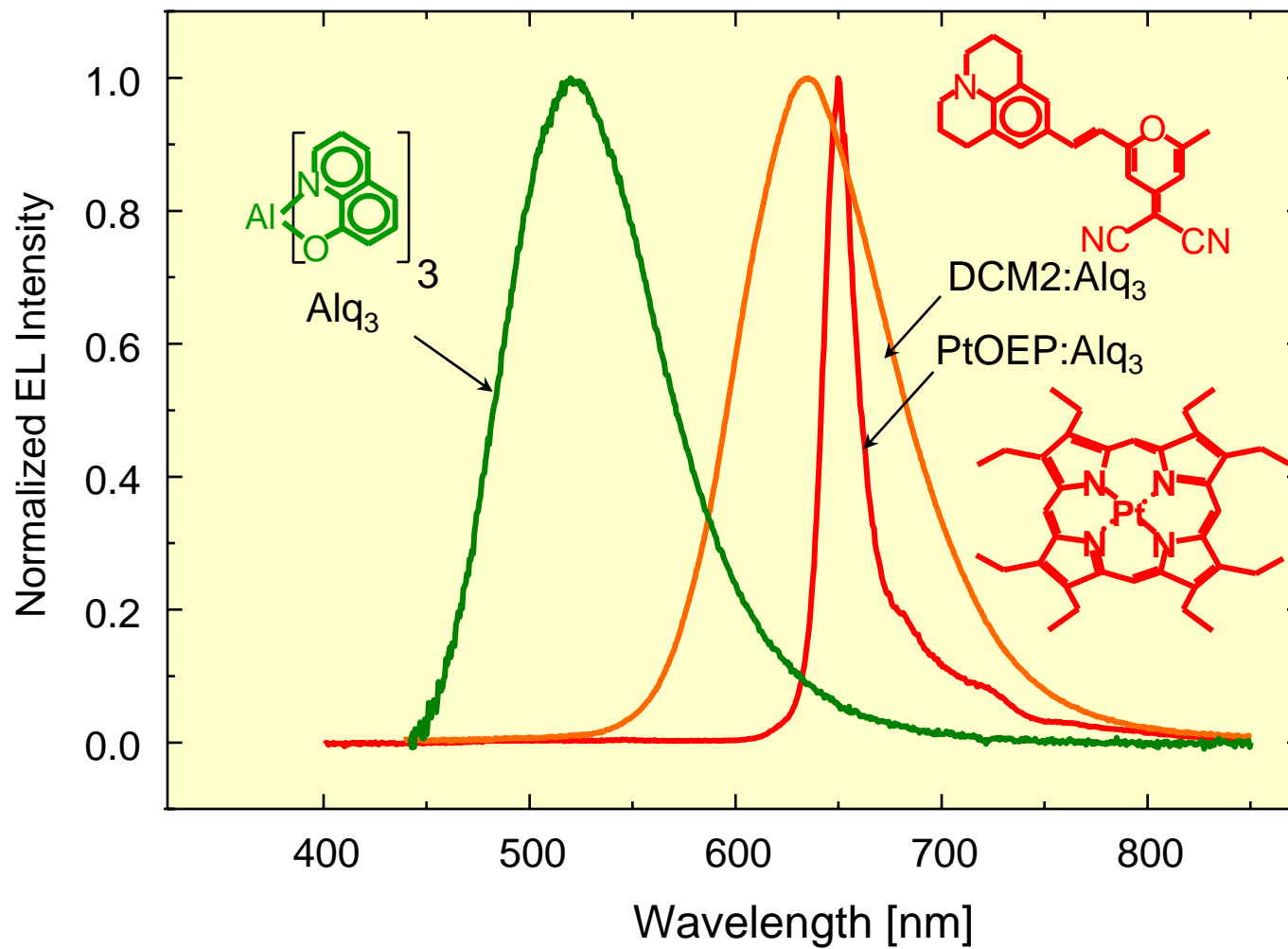
Electroluminescence in Doped Organic Films

1.
Excitons formed from combination of electrons and holes

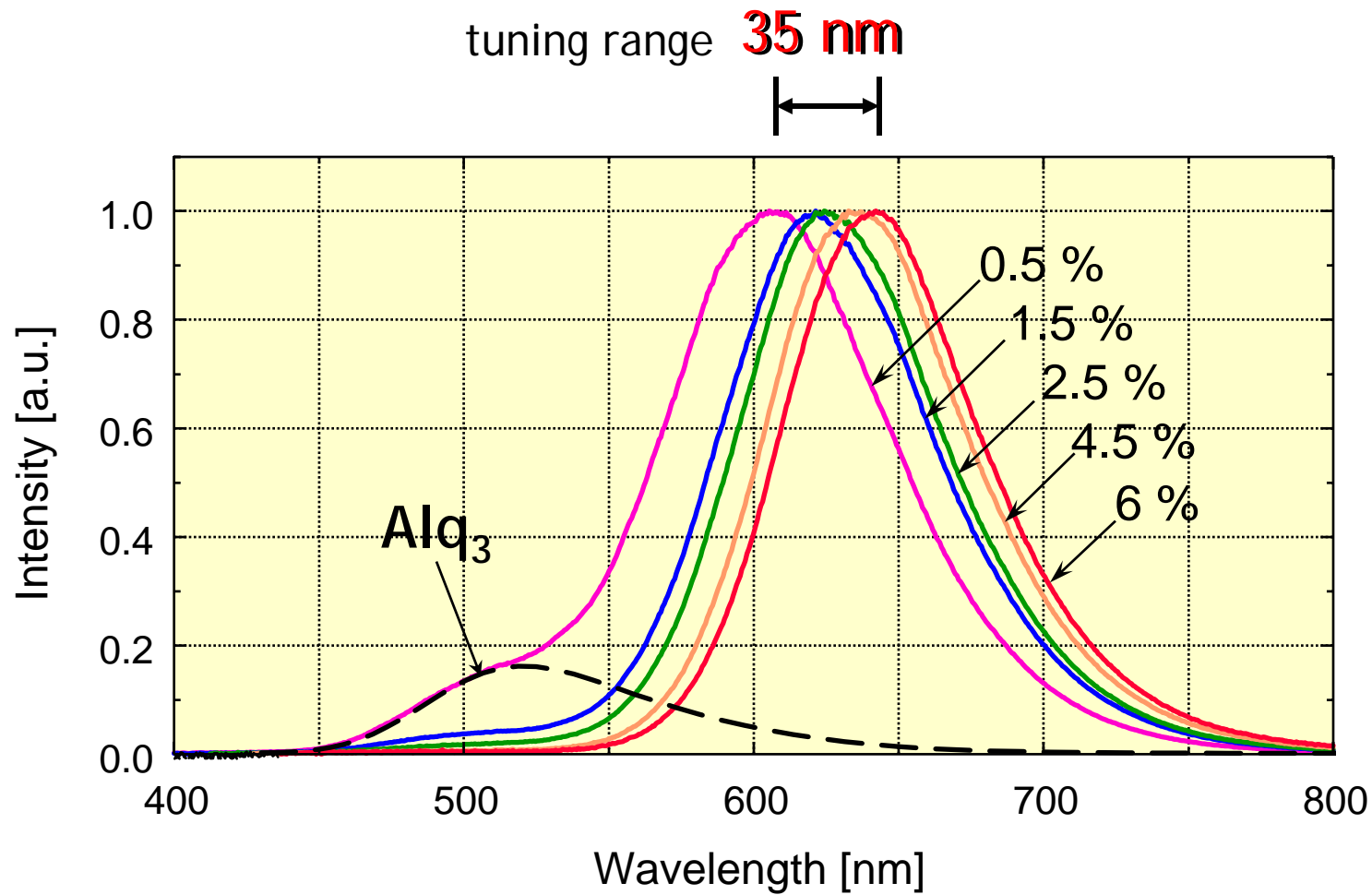


2.
Excitons transfer to luminescent dye

Effect of Dopants on the OLED EL Spectrum



Electroluminescence of x% DCM2 in Alq₃ OLEDs



Alq₃

DCM2 in Alq₃

low DCM2

high DCM2



Solvatochromism - Historical Perspective

It has been long recognized that UV/visible absorption spectra can be influenced by:

- THE PHASE (gas or liquid)
- SOLVENT

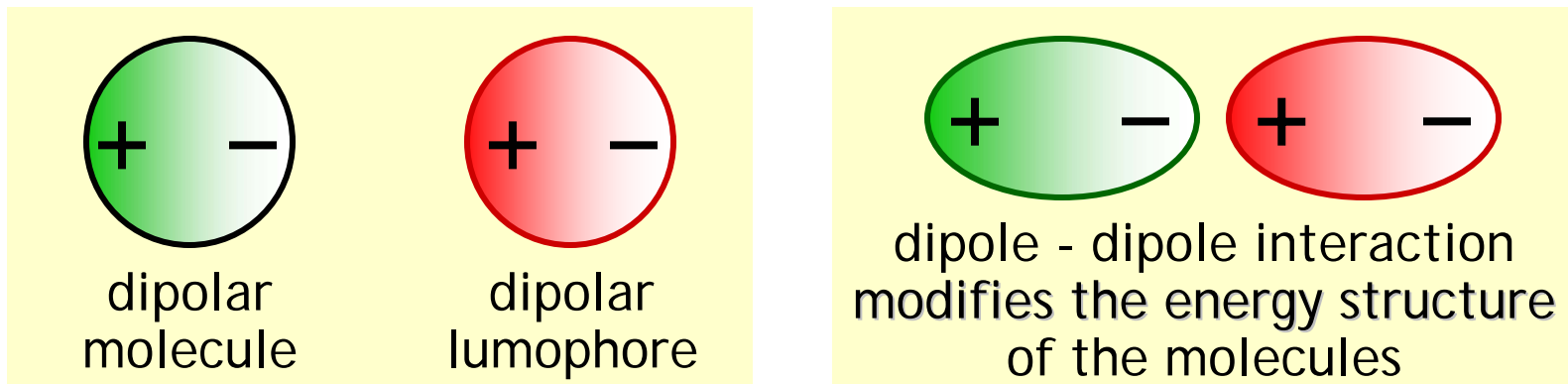
1878 - Kundt established relationship between solvent effect and solvent properties (Kundt's Rule)

using chlorophyll, fuchsin, aniline green, cyanine, quinizarine, and egg yolk, in twelve different solvents he concluded that

increasing index of refraction of the solvent is related to the red-shift in the absorption spectrum of the solute

SOLVATOCHROMISM

... change in the spectral position of
absorption/luminescence band
due to change in the polarity of the medium



- ⇒ solvation is a **physical perturbation** of lumophore's molecular states
- ⇒ isolated molecule (in a gas phase) and solvated molecule are in the same chemical state
(no solvent induced proton or electron transfer, ionization, complexation, isomerization)