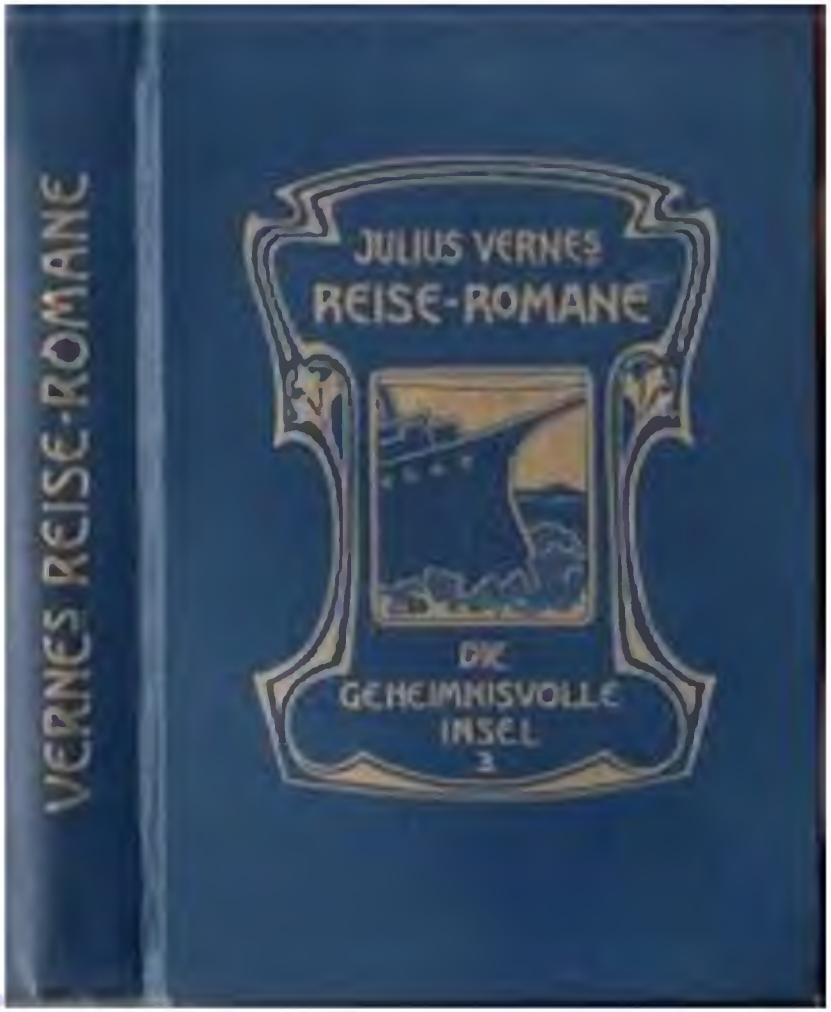
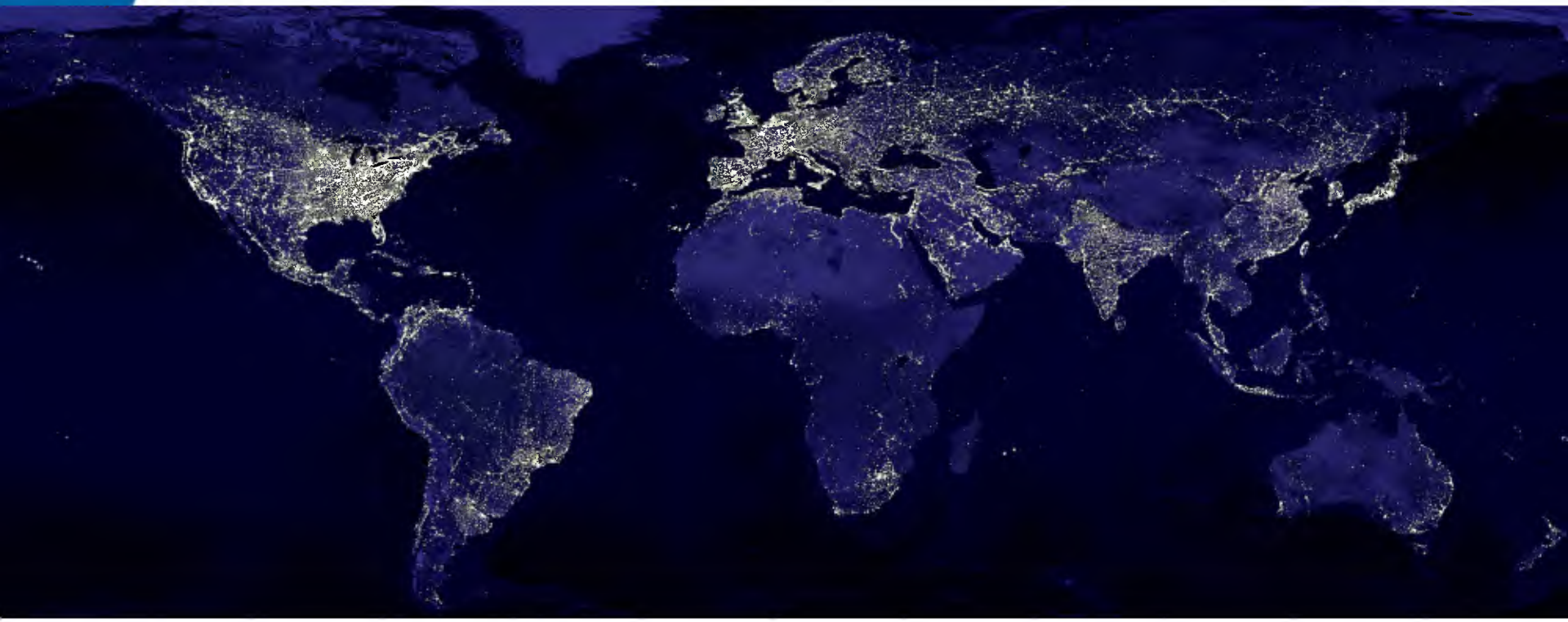
Licht-emittierende elektrochemische Zellen (LEC)

Edwin C. Constable
Universität Basel
Edwin.constable@unibas.ch

Krise ..... Was für eine Krise?



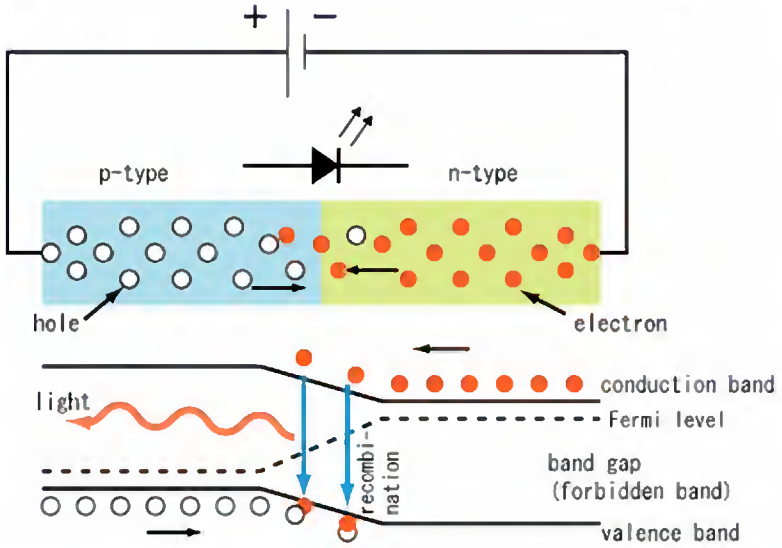
Und Gott sprach: Es werde Licht! und es ward Licht.
Und Gott sah, daß das Licht gut war. Da schied Gott das Licht von der Finsternis Genesis 1:3-4



Gluhbirne?

Die Kompaktleuchtstofflampe

Die Leuchtdiode (LED)

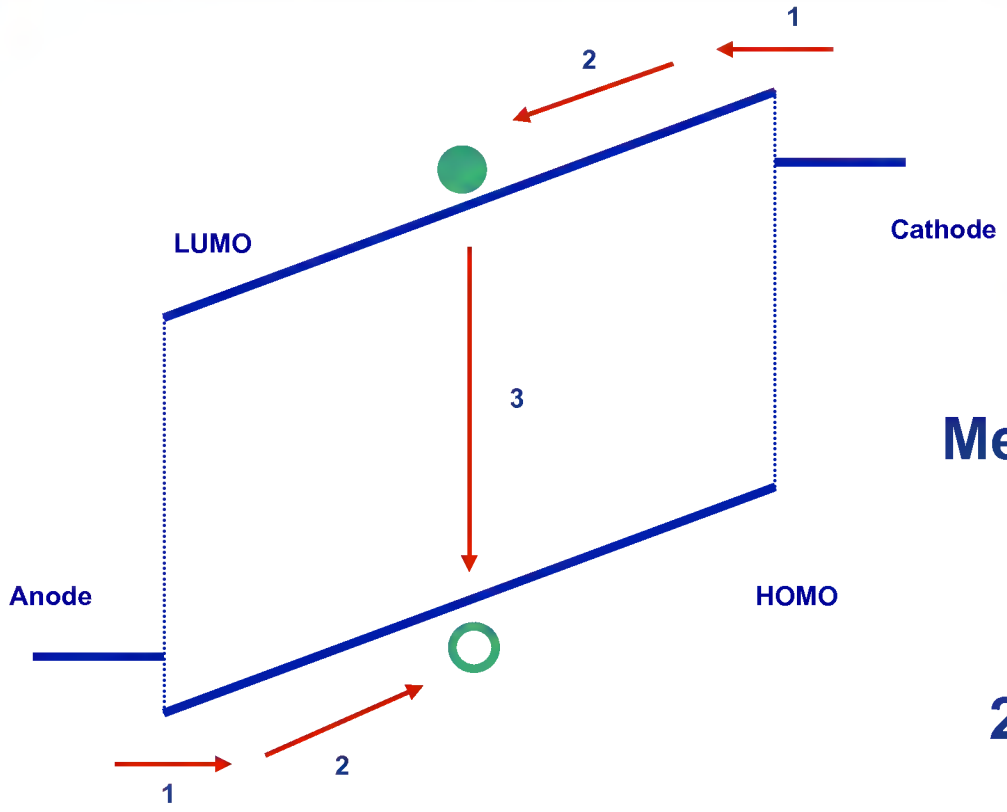


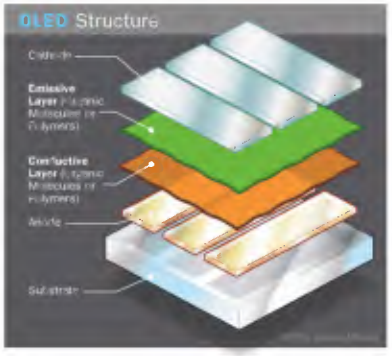
OLEDs (sind Cool)

Einfach, flexibel, billig (oder nicht wahnsinnig teuer)

Herz, was willst du mehr?

OLEDs, simple model





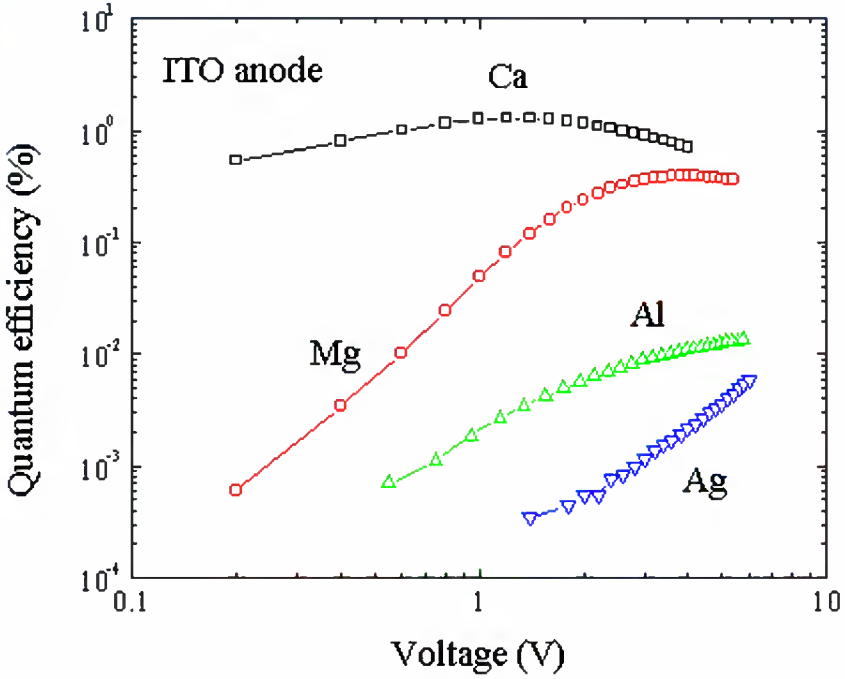
Mechanism involves:

1: Charge injection

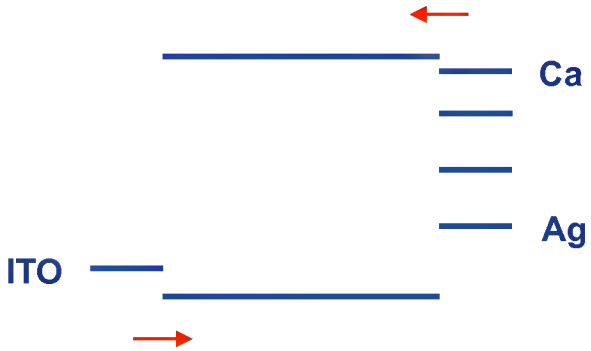
2: Charge transport

3: Charge recombination

Dependence of efficiency on cathode

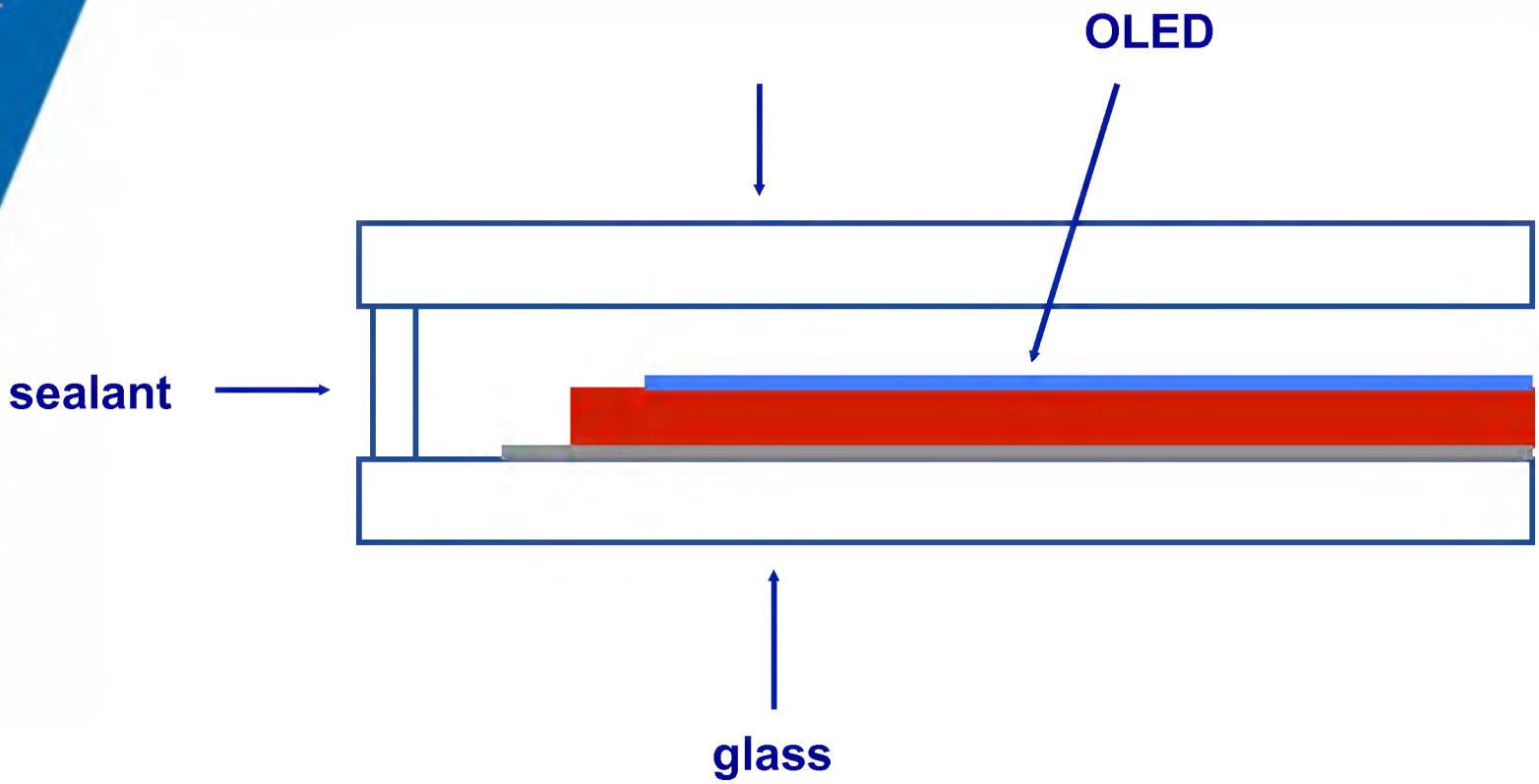


$$\eta = b \cdot \Phi \cdot (1/2n^2)$$



Low work function cathode needed for electron injection

Encapsulation

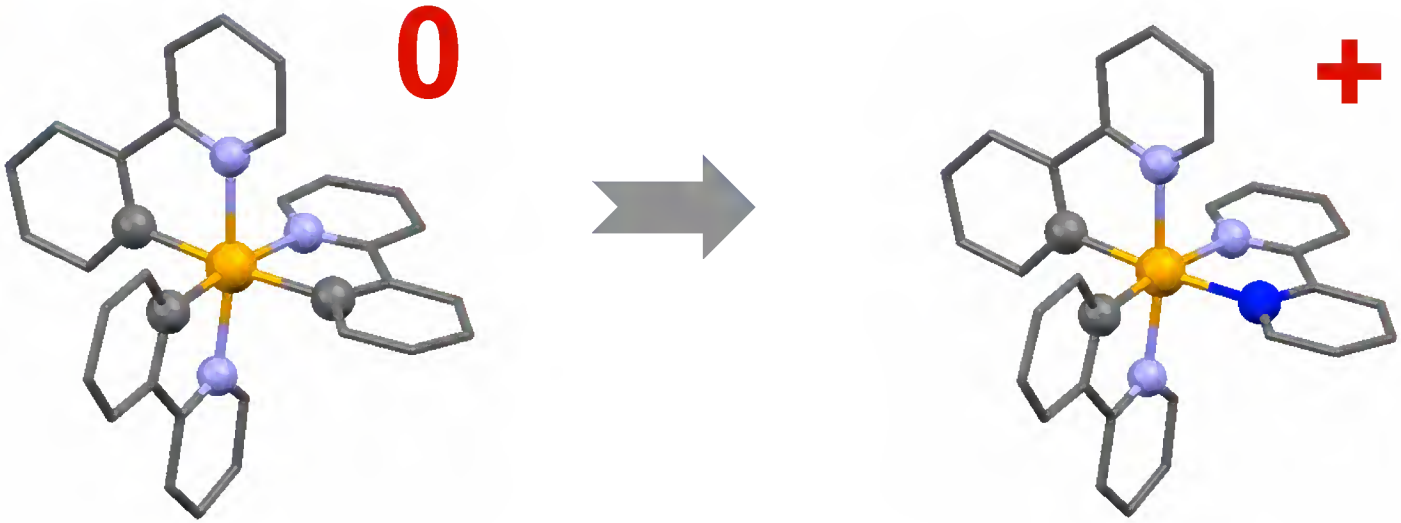


Can we make OLEDs with air-stable cathodes?

It works, but ……..

Iridium 6.März 2012 $34,561 per kilogram

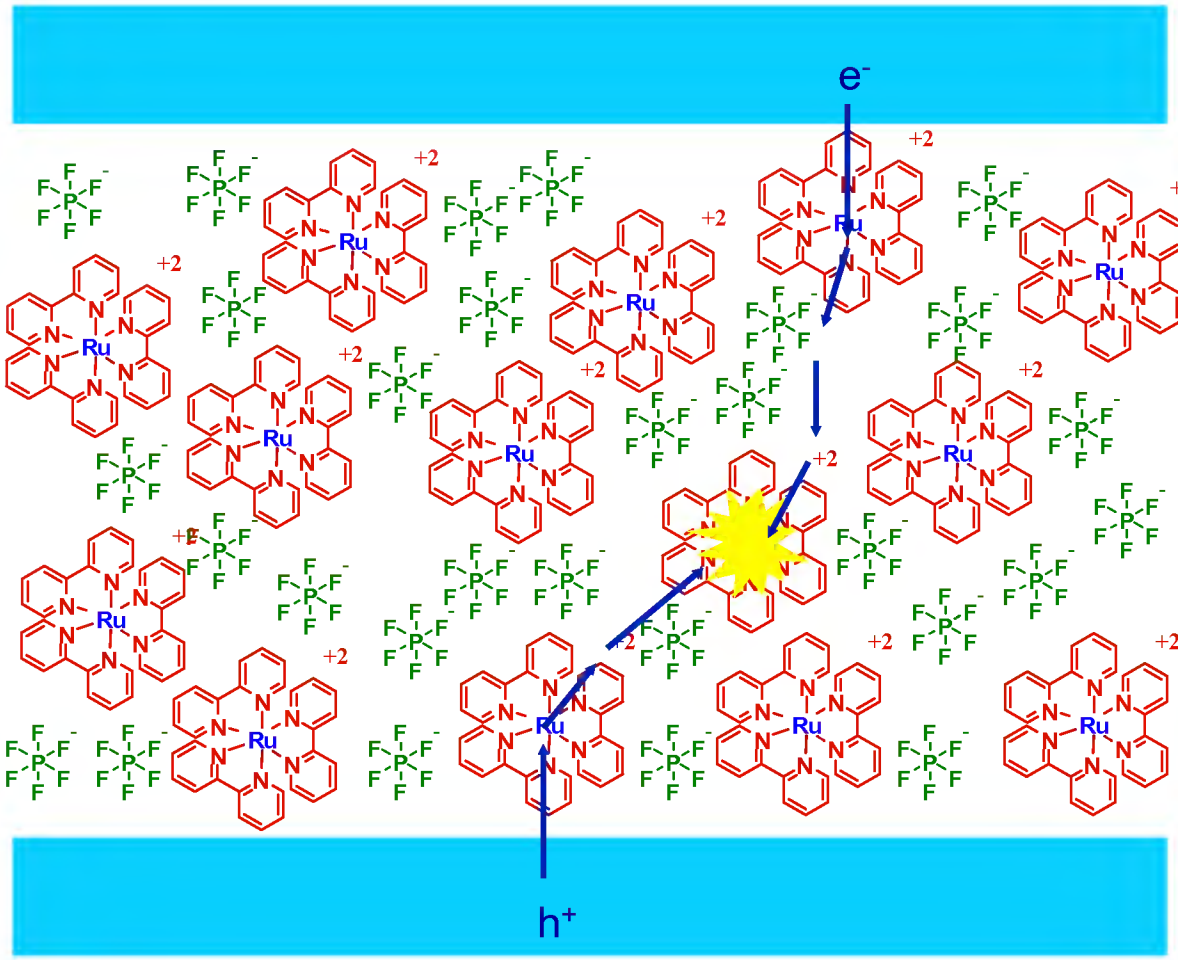
Ionic transition metal complexes



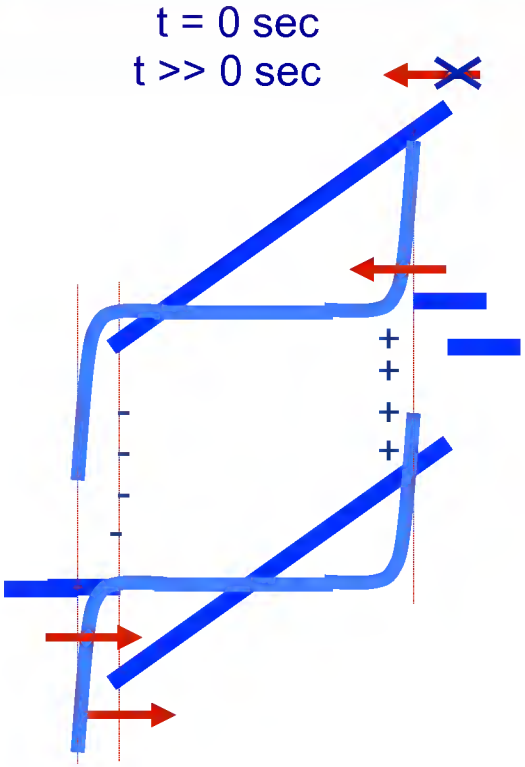
Licht emittierende elektrochemische Zell

- Hängt nicht von der Auftrittsarbeit ab
- Luft- und Wasser-stabil Elektroden
- Einfach – Einzel oder Doppel Schichten
- Unabhängig von Schichtdicke

LEC Mechanism



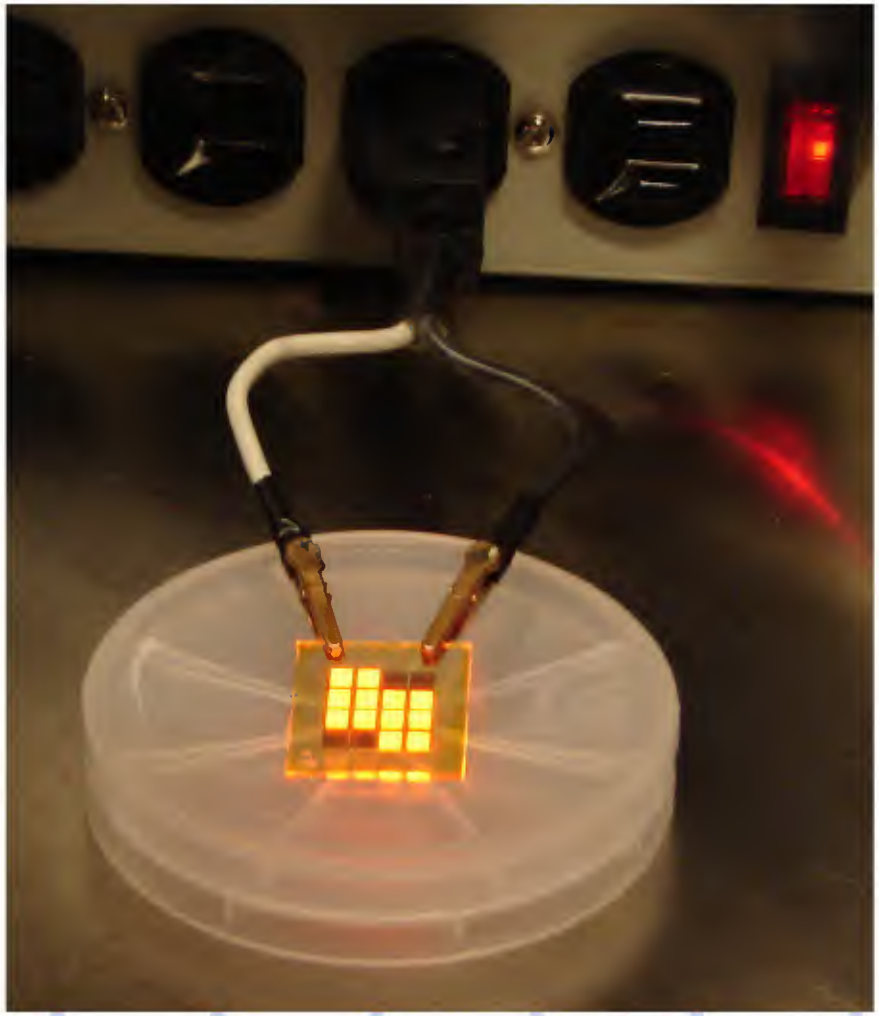
LEC Mechanism



Ionic transition metal complexes

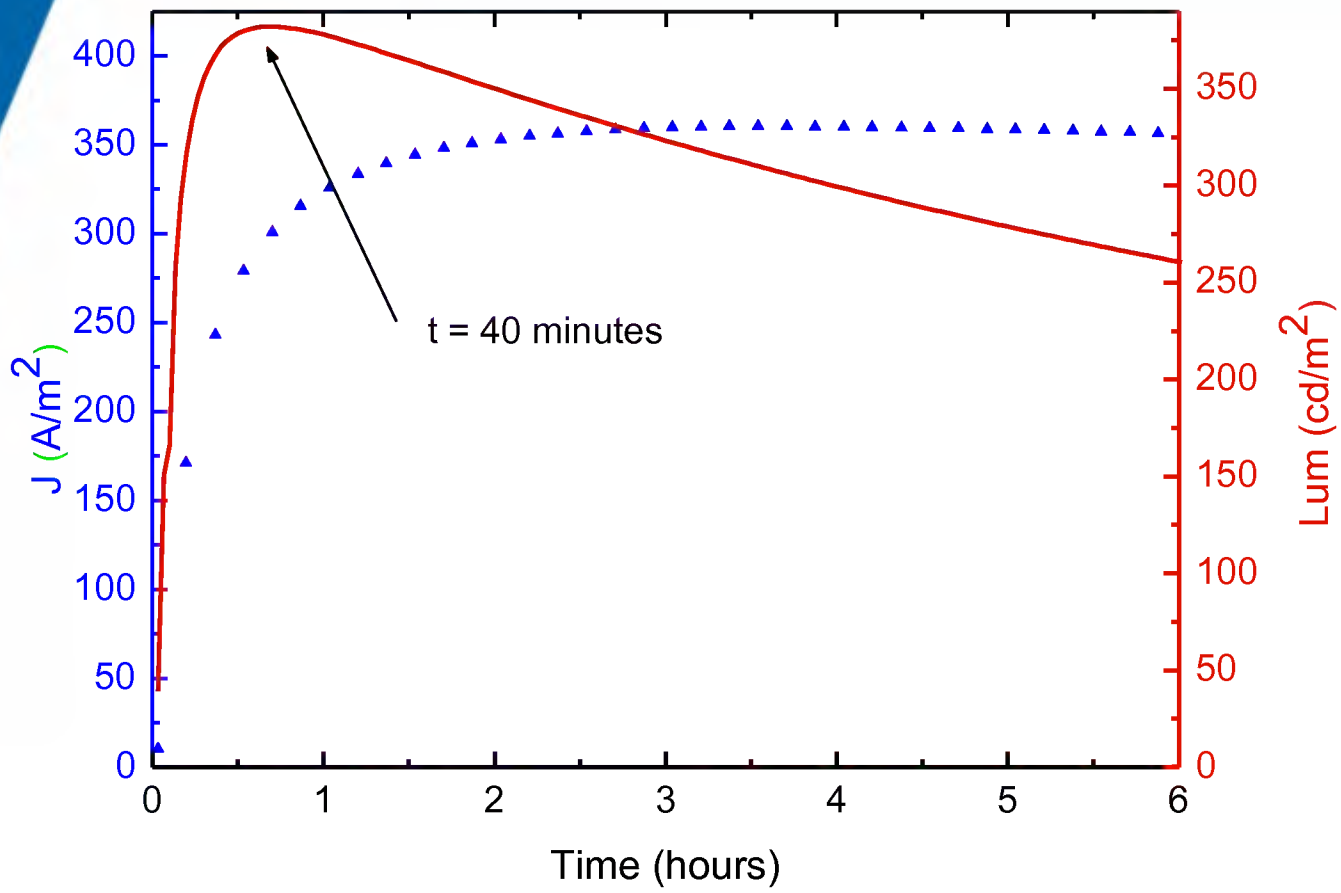
Traditional OLED

Operation straight from the outlet



Slide courtesy of
George Malliaras

Device characteristics

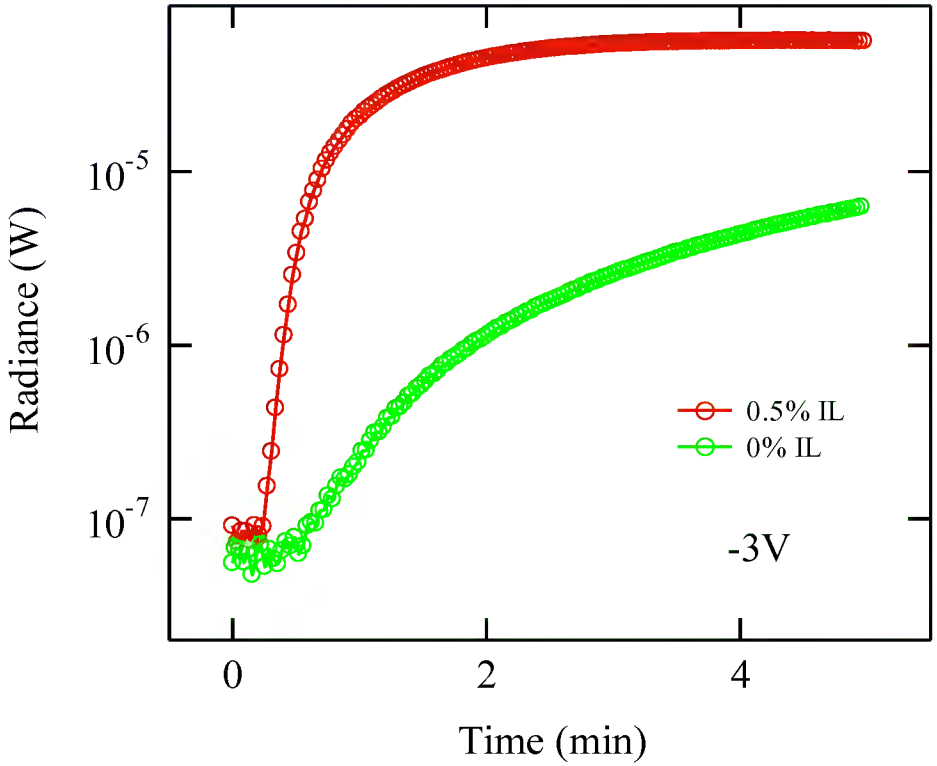


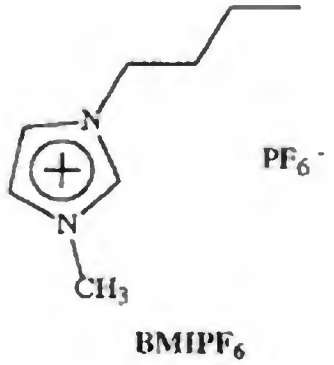
At 3V:

>300 cd/m^2

Slow turn-on, followed by decay

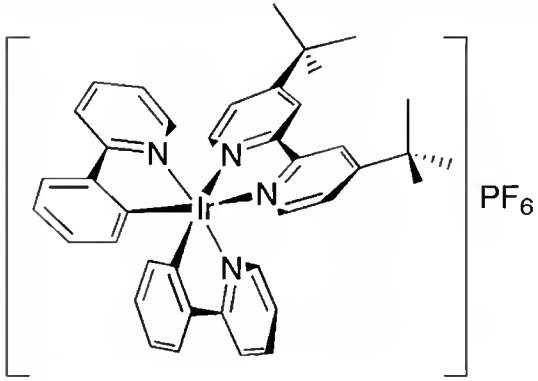
Introduction of ionic liquids





S. Parker et al., *Chem. Mater.* 17, 3187 (2005).

Ir complexes



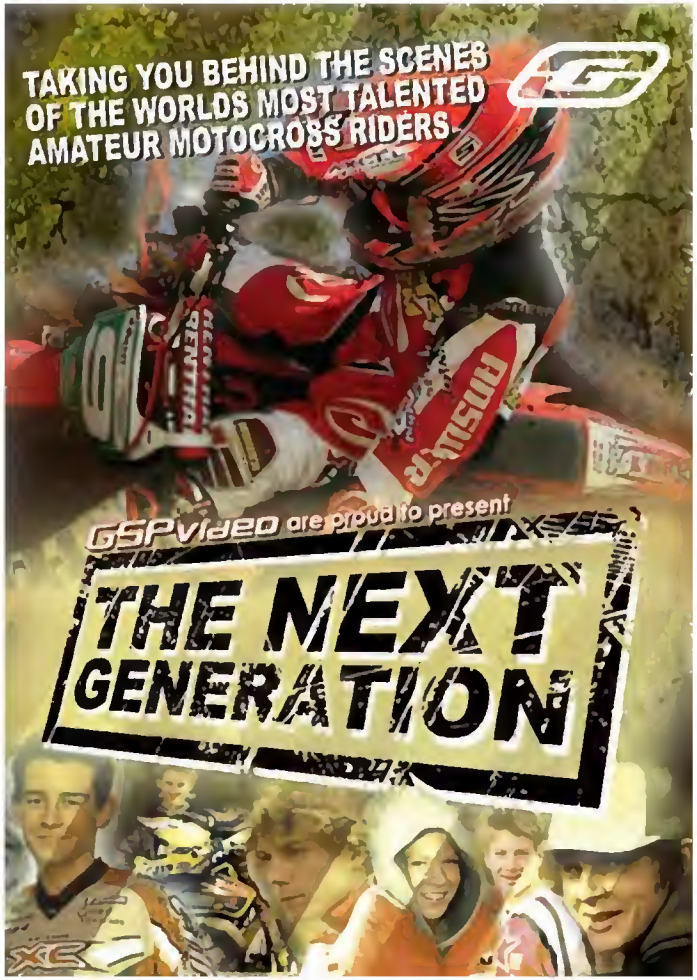
At – 3V:

η = 5%

>300 cd/m^2

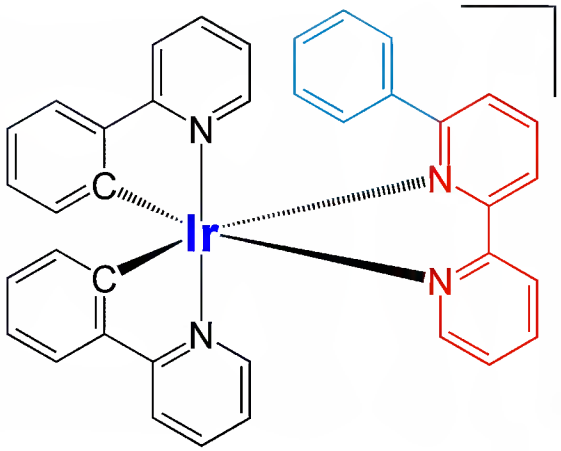
10 Lm/W

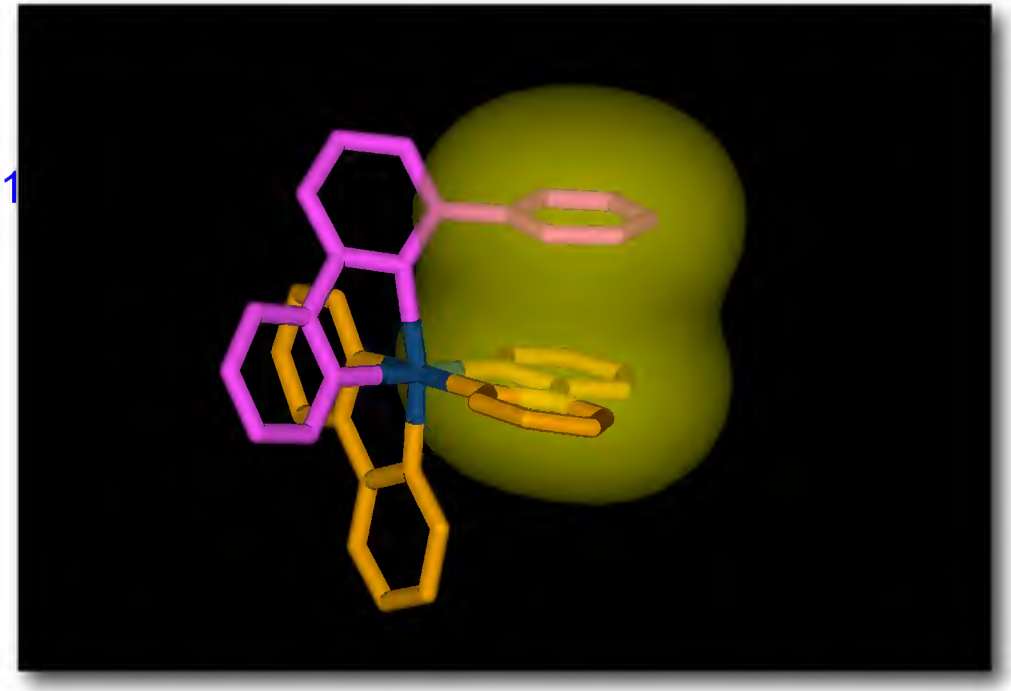
J.D. Slinker *et al.*, *J. Am. Chem. Soc.* 126, 2763 (2004).


TAKING YOU BEHIND THE SCENES
OF THE WORLDS MOST TALENTED
AMATEUR MOTOCROSS RIDERS
GSPvideo are proud to present
THE NEXT
GENERATION

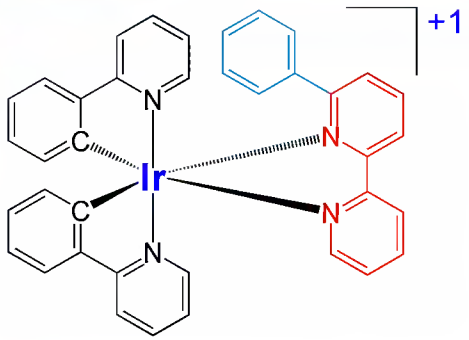
New kind of complex

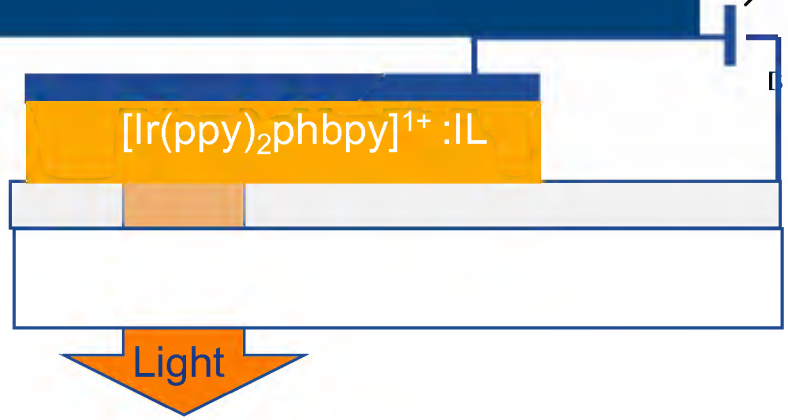
$[Ir(ppy)_2(phbpy)]^+$



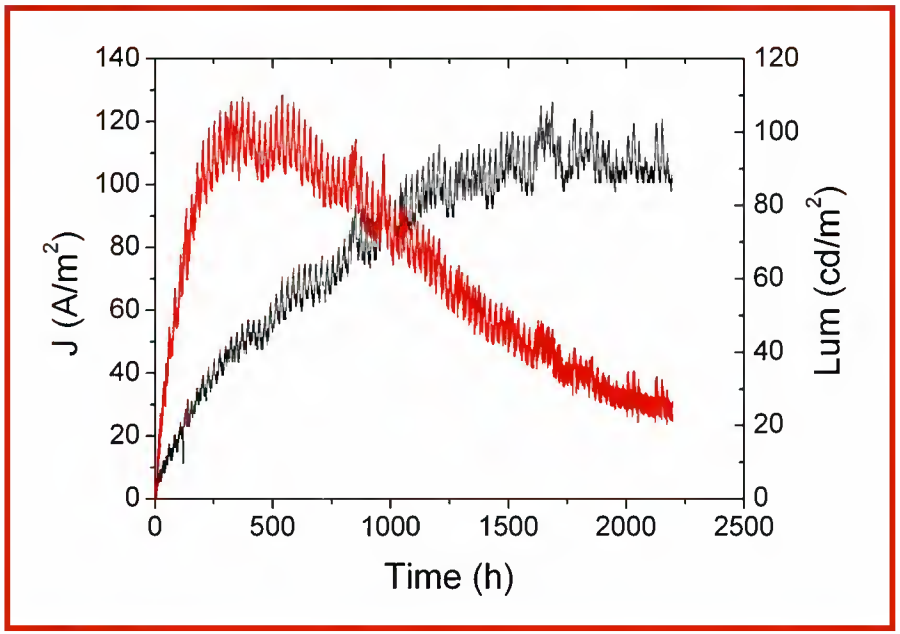


"Long" lifetimes



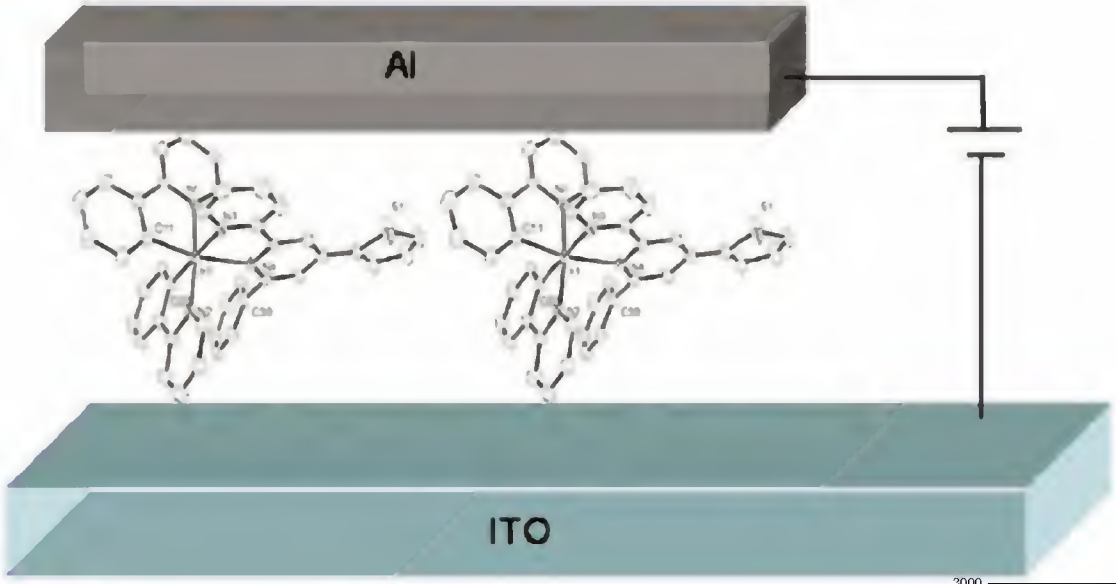


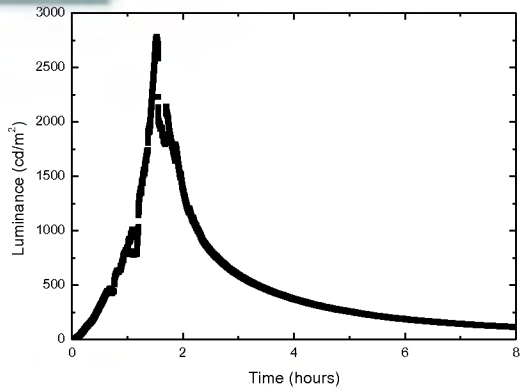
ITO/[Ir(ppy)$_2$bpy](PF$_6$):IL (4:1)/Al



$t_{1/2}$ > 1250 h
(2500 h, EQE = 4%)

Very bright and relatively stable LEEC

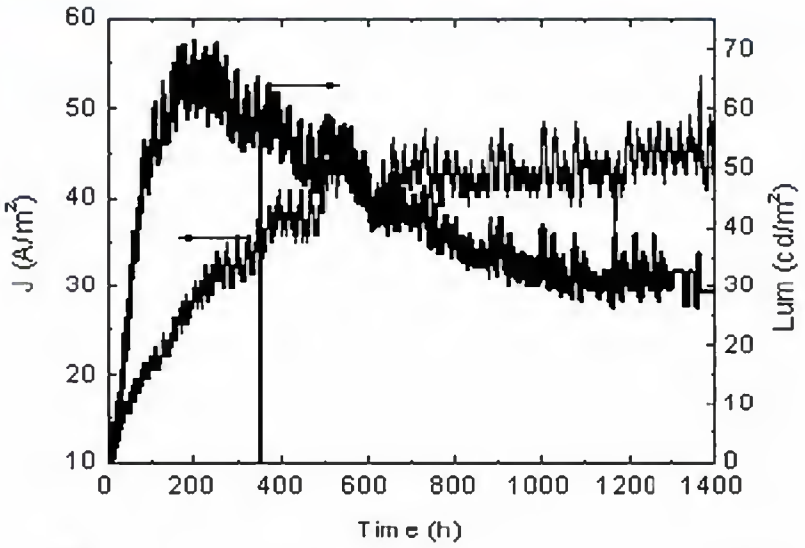


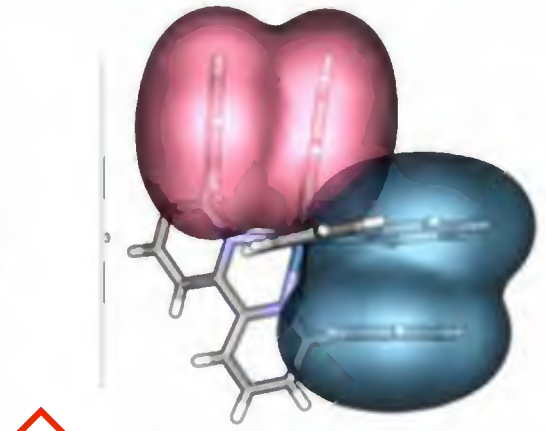


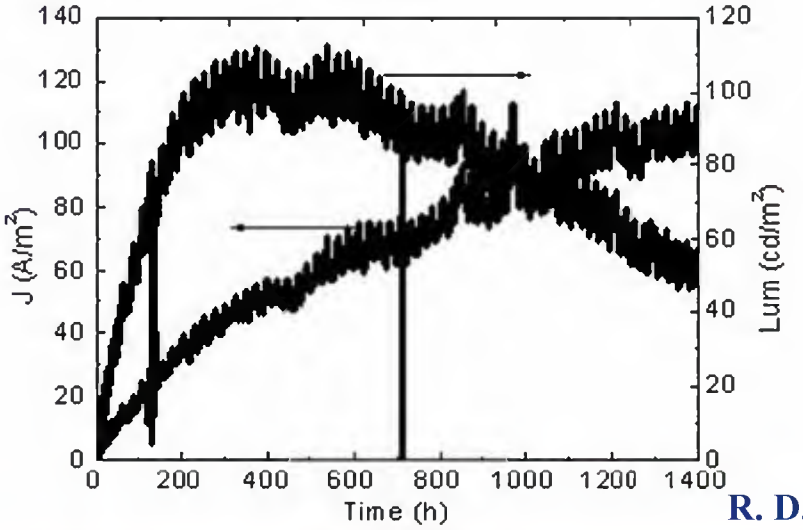
Luminance > 2500 cd/m^2

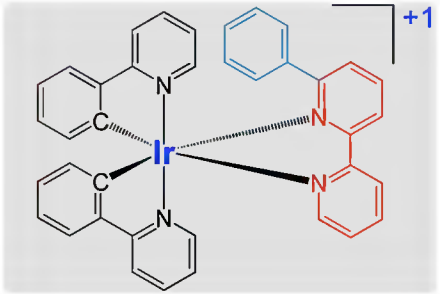
Graber, S.; Doyle, K.; Neuburger, M.; Housecroft, C. E.; Constable, E. C.; Costa, R. D Ortí, E.; Repetto, D.; Bolink, H. J., *J. Am. Chem. Soc.* 2008, 130, 14944.

Two is not always better than one !





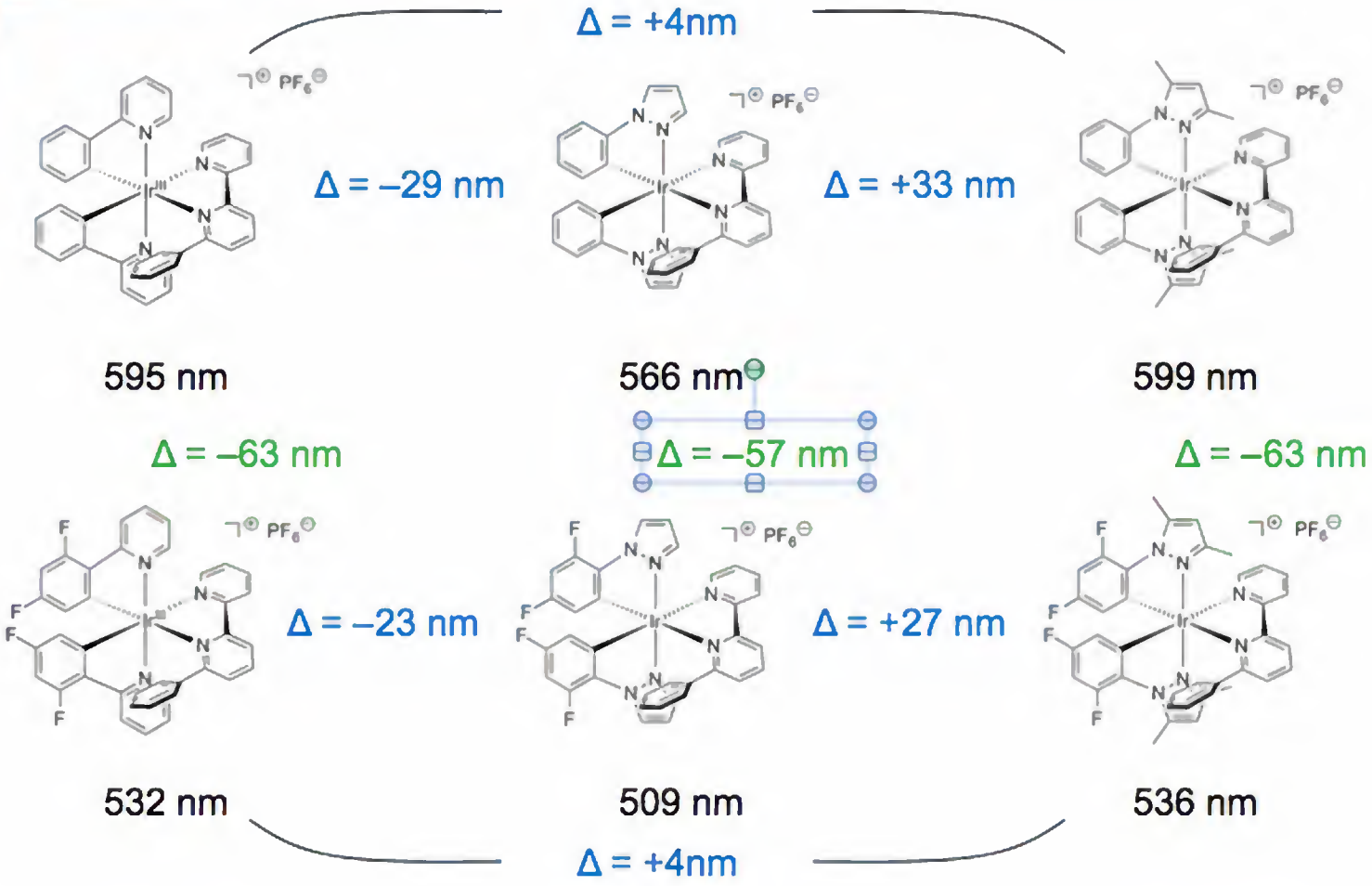




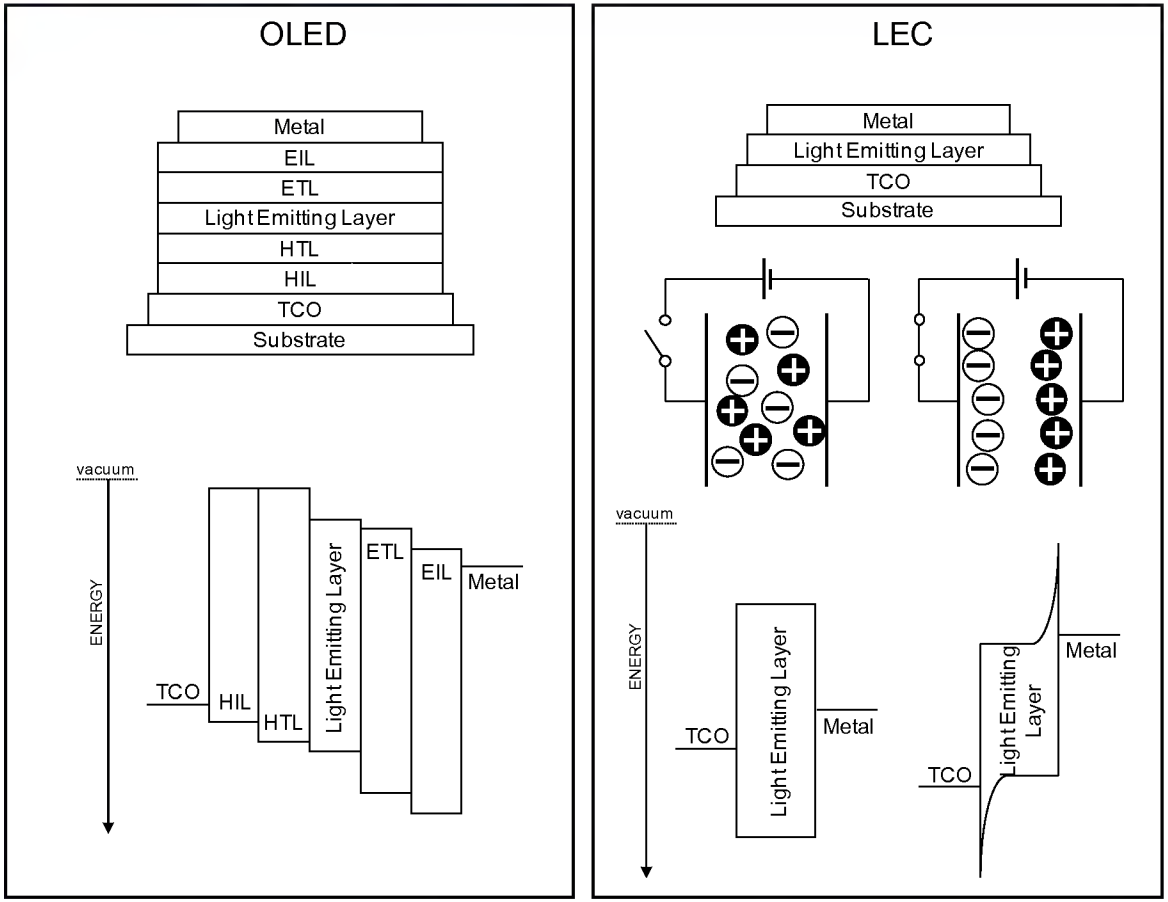
R. D. Costa, et. al, Chem. Commun. 2009, 2029

The LEC devices

Tuning the cyclometallated side



Zusammenfassung



OLEDs and LECs - Complementary technology