Chemistry 541:

Characterization of Organic Semiconductor Films

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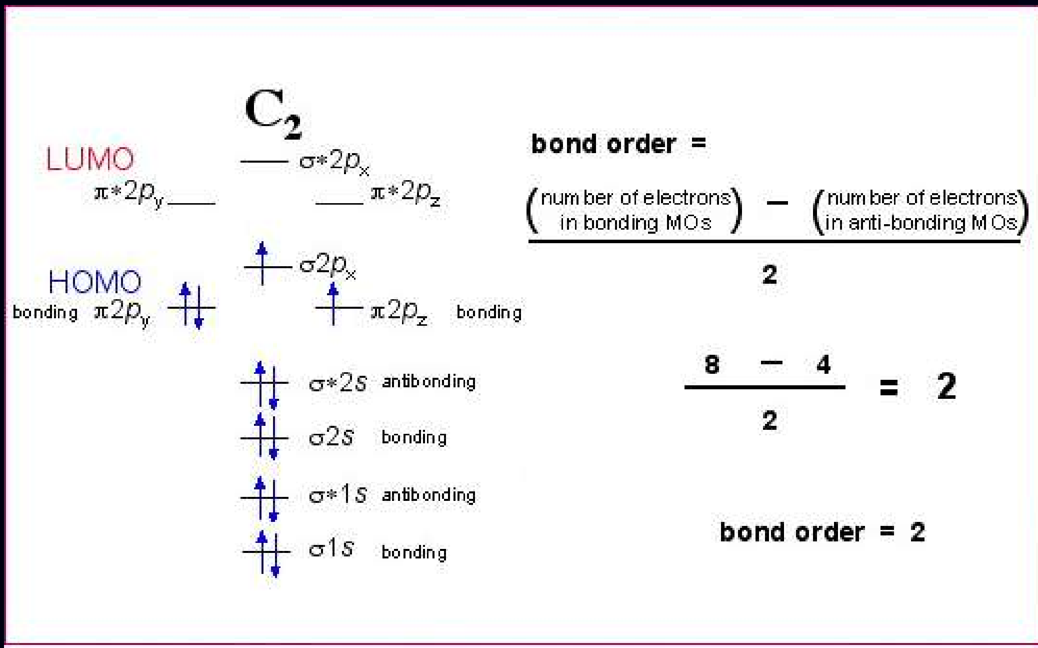
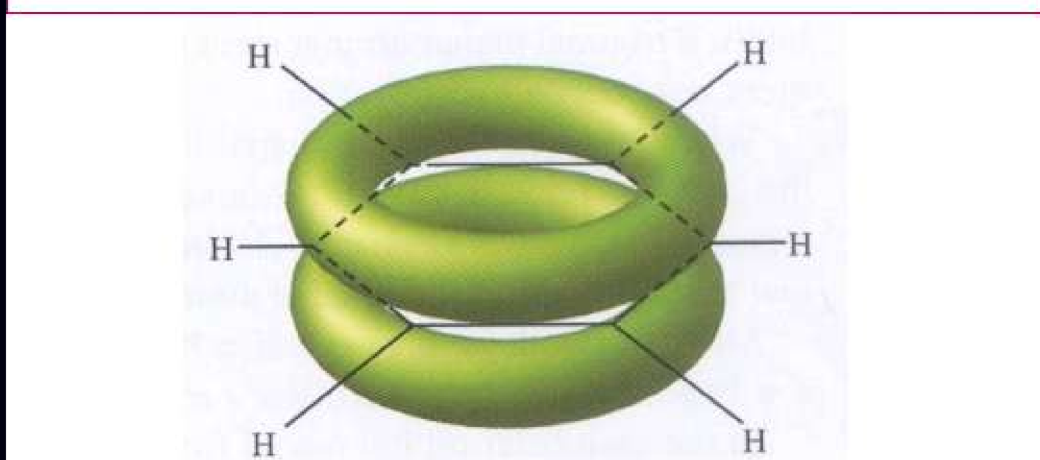
Outline

- Background Information
- Characterization
  - Visible spectrum
  - Luminescence
  - Raman imaging
  - Atomic force microscopy
  - Reflection-absorption IR
- Conclusion

Organic materials as semiconductors



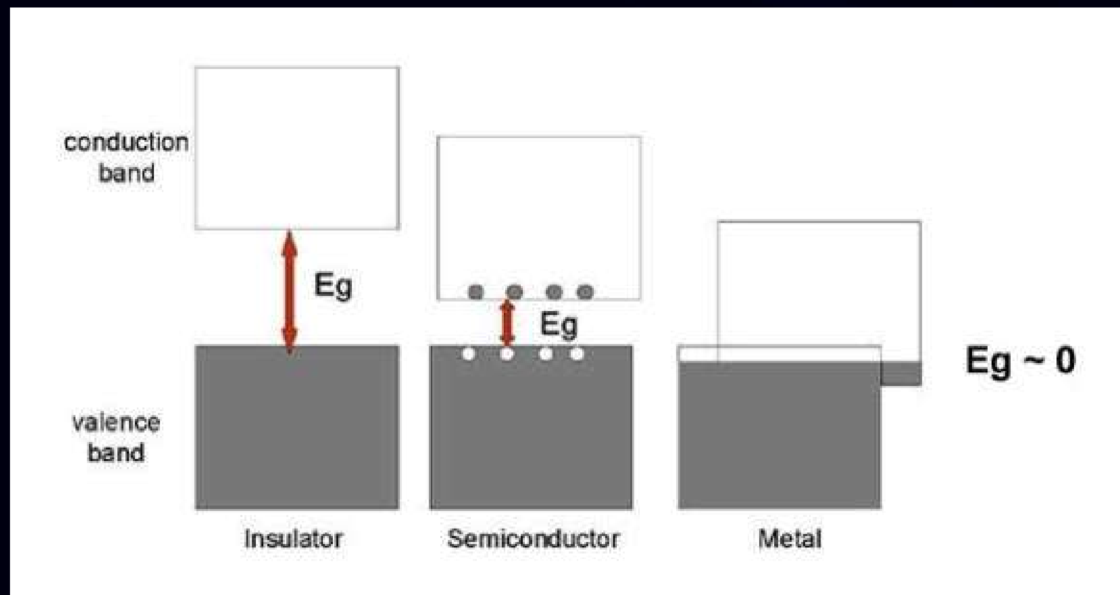


$\sigma 2p_x$ electron bonds to H.

$\pi 2p_z$ electron creates a conjugated pi network:

Band gap size proportional to conjugated pi network dimensions.

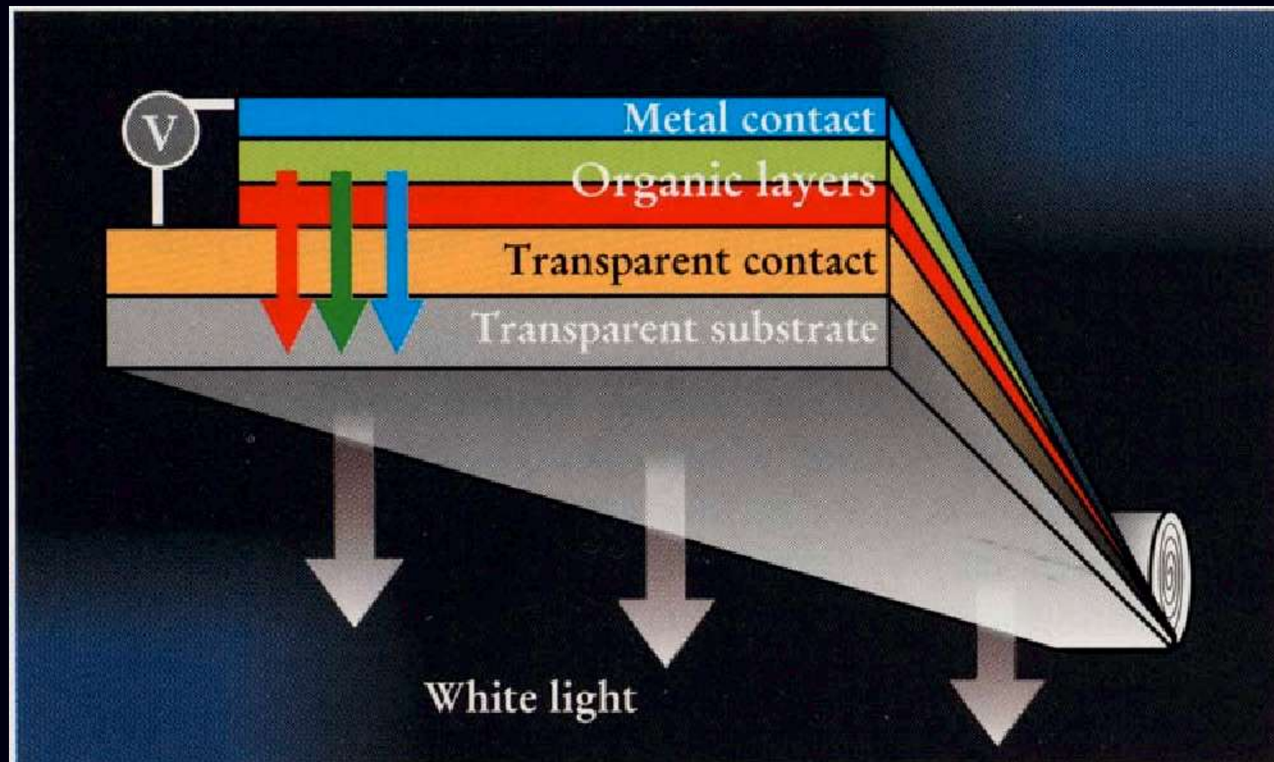
Band gap size dictates material properties



Note:

1) Conduction band equivalent to LUMO. [redacted]
2) Valence band equivalent to HOMO.
3) Light absorption creates electron hole pairs.
4) Recombination generates light.

Typical light emitting diode structure

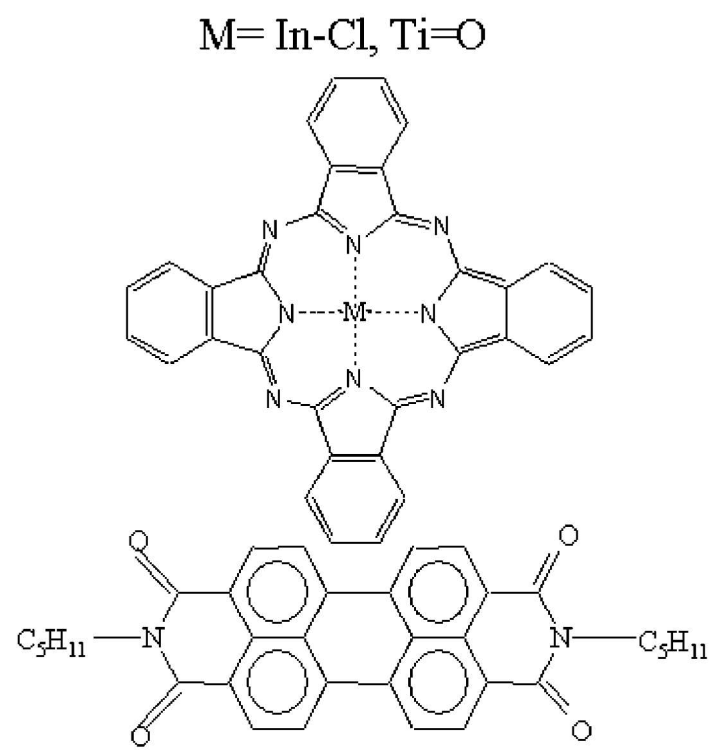


Layers:

Metal contact	aluminum
Organic material	perylene
Transparent conductor	indium tin oxide
Transparent substrate	glass

Chemicals involved in study

Scheme 1. Molecular Structure of TiOPc, ClInPc, and BNPTCD.



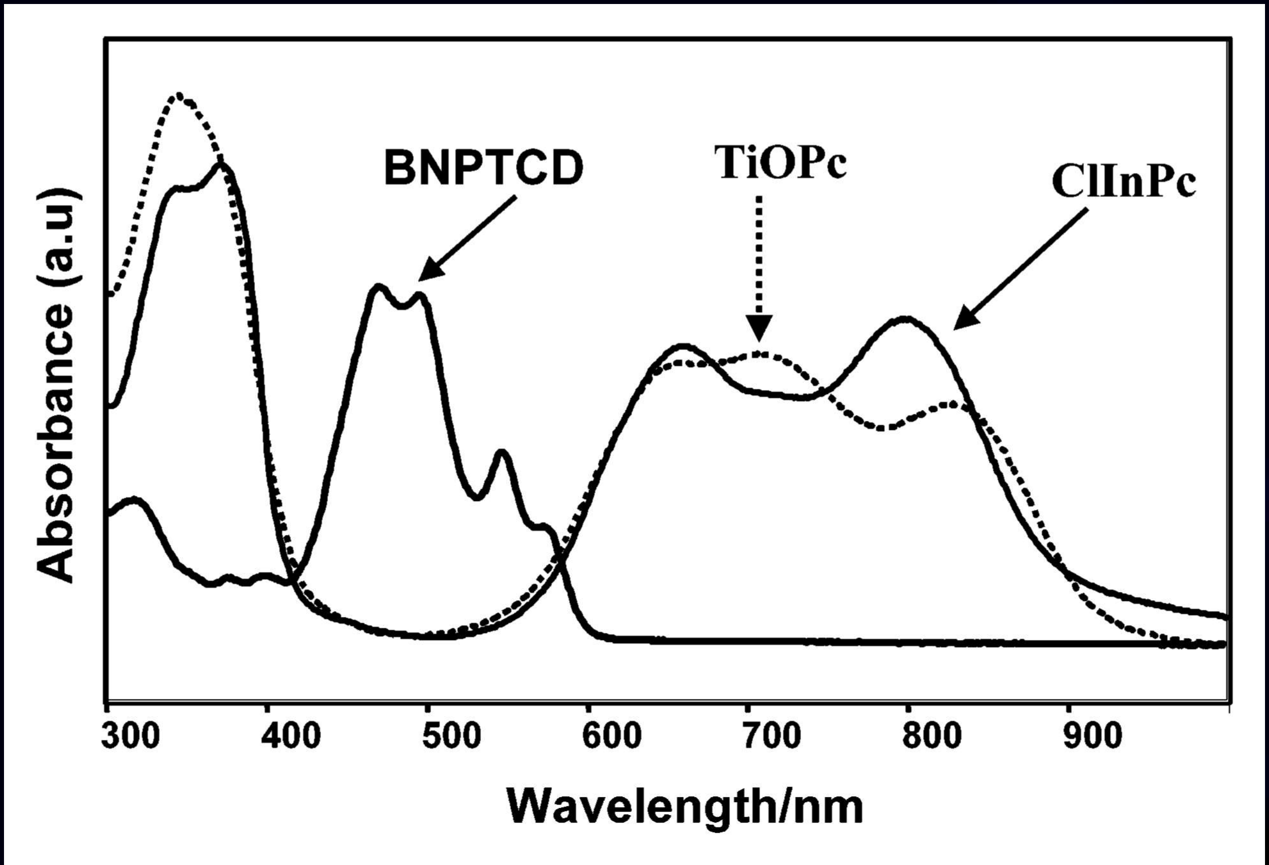
BNPTCD

Pc = phthalocyanine

BNPTCD = perylene

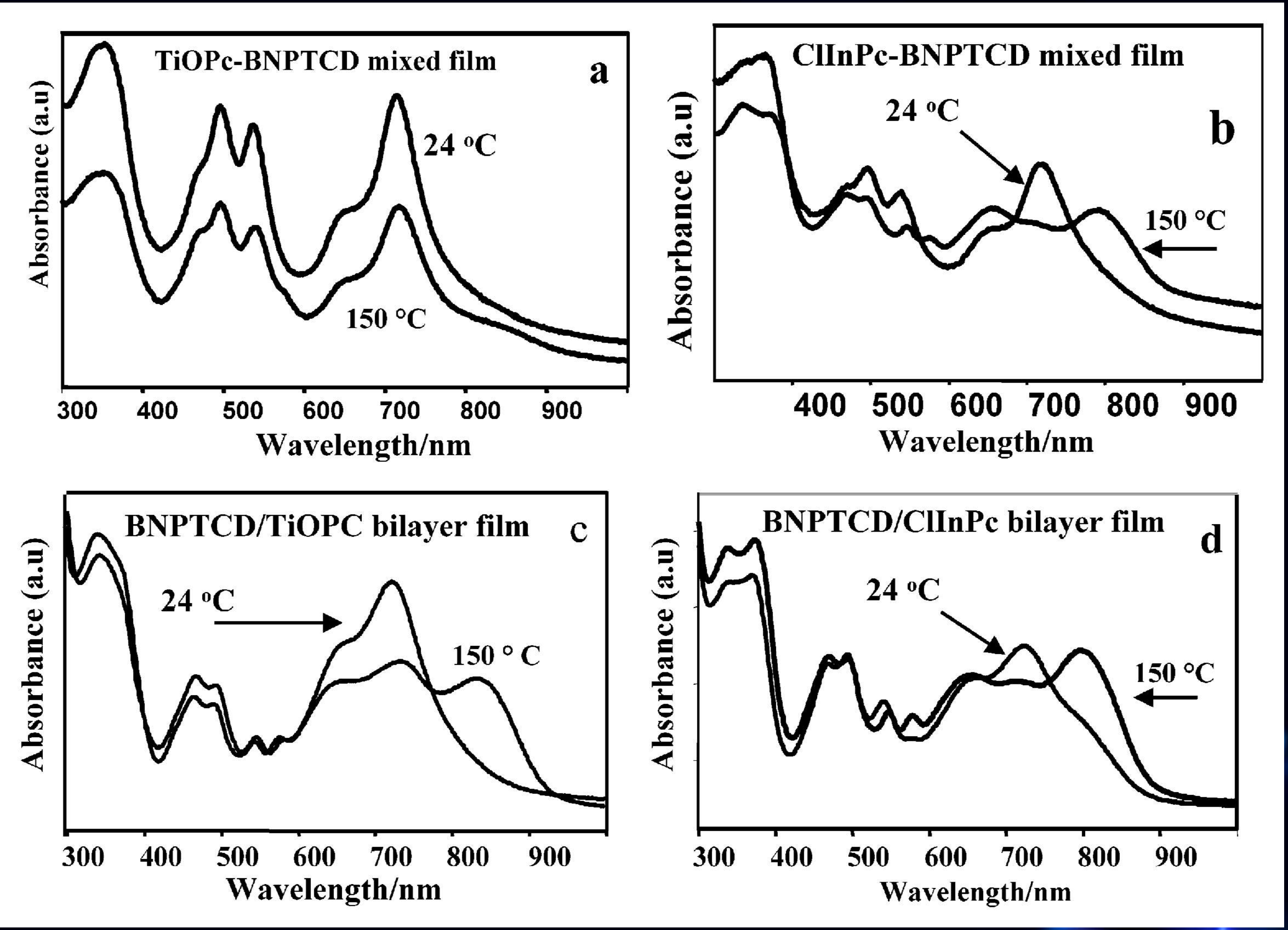
R. Aroca, T. Del Cano, and J. A. de Saja,
Chemistry of Materials, **15**, 38 (2003).

Absorption spectra of individual components



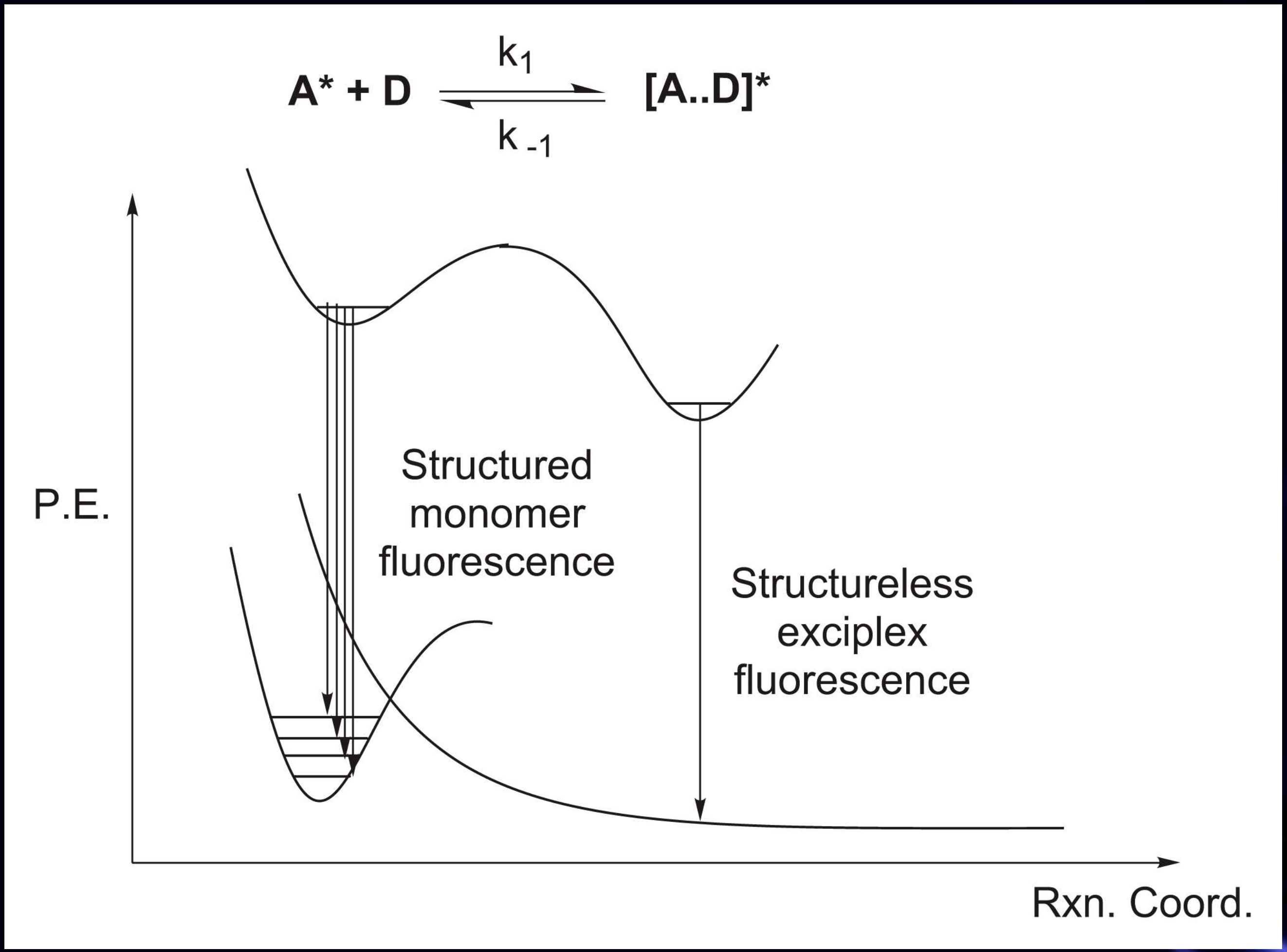
R. Aroca, T. Del Cano, and J. A. de Saja,
Chemistry of Materials, **15**, 38 (2003).

Absorption spectra of film combinations



R. Aroca, T. Del Cano, and J. A. de Saja, *Chemistry of Materials*, **15**, 38 (2003).

Origin of exciplex formation and decay

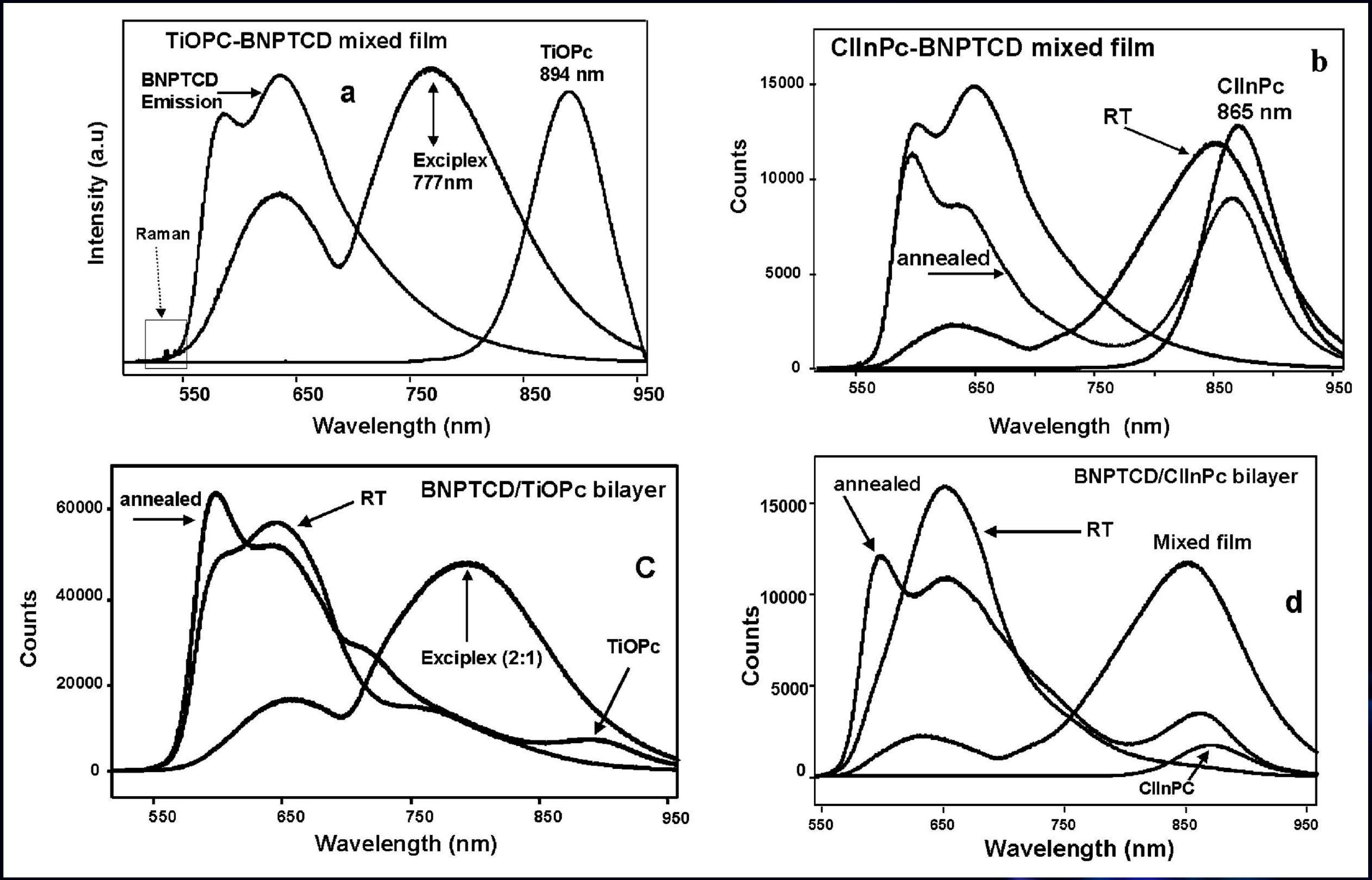


excimer = dimer

exciplex = complex

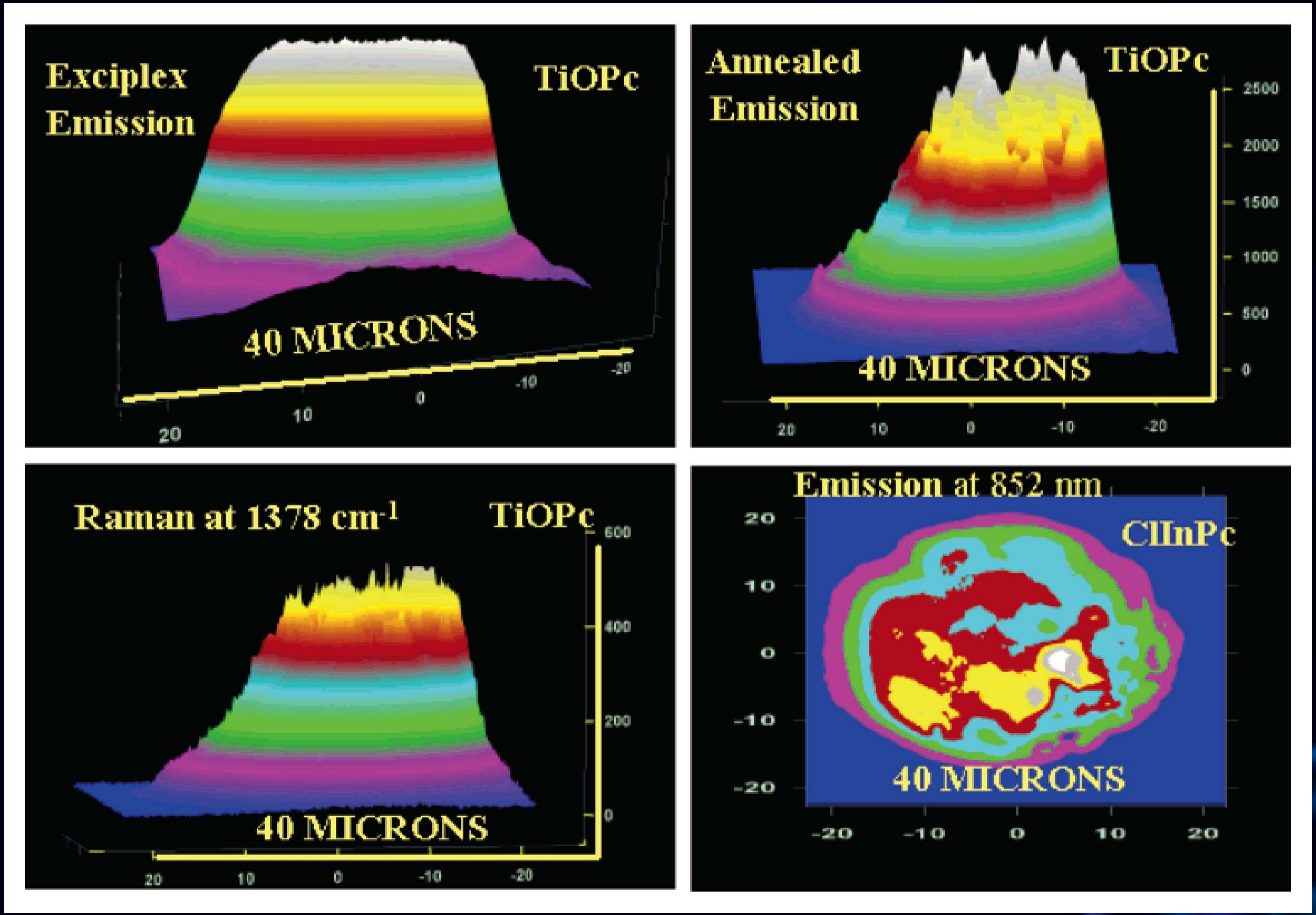
N. Chandrasekharan and L. Kelly, *Spectrum*, **15(3)** , 1 (2002).

Luminescence spectra: λ = 514.5 nm



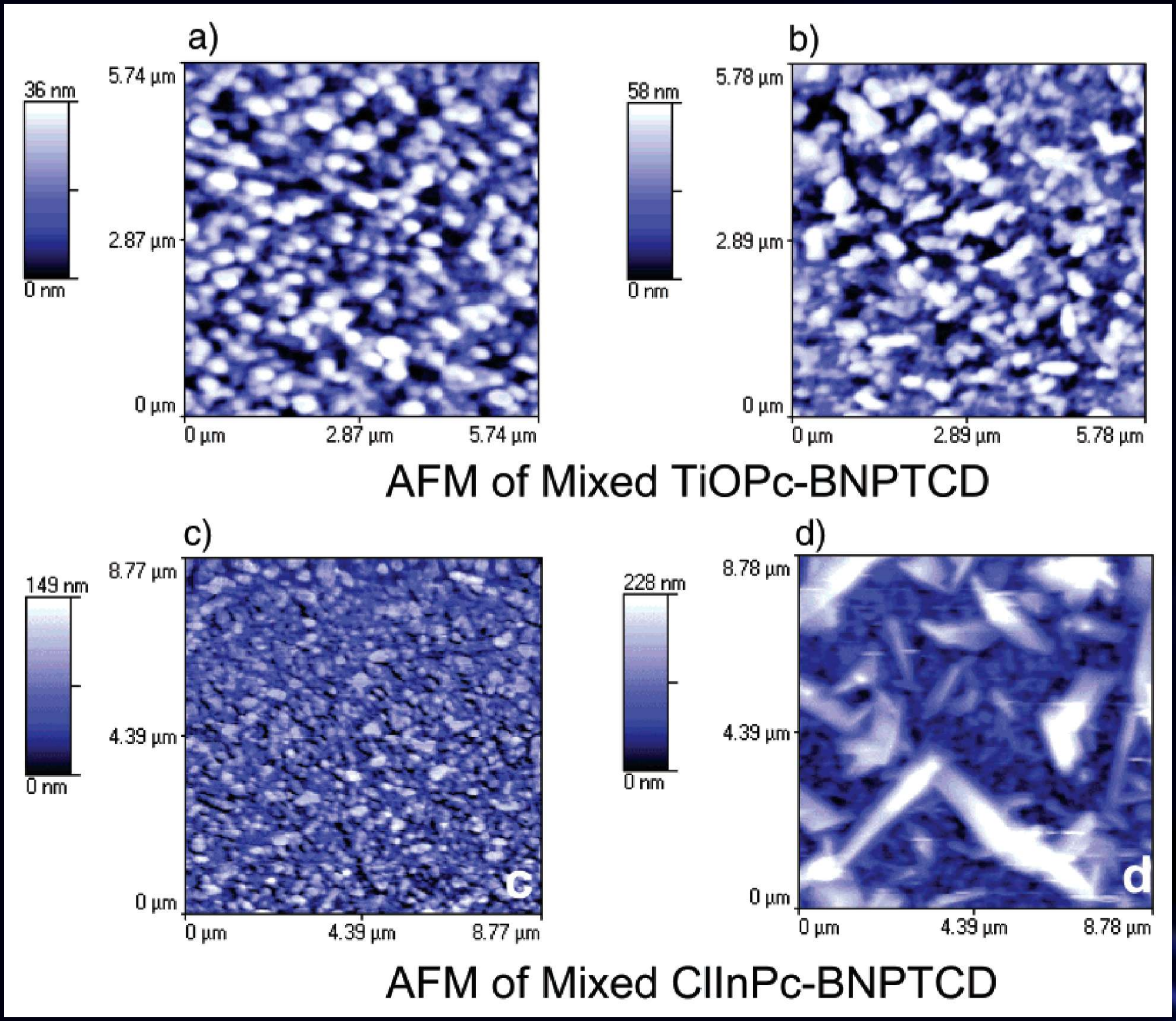
R. Aroca, T. Del Cano, and J. A. de Saja, *Chemistry of Materials*, **15**, 38 (2003).

Exciplex/ Raman imaging of perylene distribution



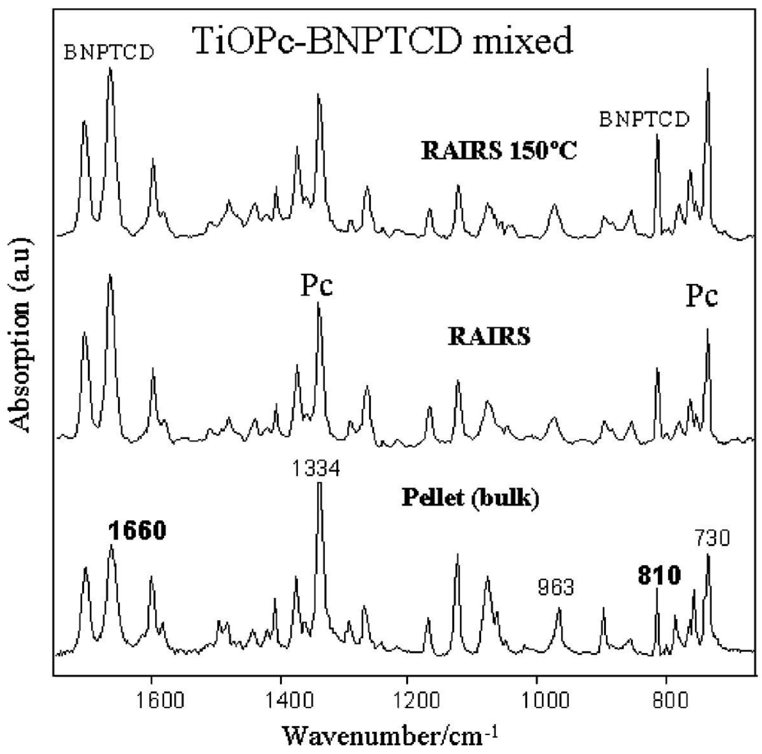
R. Aroca, T. Del Cano, and J. A. de Saja, *Chemistry of Materials*, **15**, 38 (2003).

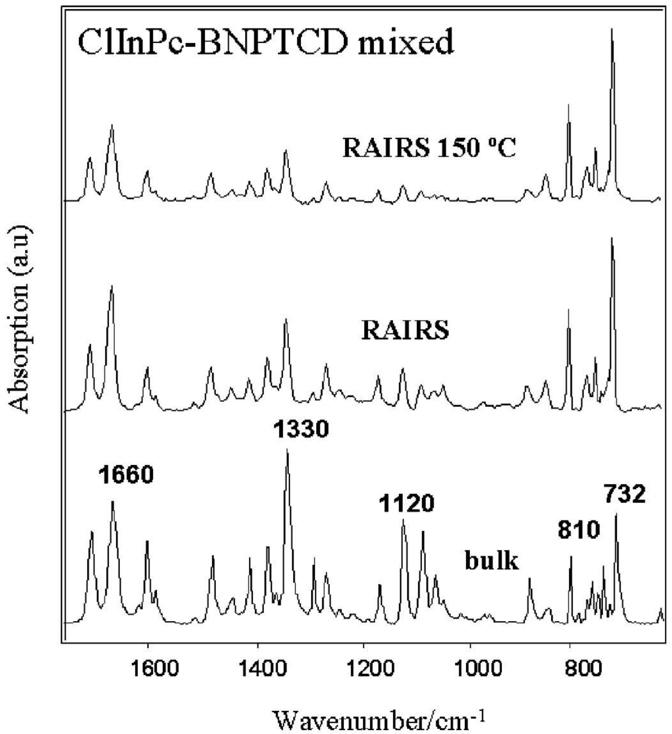
Atomic force microscopy of film topography



R. Aroca, T. Del Cano, and J. A. de Saja, *Chemistry of Materials*, **15**, 38 (2003).

Reflection-absorption infrared spectroscopy





R. Aroca, T. Del Cano, and J. A. de Saja,
Chemistry of Materials, **15**, 38 (2003).

Conclusions

- Visible spectra foreshadowed segregation in the film.
- Luminescence revealed an exciplex specie in perylene/TiOPc film and an efficient electron transfer in perylene/InClPc film.
- Collectively, the various spectroscopic techniques paint a composite image of the film morphology.