ENERGY MIGRATION AND TRANSFER IN LIGHT EMITTING POLYMER SYSTEMS.

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Overview

- Introduction - definition of terms and aim of experiment
- Experimental technique.
- Results :
    1. Migration in F8
    2. Transfer in layered films
    3. Transfer in blended films
- Conclusions
- Acknowledgements

Introduction

Förster Transfer : Non-radiative (resonance) mechanism for transferring energy from one material (donor) to another (acceptor), mediated by the Coulomb force.

Depends on distance between the molecules ($1/R^6$) and the orientation of their transition dipoles.

Energy migration : Excitations can “migrate” to lower energy sites via the Förster mechanism, observed as a red-shift in fluorescence with time.

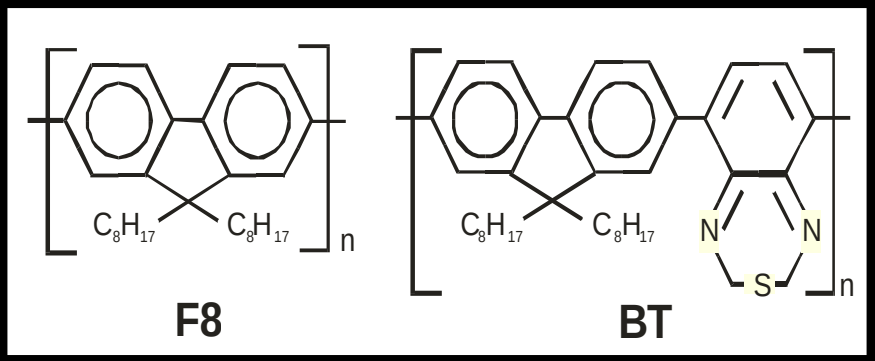
Introduction

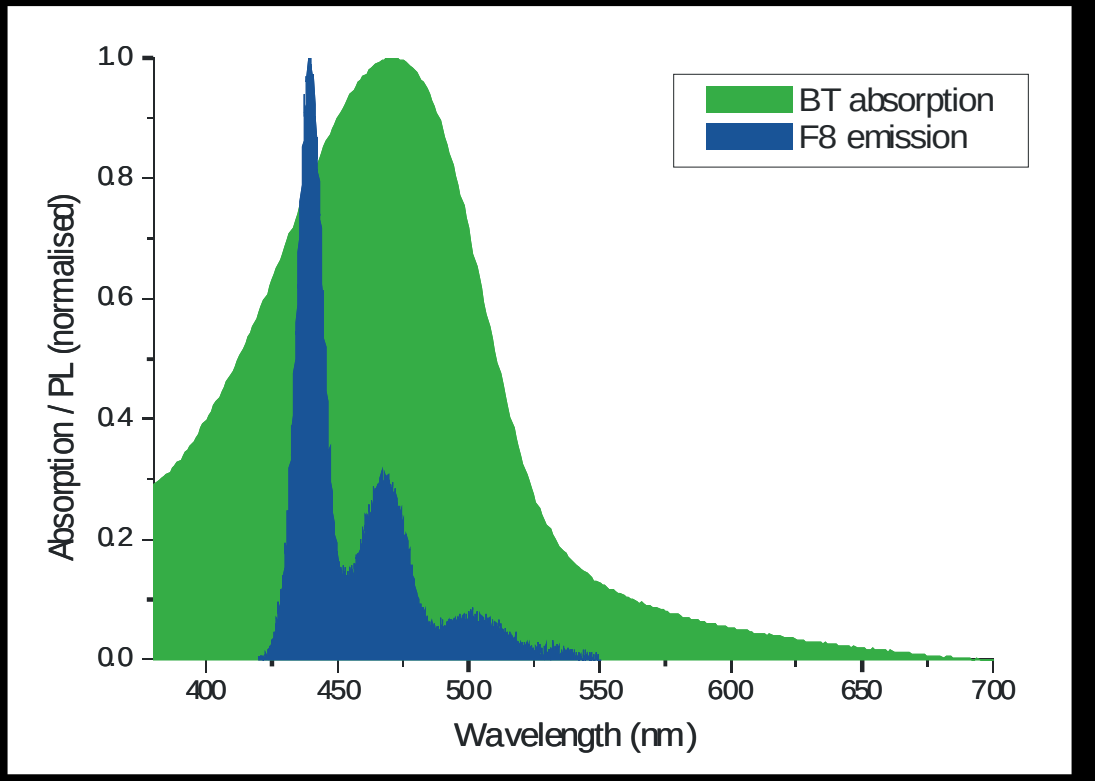
Light Emitting Polymer : Organic material that consists of many repeat units, whose excitations decay radiatively.

Two such polymers are :

Poly(9,9-dioctylfluorene) (F8)

Poly(9,9-dioctylfluorene-co-benzothiadiazole) (BT)

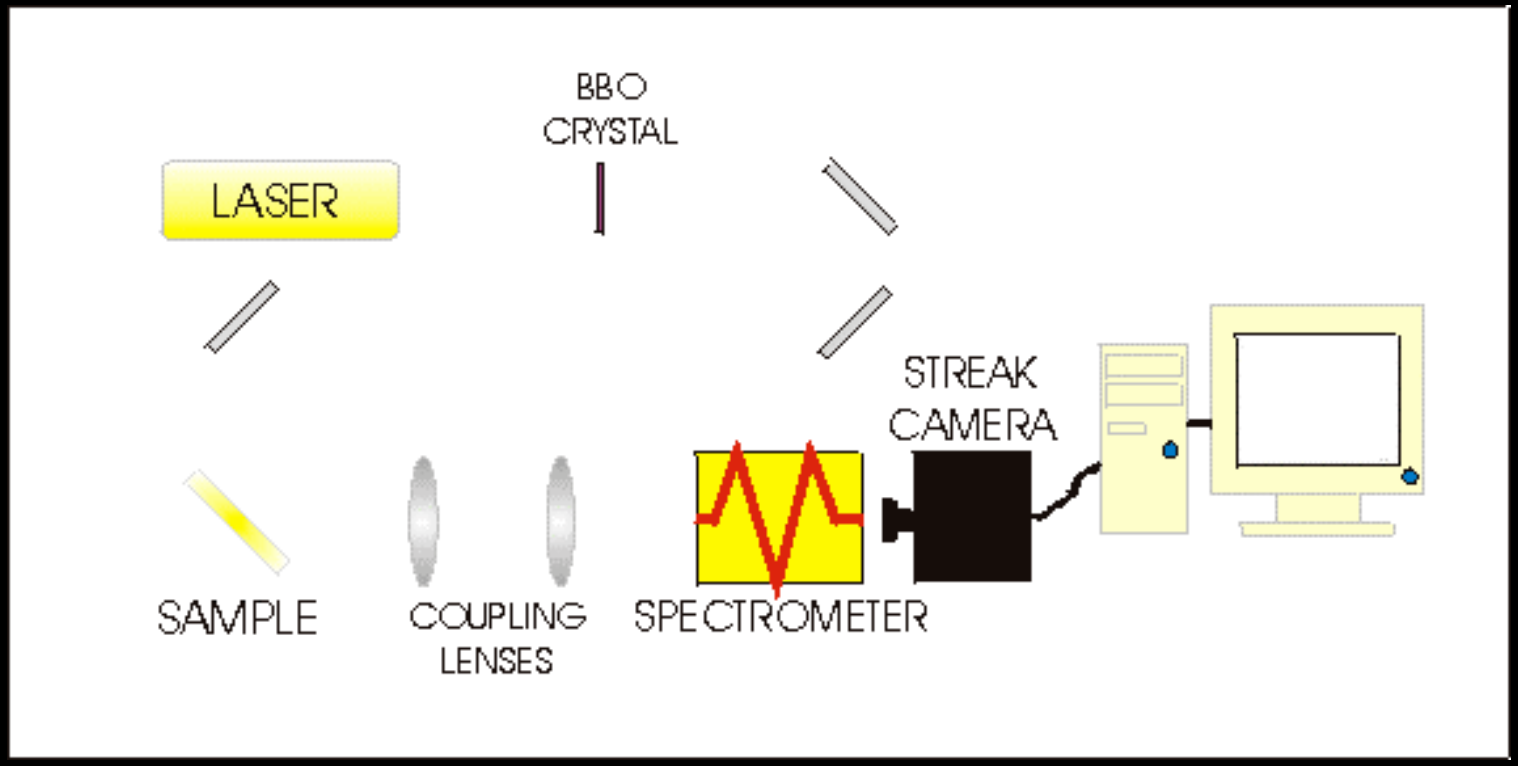




Experimental Technique

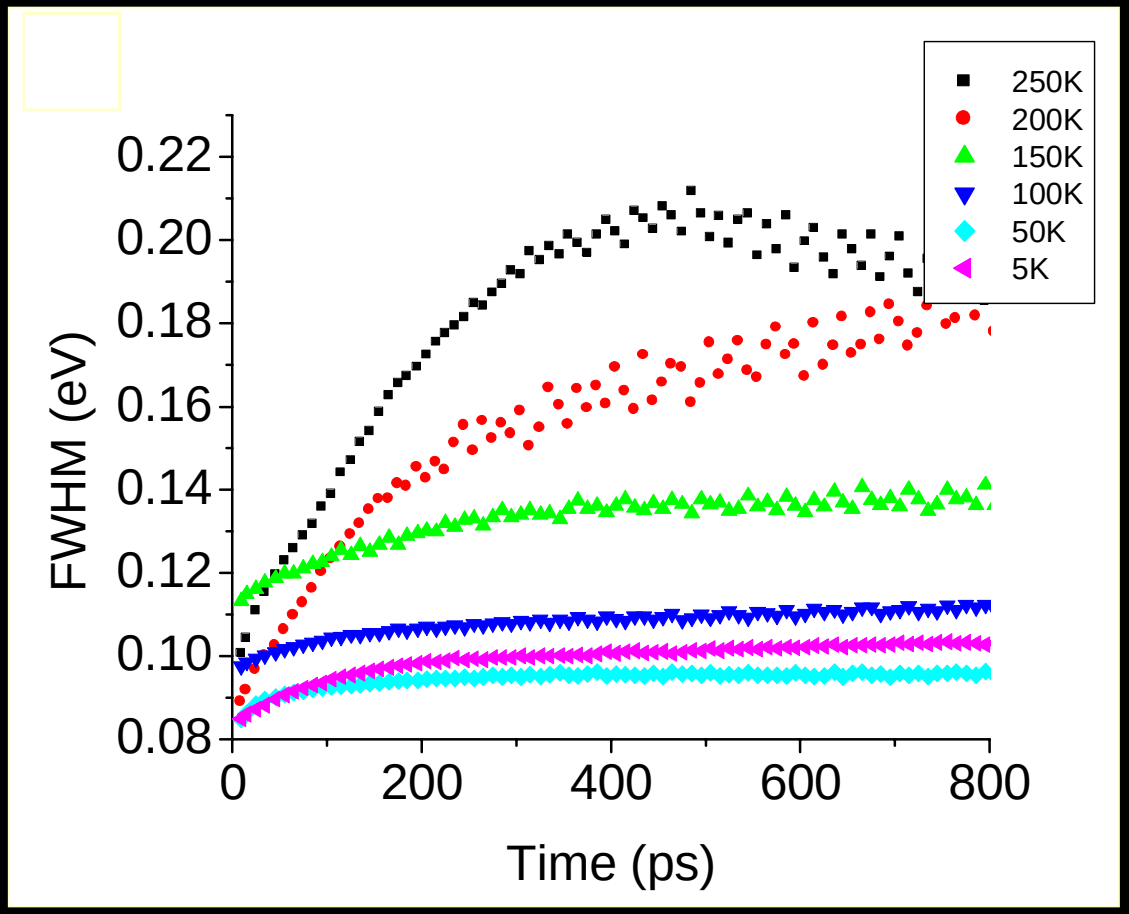
Time-resolved photoluminescence (PL) measurements were taken to determine the rates of migration and transfer.

Samples were excited using a 100fs pulsed Ti:sapphire laser.



Results (1)

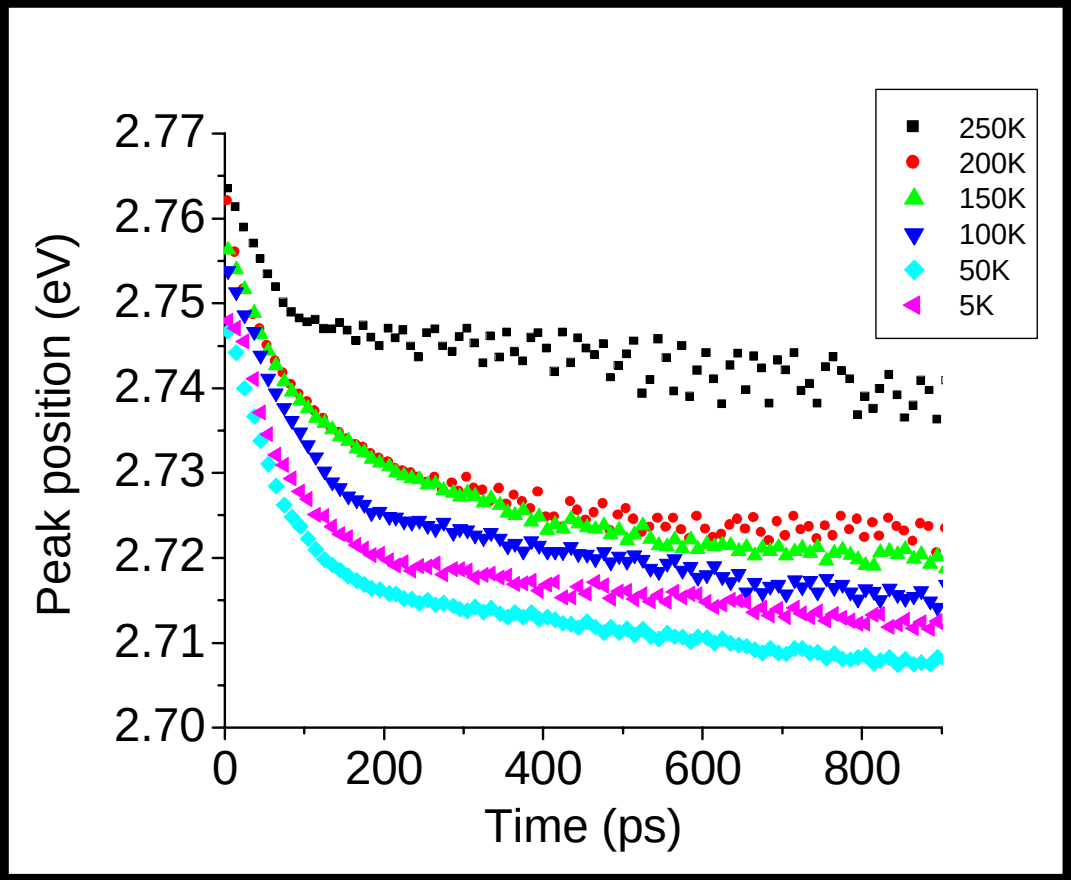
Migration in F8 was investigated as a function of temperature :



→ The PL spectra were modelled with gaussian curves.

→ Distribution of excited states increases with temperature, i.e. increased migration.

Results (1)



→ Peak position shifts more at low temperatures – contradicts previous result?

Low T - excitons migrate easily to lower energy so peak red-shifts as expected.

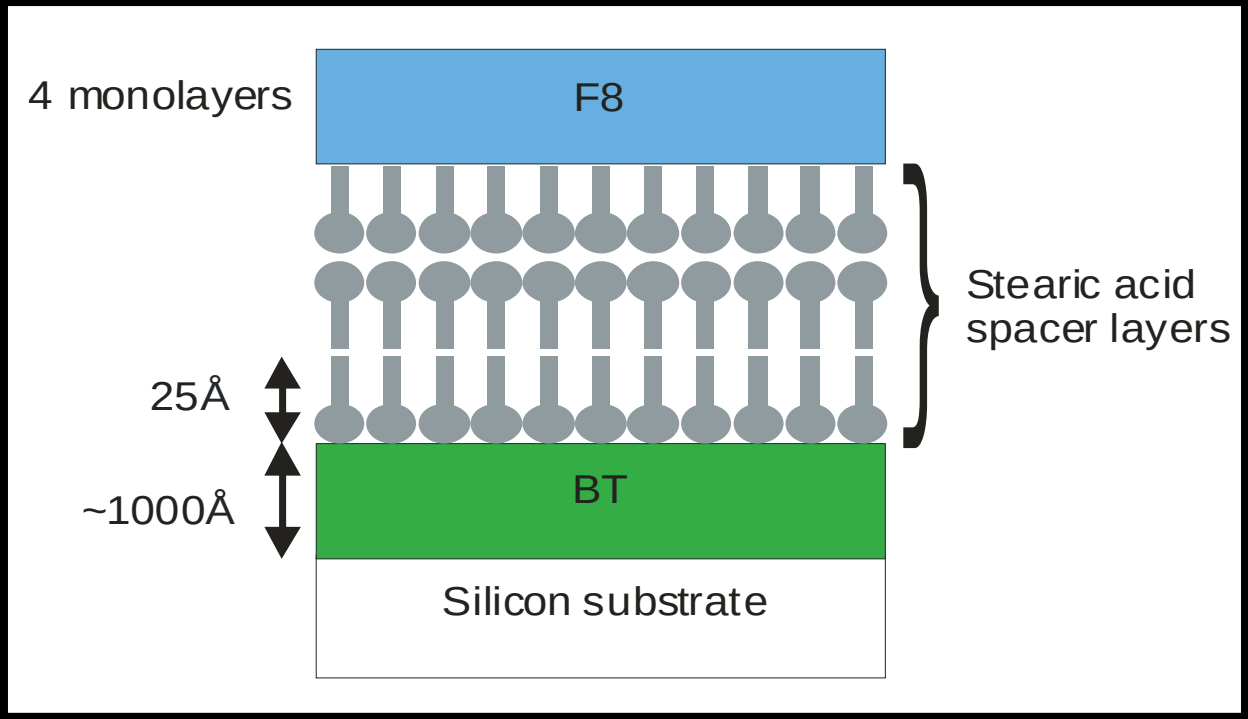
High T - thermal scattering allows excitons to migrate to higher energy states.

i.e. at high T, average exciton energy remains more static but distribution of energies is increased.

Results (2)

Energy transfer from F8 to BT was investigated as a function of donor-acceptor separation.

Layered structures were prepared which allowed precise control over donor-acceptor separation.



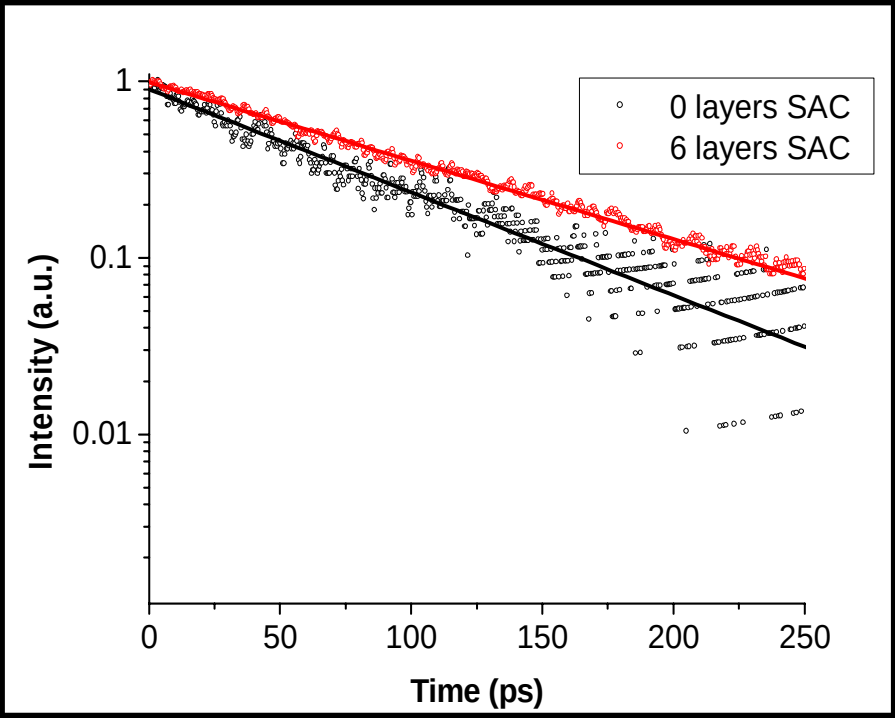
BT - spin cast onto silicon.

Stearic acid (SAC) - deposited via Langmuir-Blodgett (LB) technique. (Optically inert layers of known thickness.)

F8 - deposited via fast LB technique

Results (2)

The lifetime of the donor (F8) fluorescence was measured for a number of samples with varying spacer layer thicknesses.



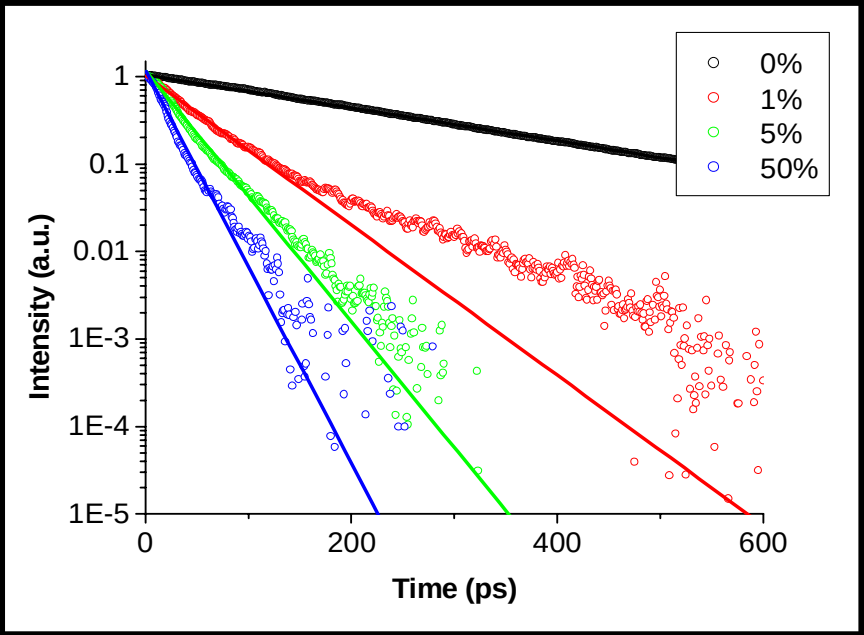
Samples with larger spacer layers exhibited a longer donor lifetime due to reduced energy transfer between polymers.

The sample with no spacer layers exhibited a lifetime of ~60ps, c.f. pure donor lifetime of ~105ps.

Two sample decays are shown above - note that decays are single exponential.

Results (3)

Blended spin cast samples were prepared by mixing the required concentration of F8 and BT in solution. Transfer as a function of guest concentration was investigated.



Typical PL decays from blend samples. Solid lines are fitted single exponentials.

→Observed donor decay dynamics are different than those in the layered structures.

→ Decays are no longer exponential in shape – attributed to increased migration affecting the Förster rate.

Conclusions

- Energy migration occurs in F8 over a timescale of ~500ps.
- The sample structure affects how energy transfer proceeds.
- Layered structures give exponential donor decays.
- Blended samples give non-exponential donor decays.
- This has implications for understanding the energy transfer process in many real-world applications, such as polymer LEDs.

Acknowledgements

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