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Comparing electroluminescence efficiency and photoluminescence quantum yield of fluorene-based π-conjugated copolymers with narrow band-gap comonomers

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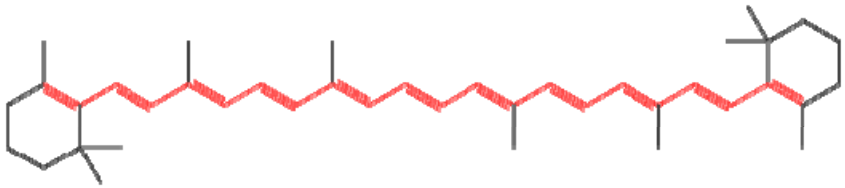
Introduction

π-conjugation



β-carotene (From wikipedia)

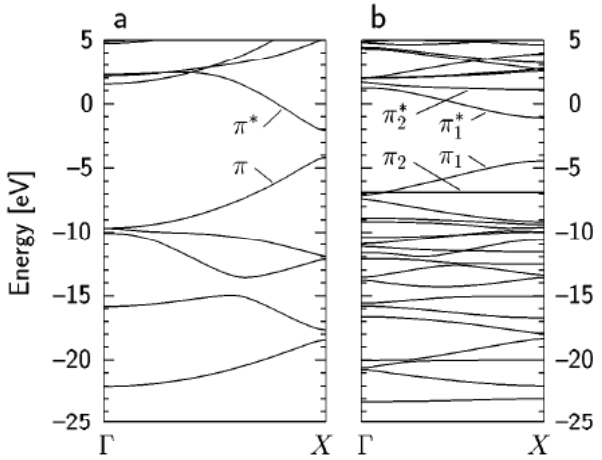
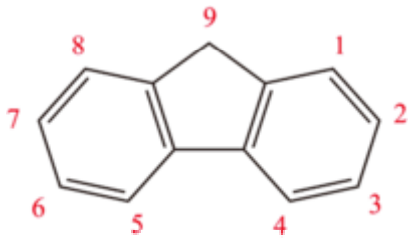


FIG. 1. Quasiparticle band structures of trans-polyacetylene (a) and of PPV (b), as calculated within the *GW* approximation. The vacuum level is at 0 eV.

PRL 82 1959 (1999)

Materials



Fluorene (From wikipedia)

9,9-bis(2′-ethylhexyl)fluorene

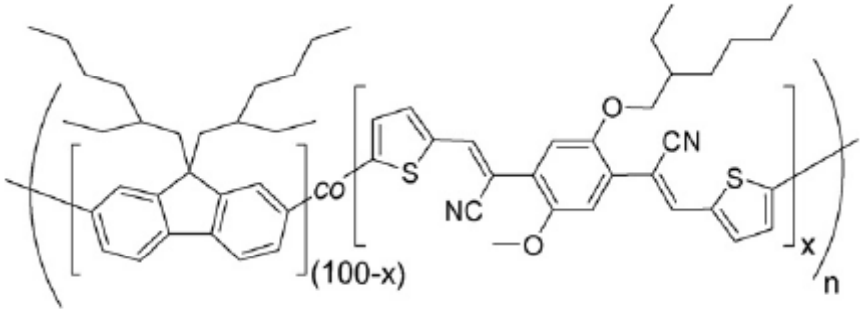
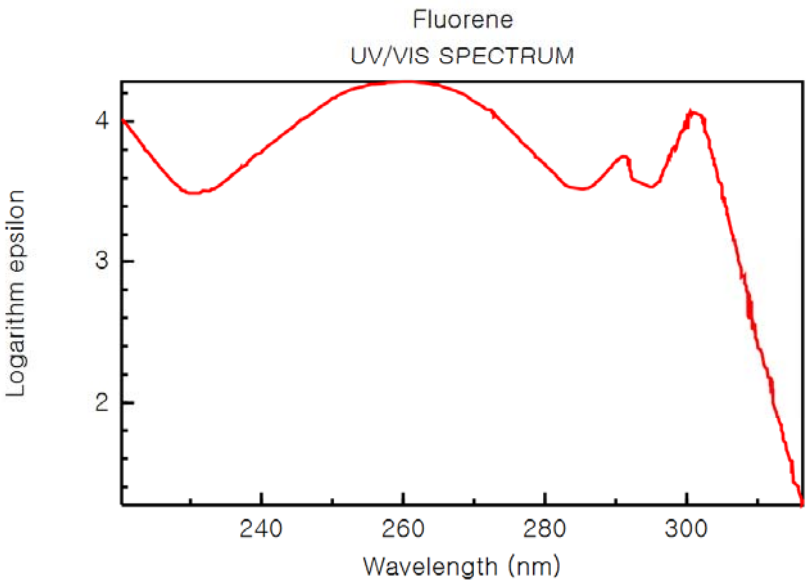


Fig. 1. Chemical structure of PFTCVBx.

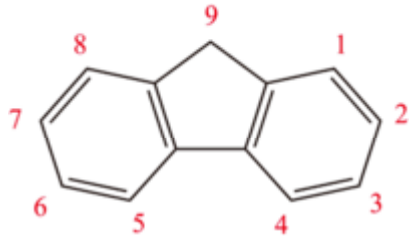
2,5-bis(2-(thienyl)-1-cyanoviyl)-1-(2″-ethylhexyloxy)-4-methoxybenzene

in chloroform
1.4 x 10^{-4}wt% for UV-Vis
1.6 x 10^{-5}wt% for PL
0.8wt% for spin-cast

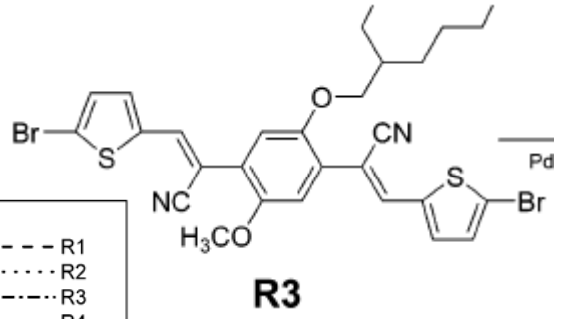
Monomer



NIST Chemistry WebBook (http://webbook.nist.gov/chemistry)



TCVB



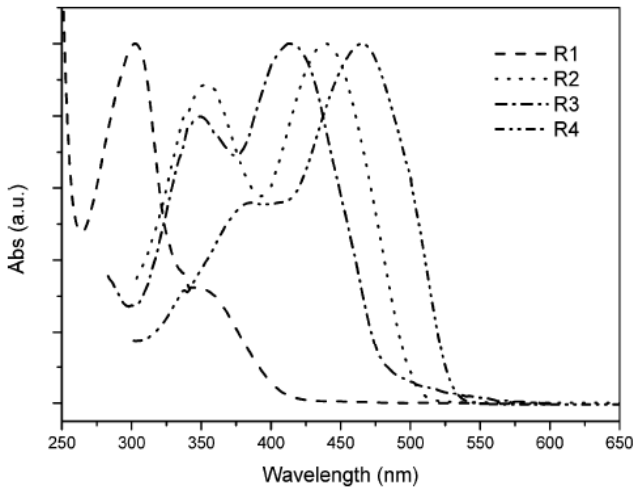


Figure 3. UV−vis absorption spectra of the monomers-R1, R2, R3, and R4 in the chloroform solutions.

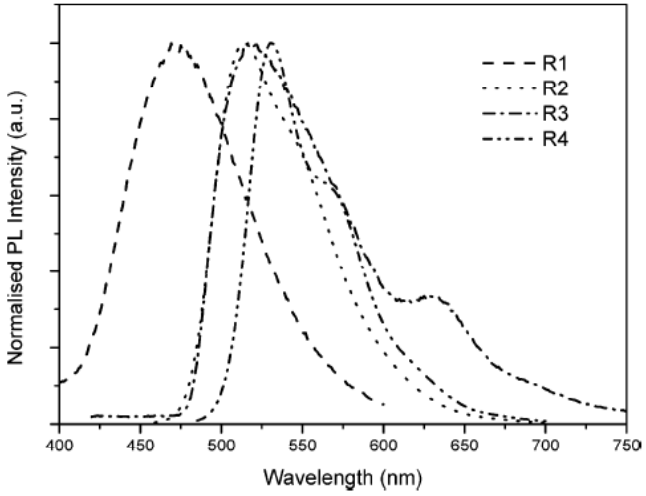


Figure 4. Photoluminescence spectra of the monomers-R1, R2, R3, and R4 in the chloroform solutions.

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Copolymer, UV-Visible Absorption

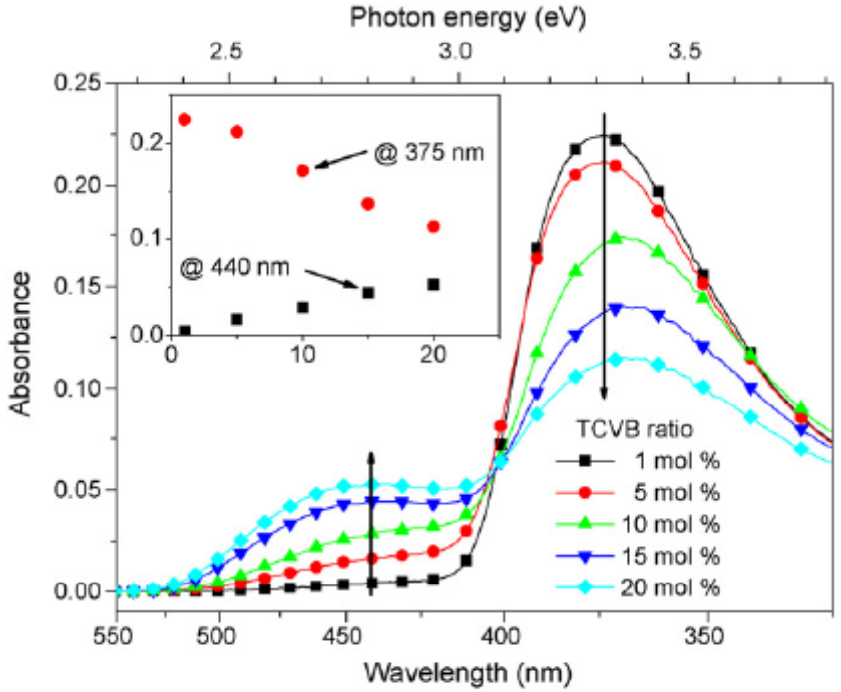


Fig. 2. UV–vis spectra of PFTCVB*x* solution samples. (*Inset*: plot of the absorbance maxima as a function of the TCVB ratio in mol%.)

1. Intensities of Blue Bands are decreased with TCVB concentration

2. Intensities of Red Bands are increased with TCVB concentration

Blue Bands -> EHF
Red bands -> TCVB

Copolymer, UV-Visible Absorption

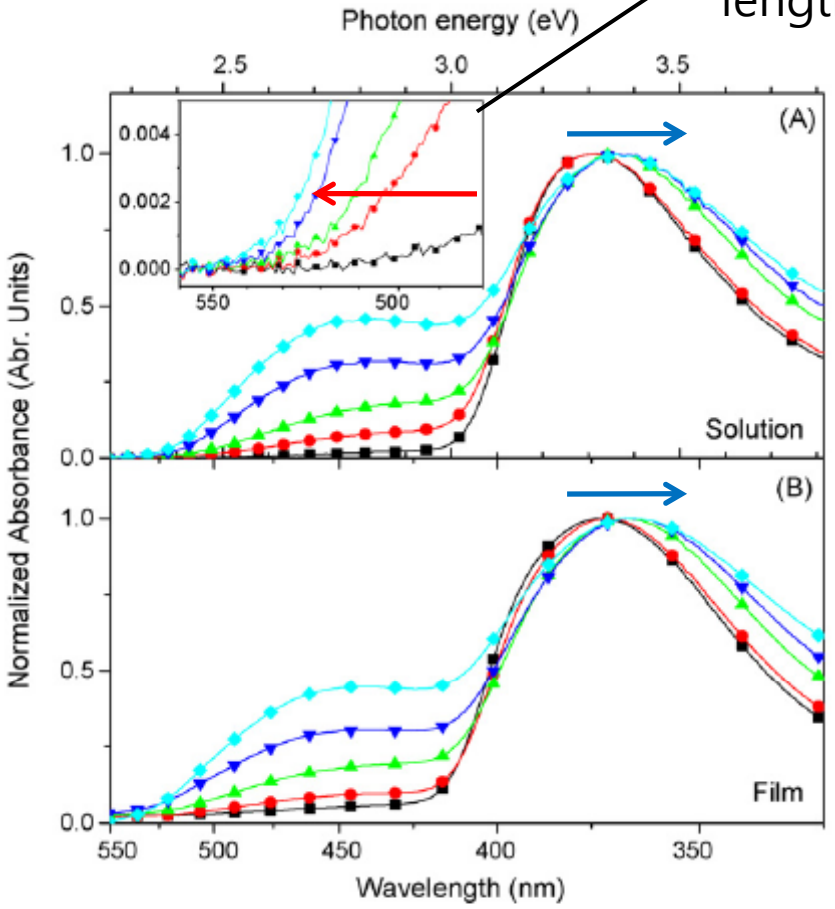


Fig. 3. Normalized UV–vis spectra of PFTCVB*x* as (A) diluted chloroform solutions and (B) spin-cast films. (Same symbols as in Fig. 2; *inset A*: magnification at the absorption edges of UV–vis spectra.)

TCVB Effective conjugation length change

Band Broadening

Closely packed chains in film

↓

Stronger chromophore-to-chromophore interaction

↓

Increasing disorder effect

Copolymer, Photoluminescence

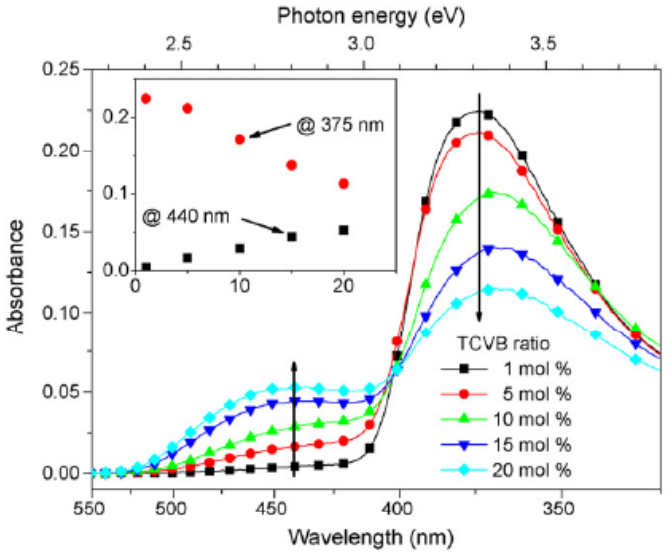


Fig. 2. UV–vis spectra of PFTCVB*x* solution samples. (*Inset*: plot of the absorbance maxima as a function of the TCVB ratio in mol%.)

TCVB-induced PL quenching
(1) FRET
(2) "blinking"
(3) Photochemical oxidation

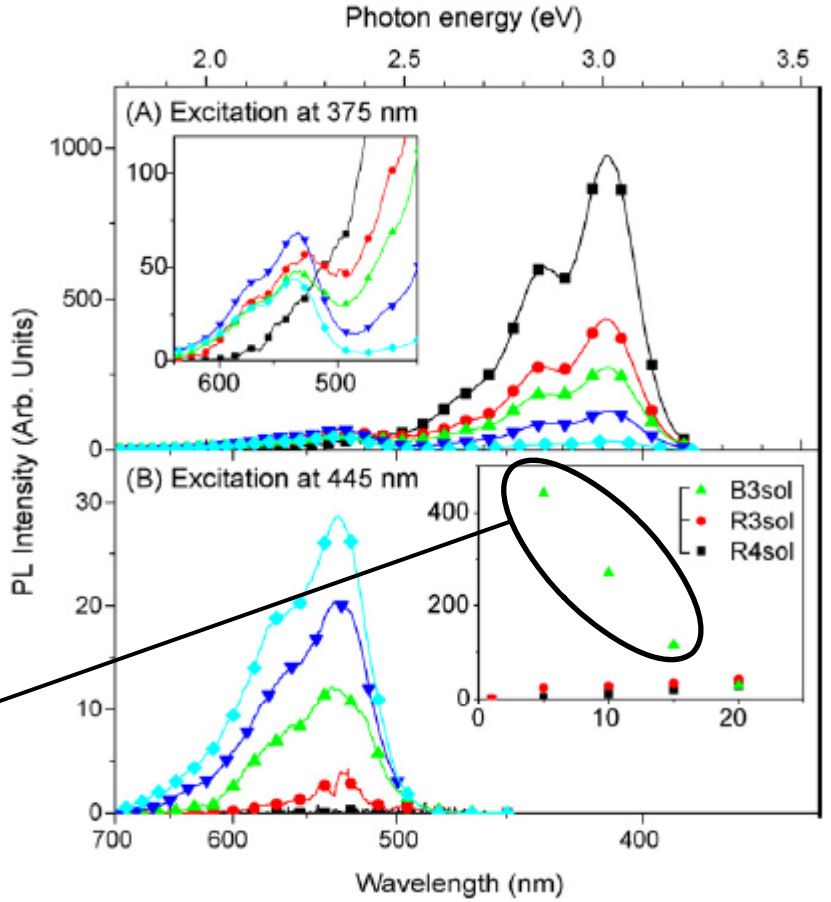


Fig. 4. PL spectra of PFTCVB*x* solution samples with excitation at (A) 375 nm and (B) 445 nm. *Inset A*: magnified PL spectra for the wavelength range of 450–650 nm; *inset B*: plot of PL intensity as a function of the TCVB ratio in mol%. (Same symbols as in Fig. 2.)

Copolymer, Photoluminescence

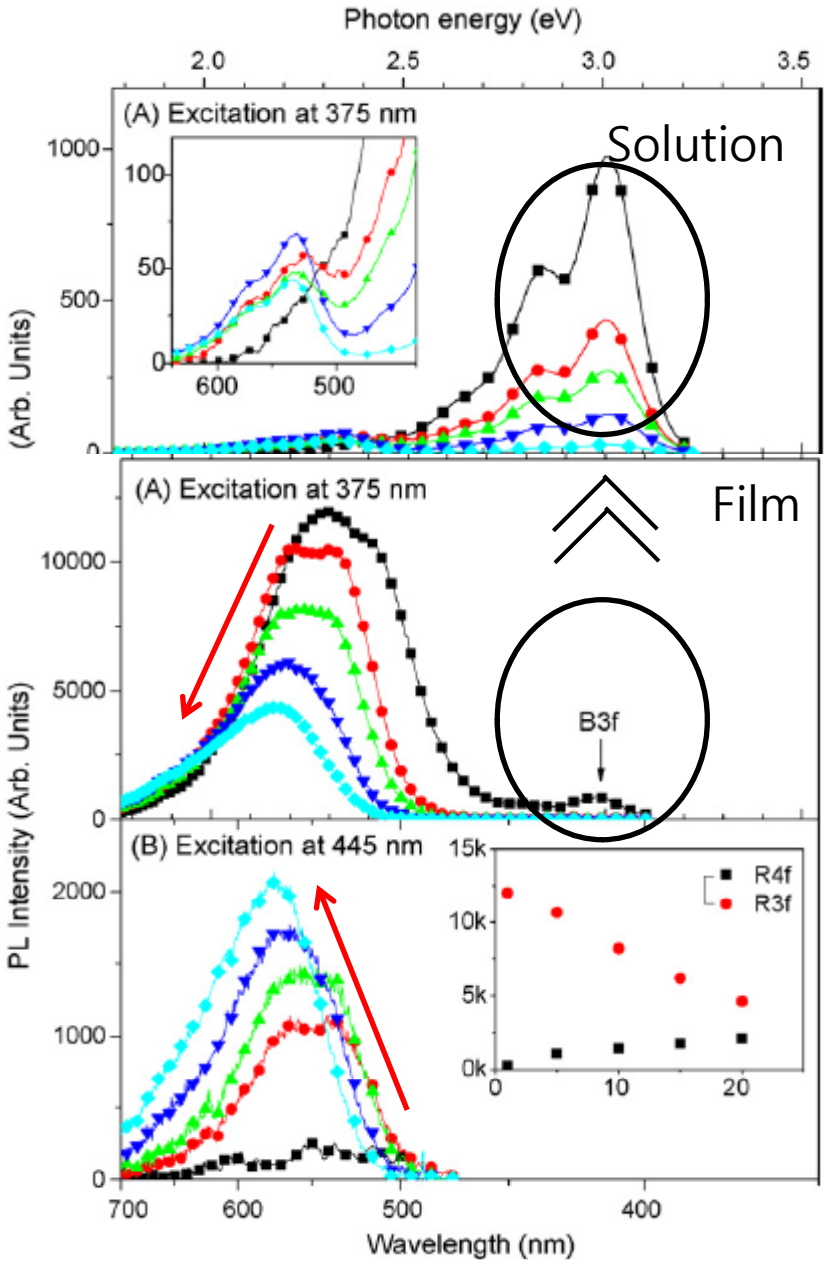
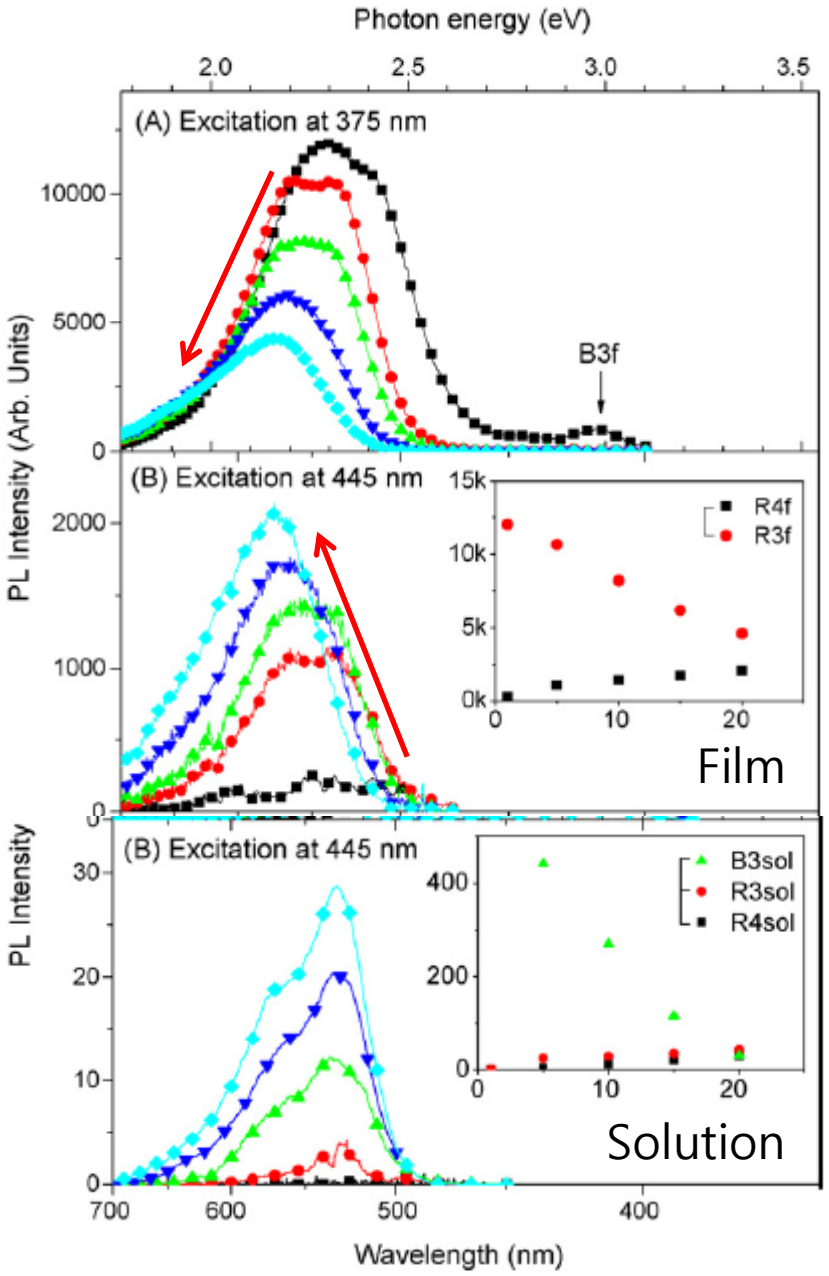


Fig. 5. PL spectra of PFTCVB*x* film samples with excitation at (A) 375 nm and (B) 445 nm; *inset*: PL intensity (arbitrary units) as a function of the TCVB ratio in mol%. (Same symbols as in Fig. 2.)

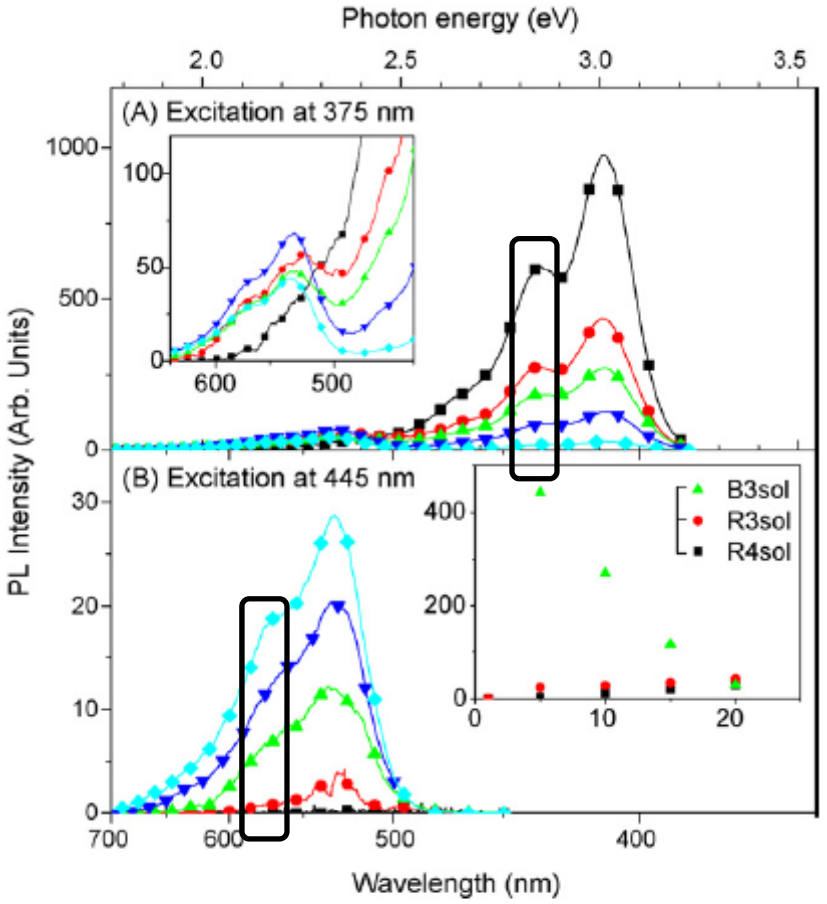
Copolymer, Photoluminescence

Red shift of Red bands
Extended DOF



Copolymer, Photoluminescence

Dissappearance of vibronic fine structures (C=C) Stretch mode



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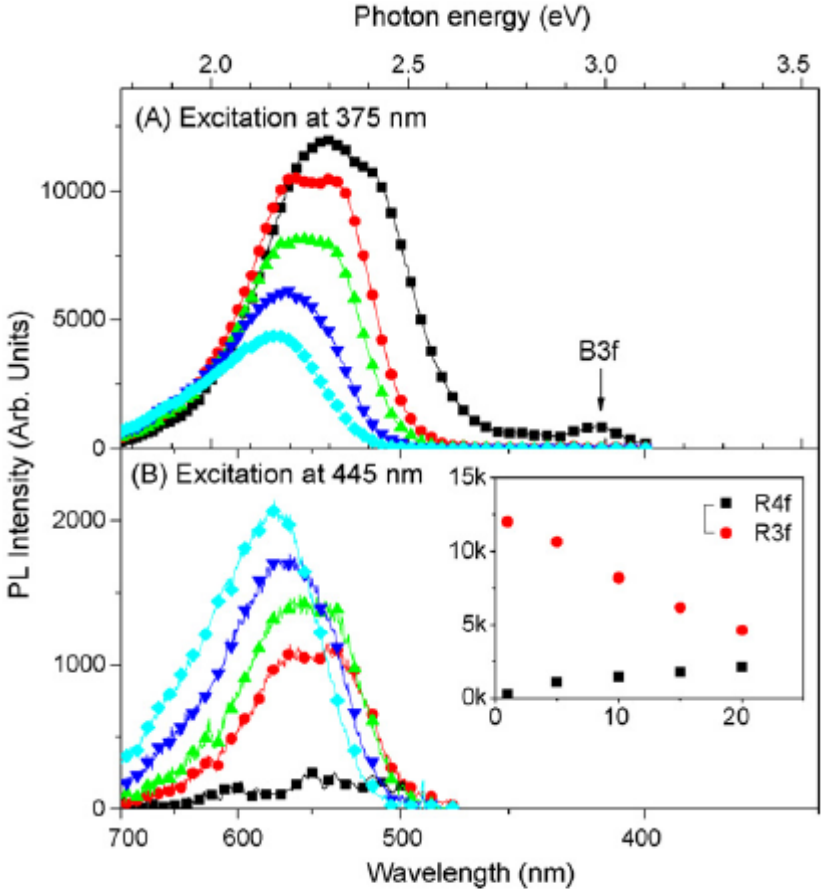

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Review

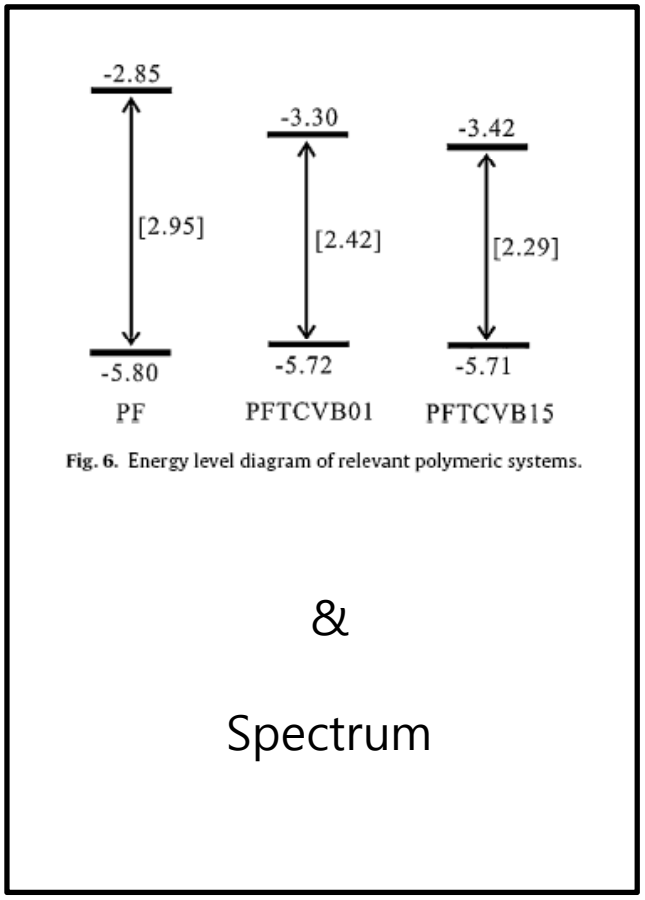

Fig. 6. Energy level diagram of relevant polymeric systems.

&

Spectrum

Red Sites & Blue Sites

Solutions & Films

Excition Dissipation : solution versus film

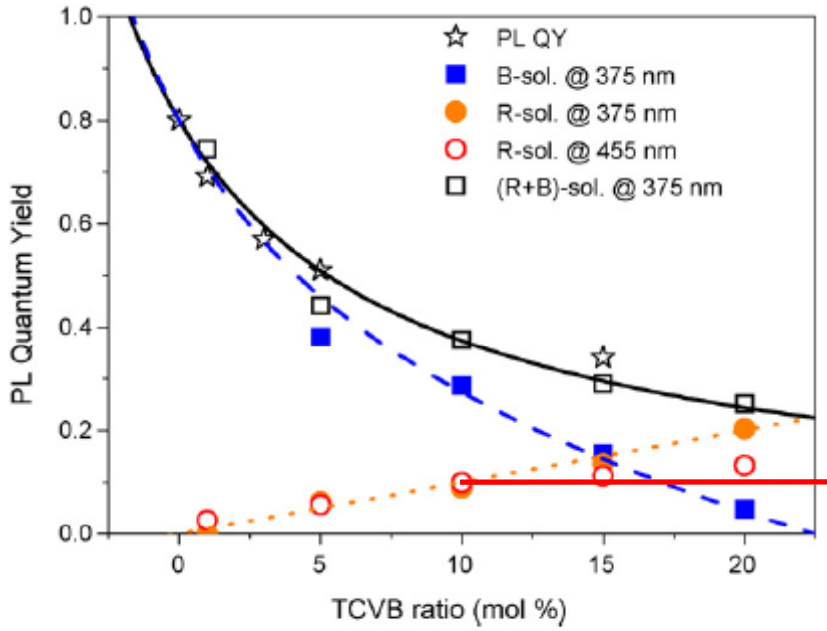

Fig. 7. PL QYs as a function of the TCVB ratio in mol% (PL QY: data from [6]).

Direct excitation - converge

Comparison of the PL QY and device effciency

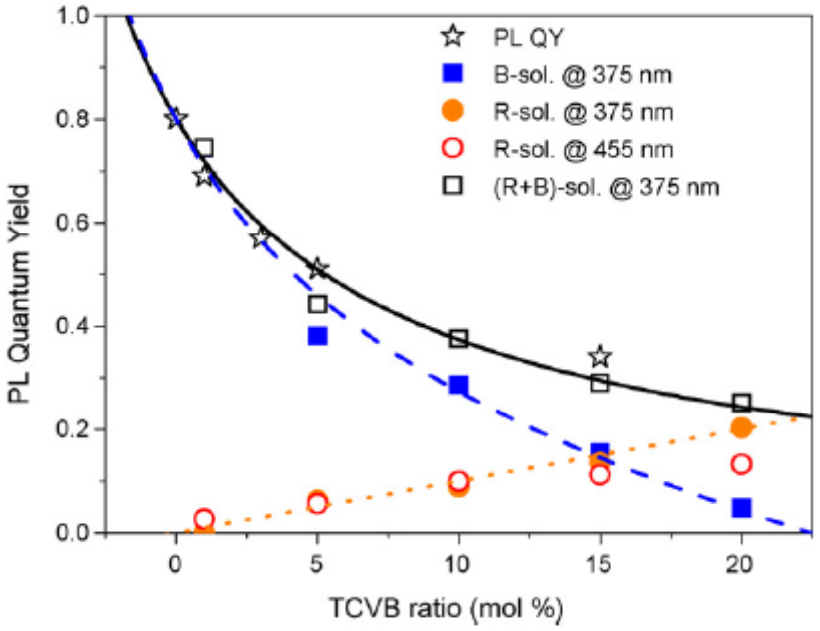

Fig. 7. PL QYs as a function of the TCVB ratio in mol% (PL QY: data from [6]).

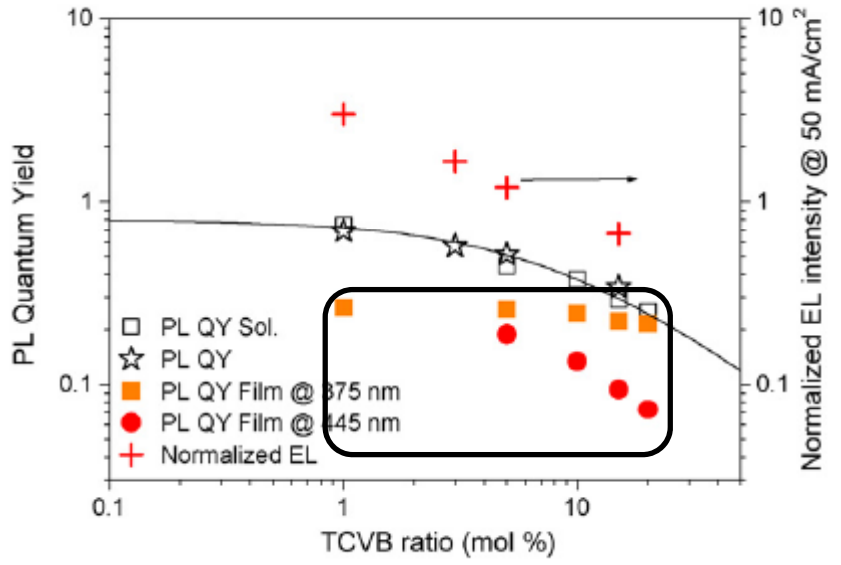

Fig. 8. PL QYs and normalized EL intensities as a function of the TCVB ratio in mol%.

Quenching