

Blue-Shifted Photoluminescence of MEHPPV Nanoparticles Fabricated by a Novel Visible-Laser Solution-Droplet Processing

Graduate School of Engineering, Osaka Electro-Communication University
Akihiro Tomioka, Kouhei Takada and Masato Kawabata



Research Target

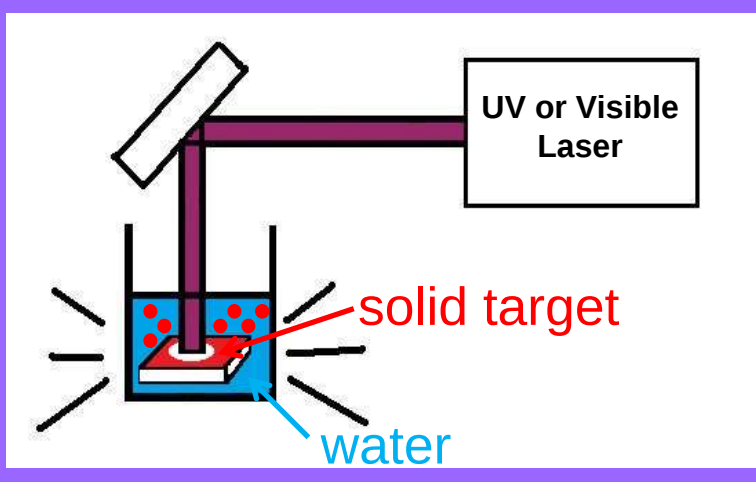
- Seek phase transition of molecularly-dispersed material
- Resonant photoexcitation to invoke molecular vibration via e-ph coupling
- Visible laser usage to avoid material degradation
- Nanoparticle droplet as irradiated target (solution-phase)

Laser Processing of Fragile Organic Material

Liquid-Phase Laser Processing

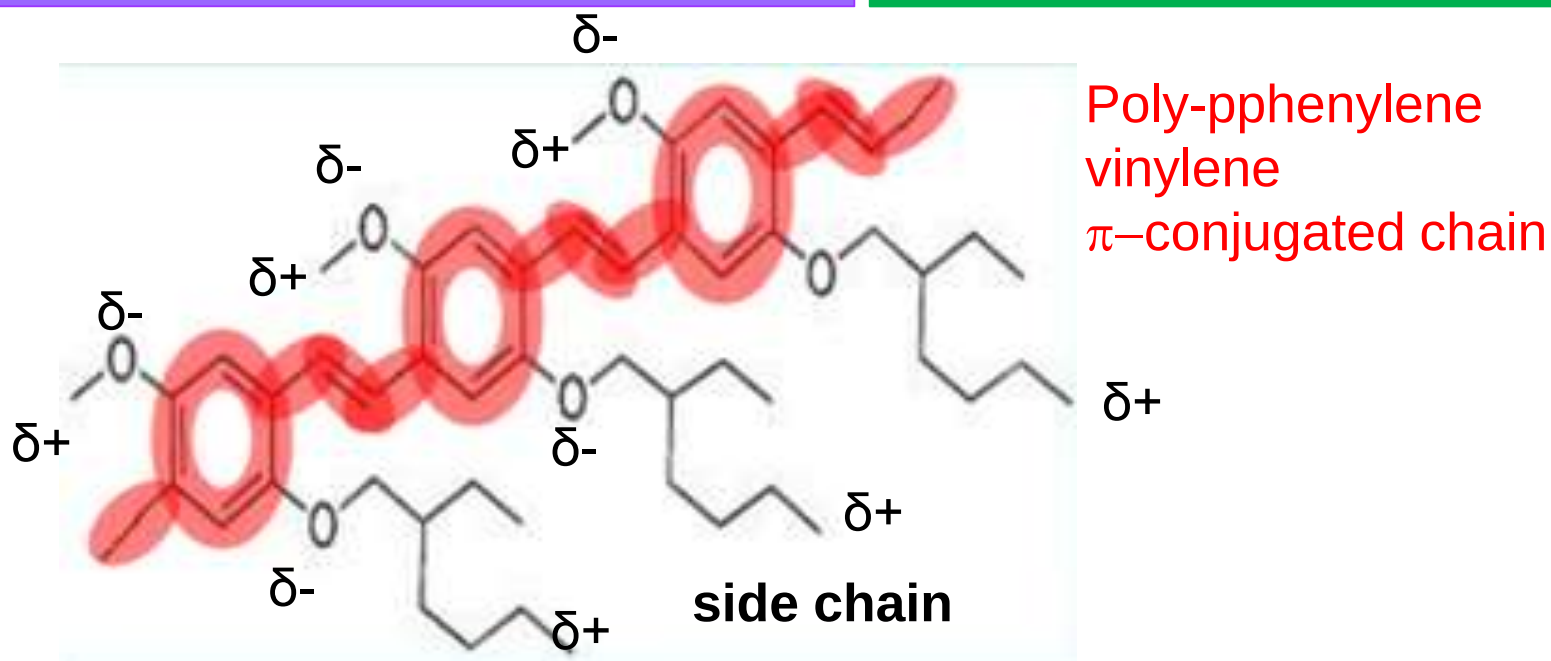
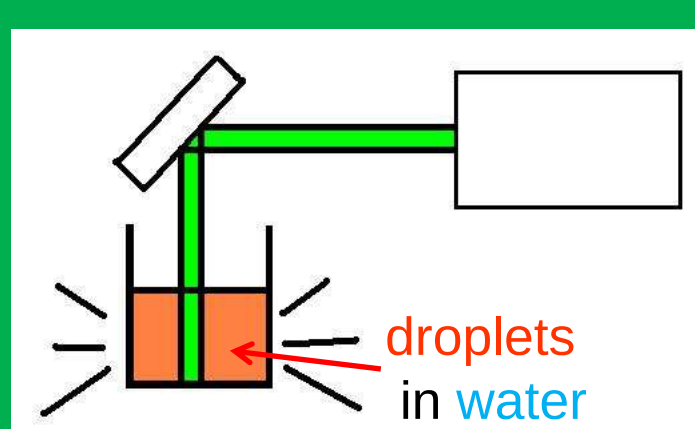
- Solid Target
- UV Laser
- cluster formation

Target material immersed in water



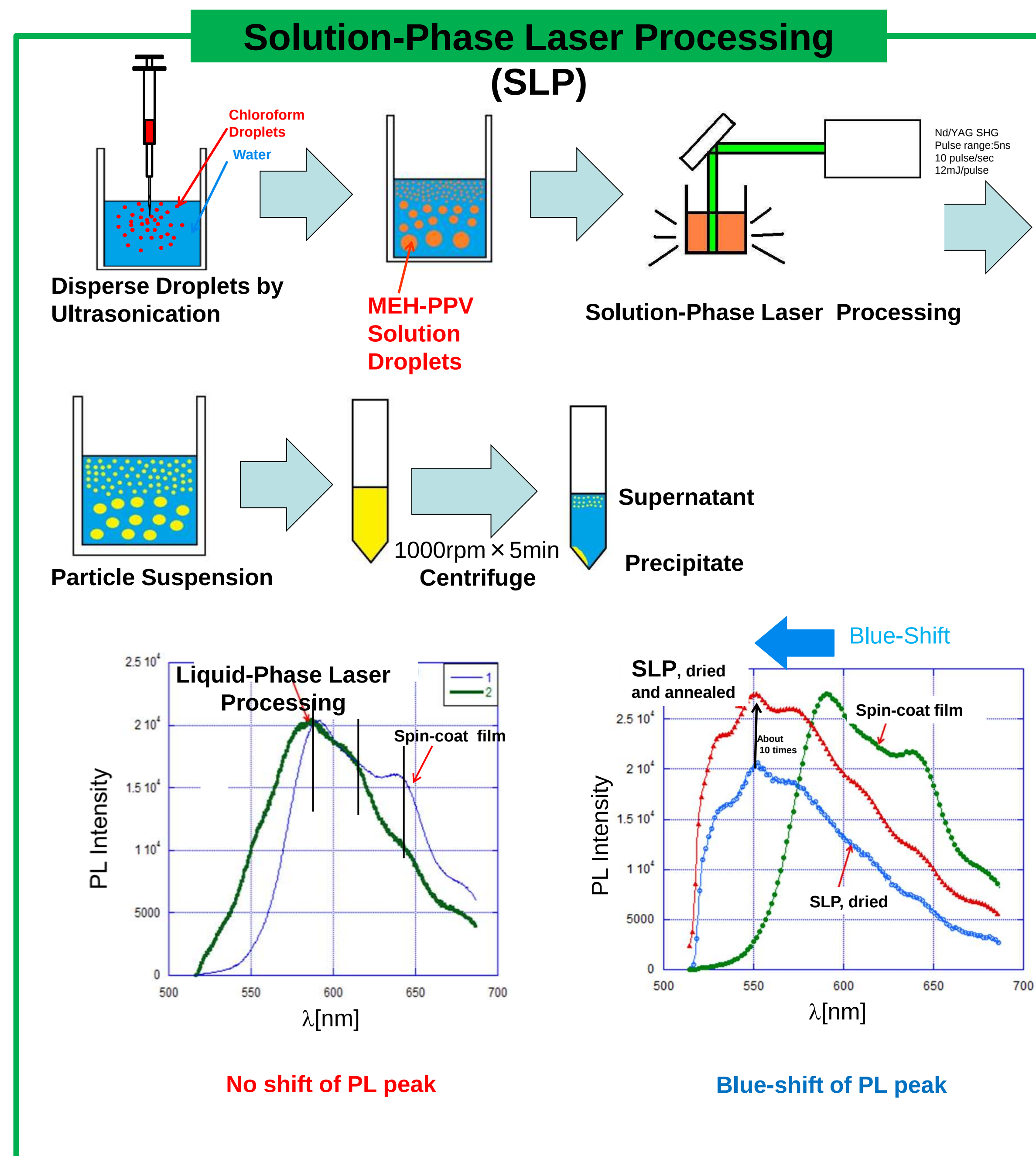
Solution-Phase Laser Processing

- Solution Droplet: Target
- Visible Laser
- no Degradation

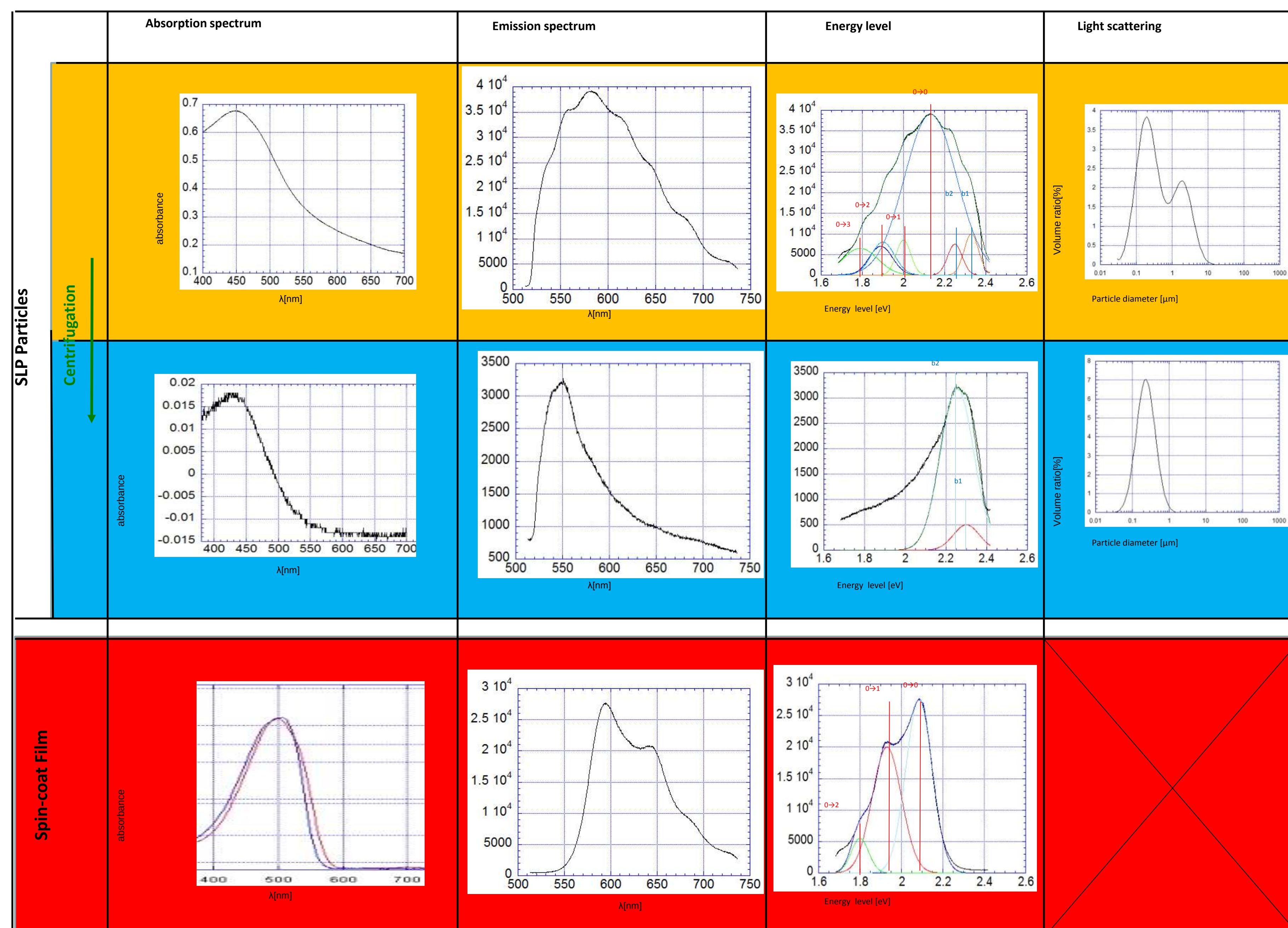
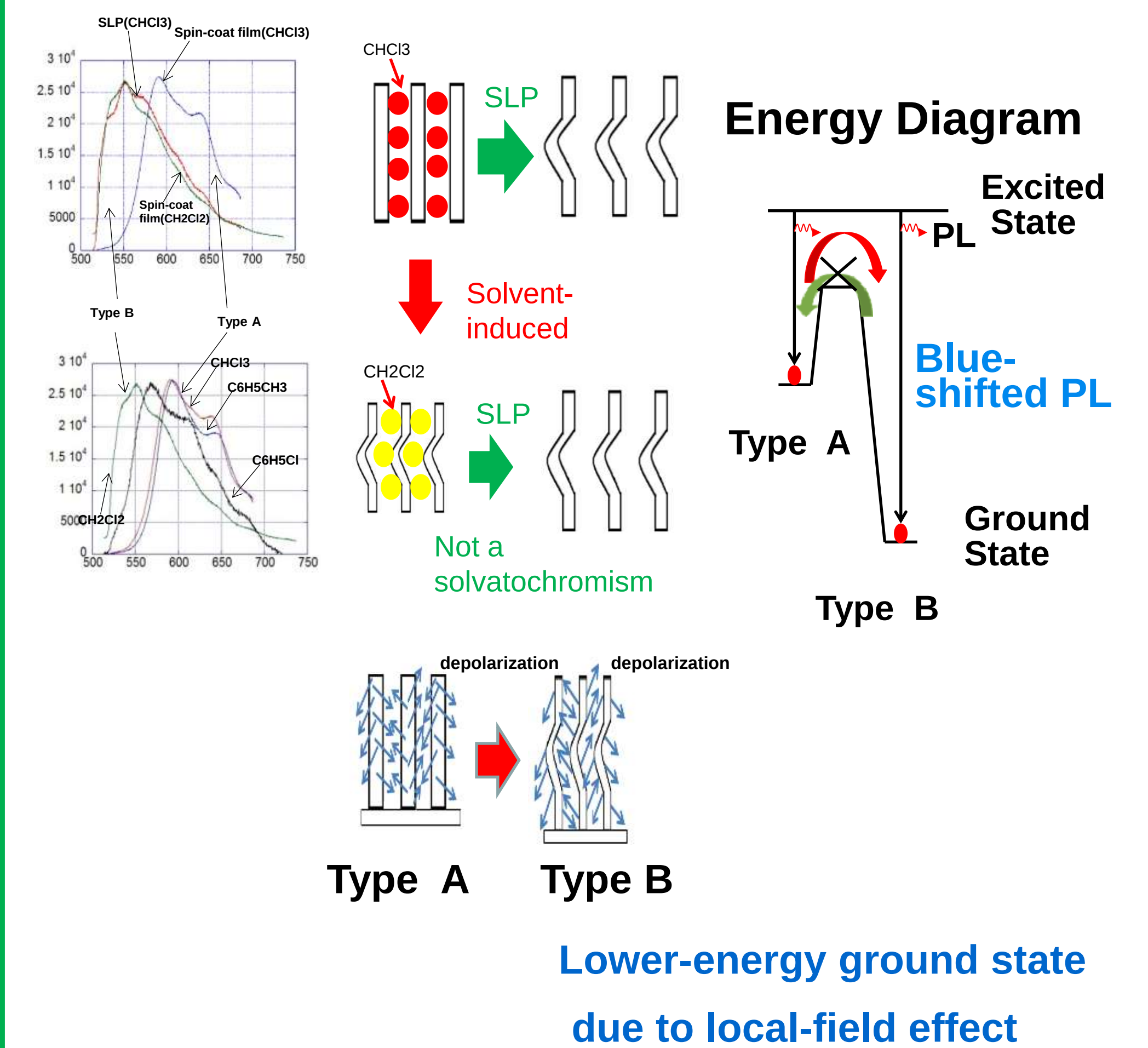


Target Material: MEH-PPV

- Long π -conjugated chain
- large optical absorption
- π electrons under local electric field of polar side chain
- side chain conformation may be altered via molecular vibration



Tentative Model of Conformational Change



SLP		energy level [eV]	λ [nm]	ΔE [eV]
Before Centrifugation	0→3	1.79	693	-0.34
	0→2	1.90	653	-0.23
	0→1	2.00	620	-0.13
	0→0	2.13	582	
	b2	2.25	551	0.12
After Centrifugation	b1	2.33	532	0.20
	b2	2.26	550	0.13
	b1	2.30	539	0.17

		energy level [eV]	λ [nm]	ΔE [eV]
Spin-coat Film	0→2	1.80	689	-0.29
	0→1	1.93	642	-0.16
	0→0	2.09	595	

Fitting equation

Gauss distribution

$$E = A \exp\{(E_0 - E_x)^2 / d^2\}$$

:Well Fitted

Lorentz distribution

$$E = \frac{A}{(E - E_0)^2 + d^2}$$

:NG

Conclusion

- Solution-Phase Laser Processing (SLP) of π -conjugated polymer solution droplets brought about new state of dye aggregation.
- Resonant photoexcitation invokes molecular motion via e-ph coupling, leading to a phase transition of the polymer.
- New molecular state showed blue shifted photoluminescence, consistent with the stabilized lower ground state after SLP.
- Tiny droplet suspension is indispensable for effective SLP, leading to phase transition of monodispersed nanoparticles.