

Characterization of PTB7-Th:PC₇₁BM bulk heterojunction solar cells: influence of blend ratio

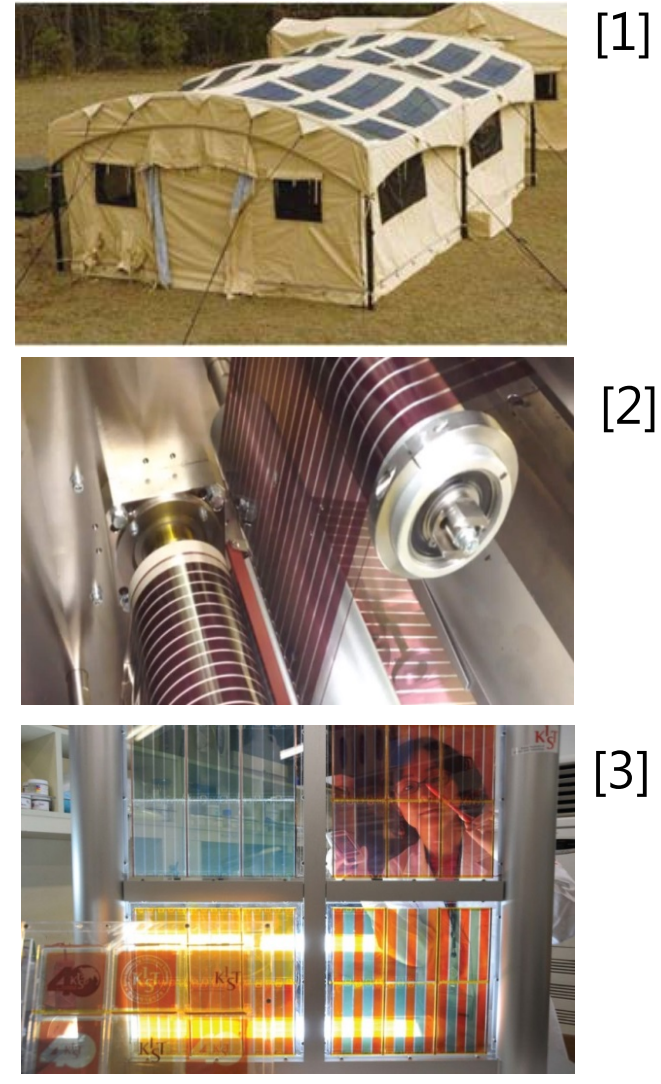
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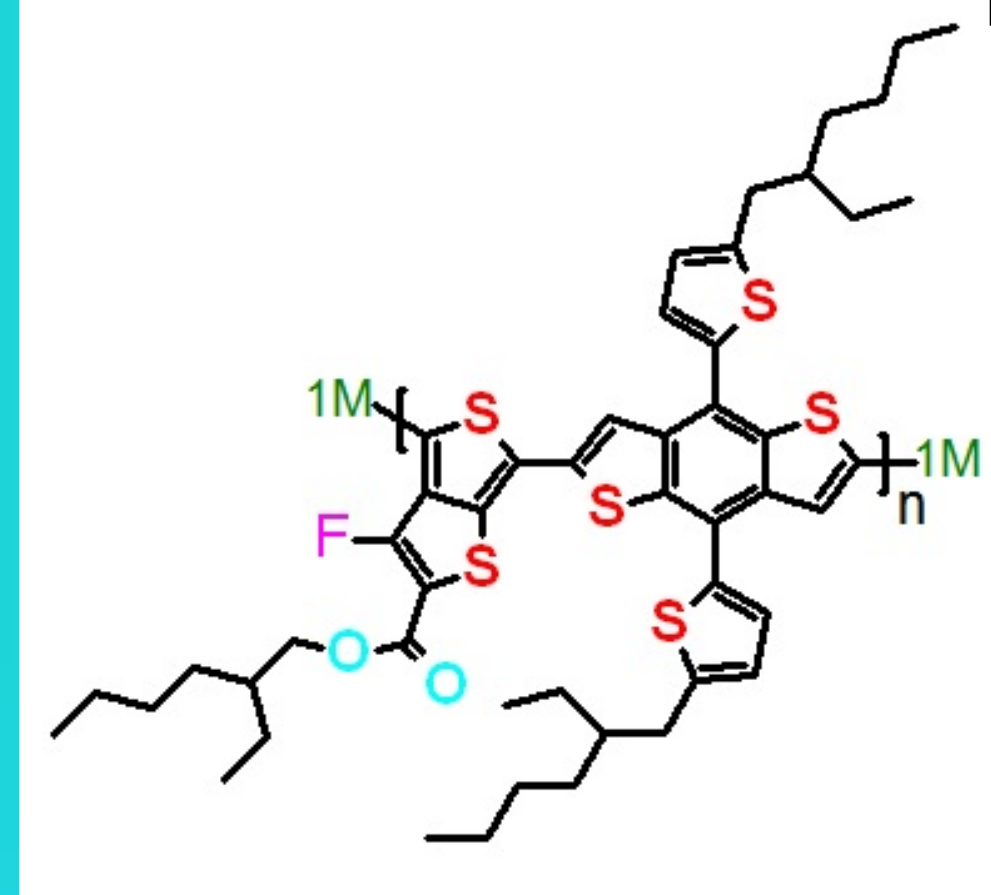
1. Motivations

- light weight
- flexible
- semitransparent
- potentially cheap production
- easy to scale to industrial production

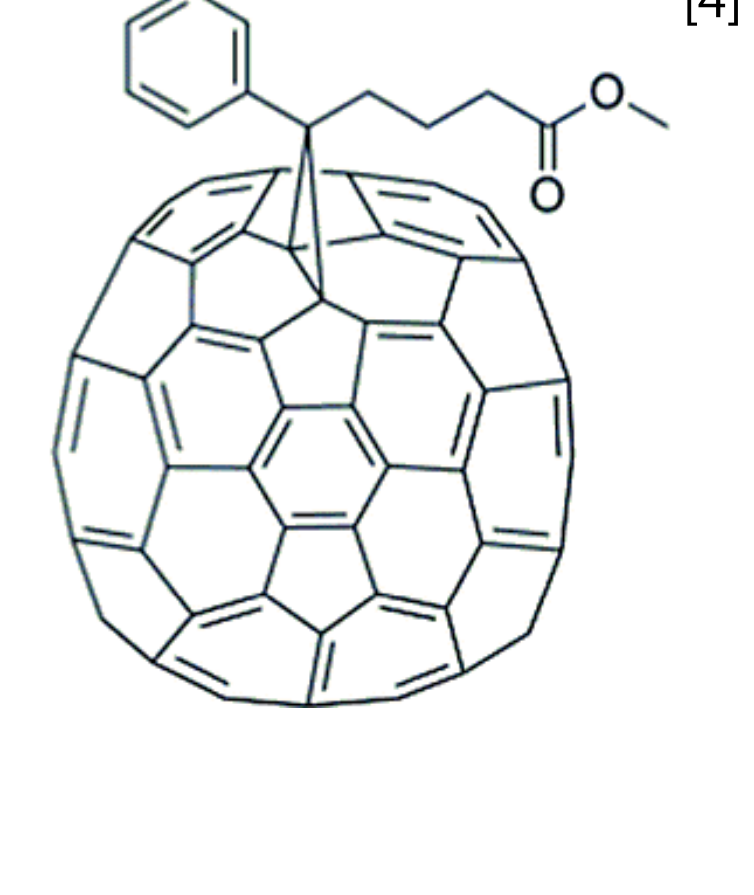


2. Materials

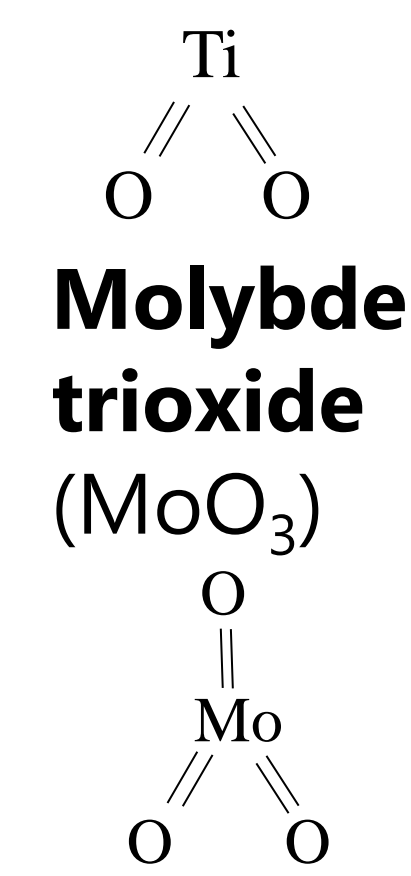
PTB7-Th (C₄₅H₅₇FO₂S₆)_n (PCE10, PBDTTT-EFT)



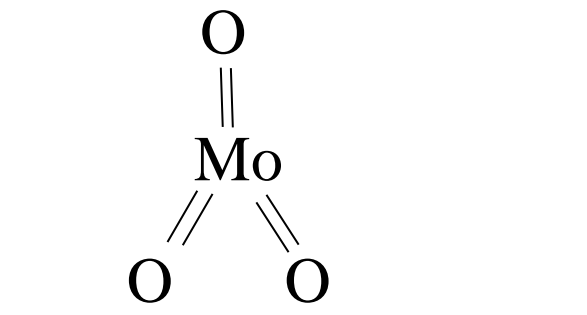
PC₇₁BM (C₈₂H₁₄O₂)



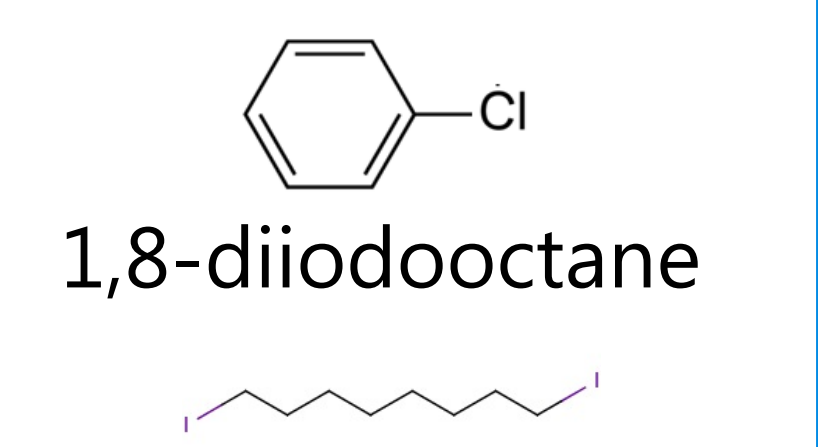
Titanium dioxide (TiO₂)



Molybdenum trioxide (MoO₃)



Solvent & additive
Chlorobenzene (C₆H₅Cl)



1,8-diiodooctane



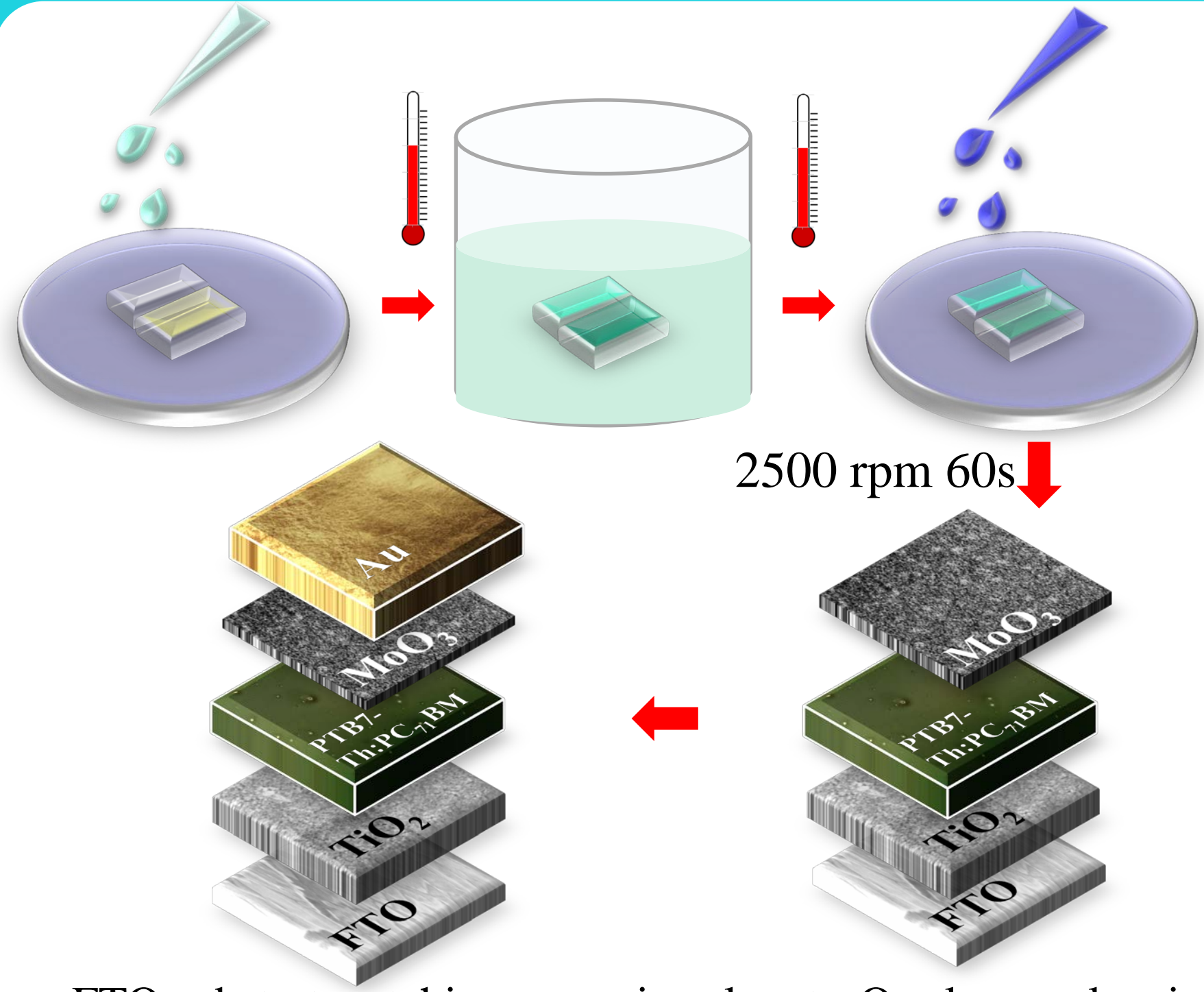
Substrate
Fluorine Tin Oxide SnO₂/F

3. Ratio

material	HOMO [eV]	LUMO [eV]	band gap [eV]	M _w [g/mol]
PTB7-Th	-5.38	-3.81	1.57	105 000
PC ₇₁ BM	-6.10	-4.20	1.90	1 031

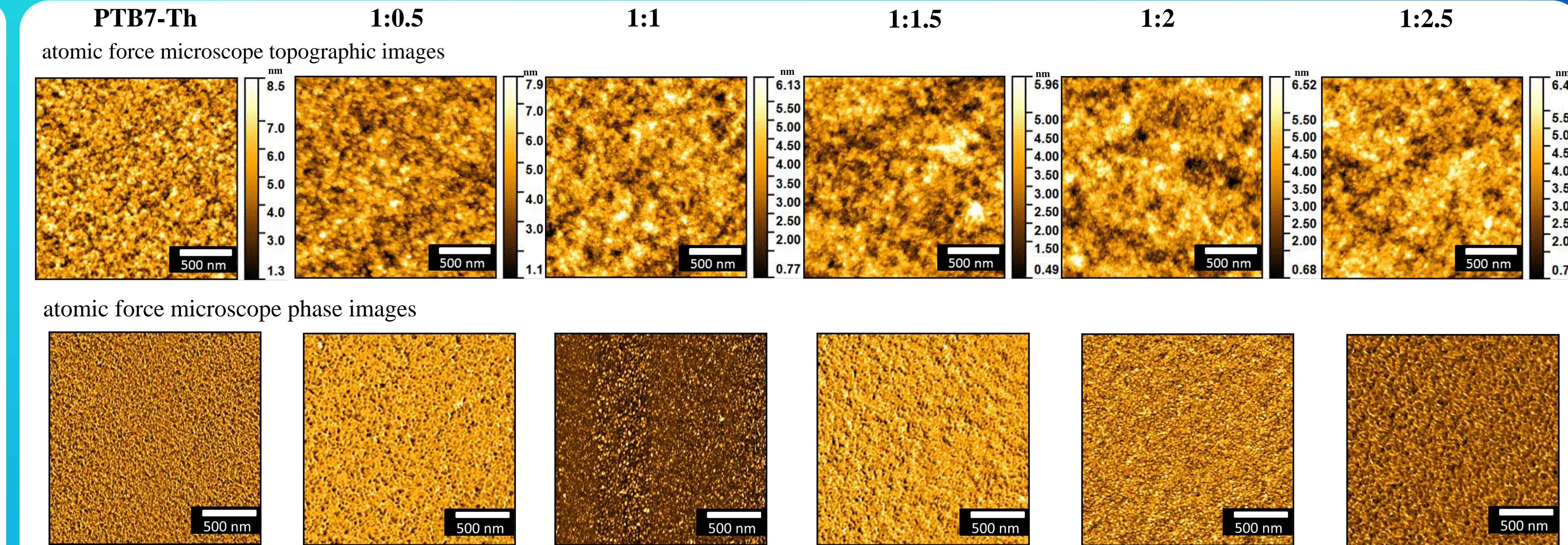
ratio	PTB7-Th	1:0.5	1:1	1:1.5	1:2	1:2.5	PC ₇₁ BM
conc. PTB7-Th [mg/ml]	10	10	10	10	10	10	/
conc. PC ₇₁ BM [mg/ml]	/	5	10	15	20	25	15
thickness [nm]	48	61	77	98	116	133	31

4. Sample preparation



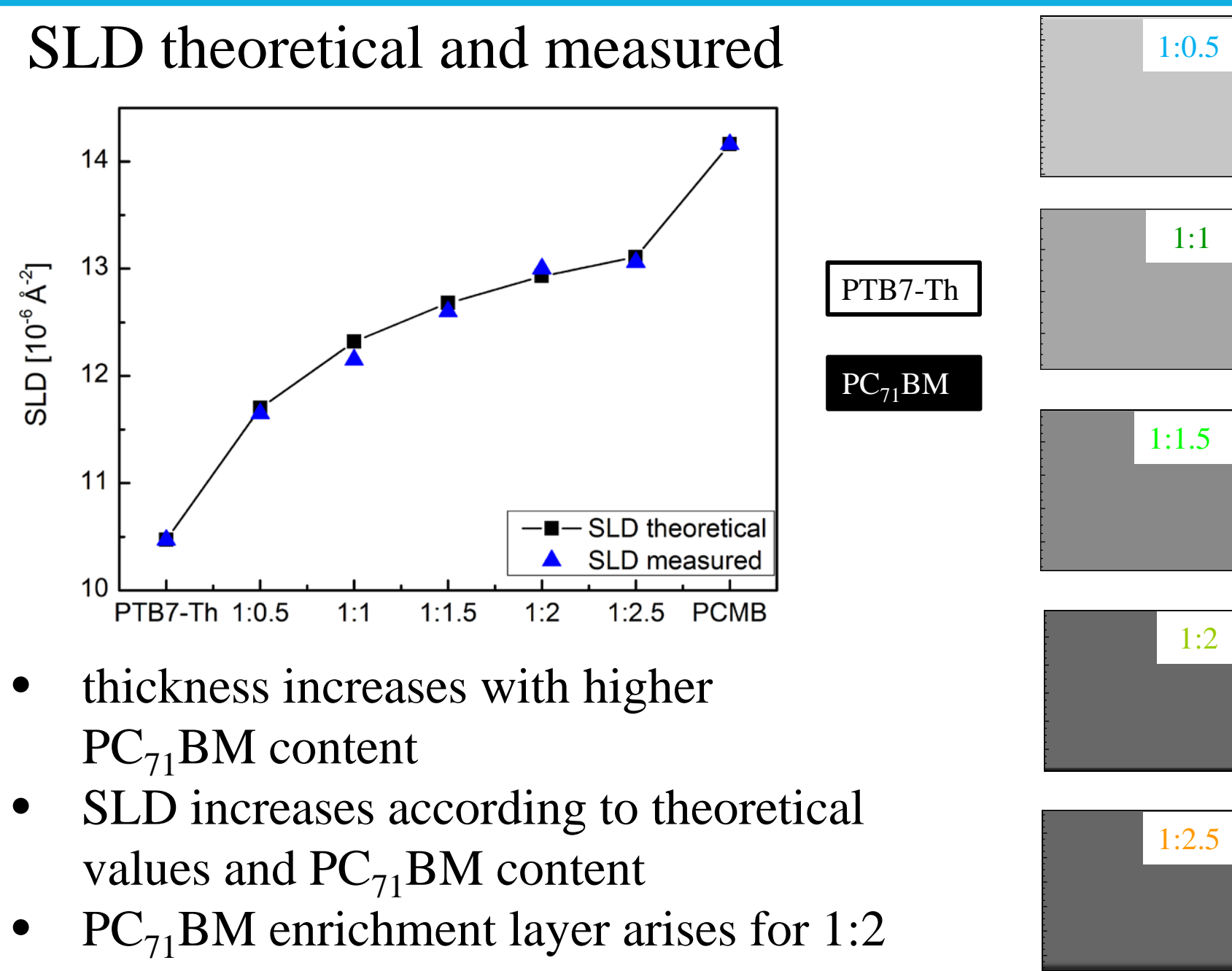
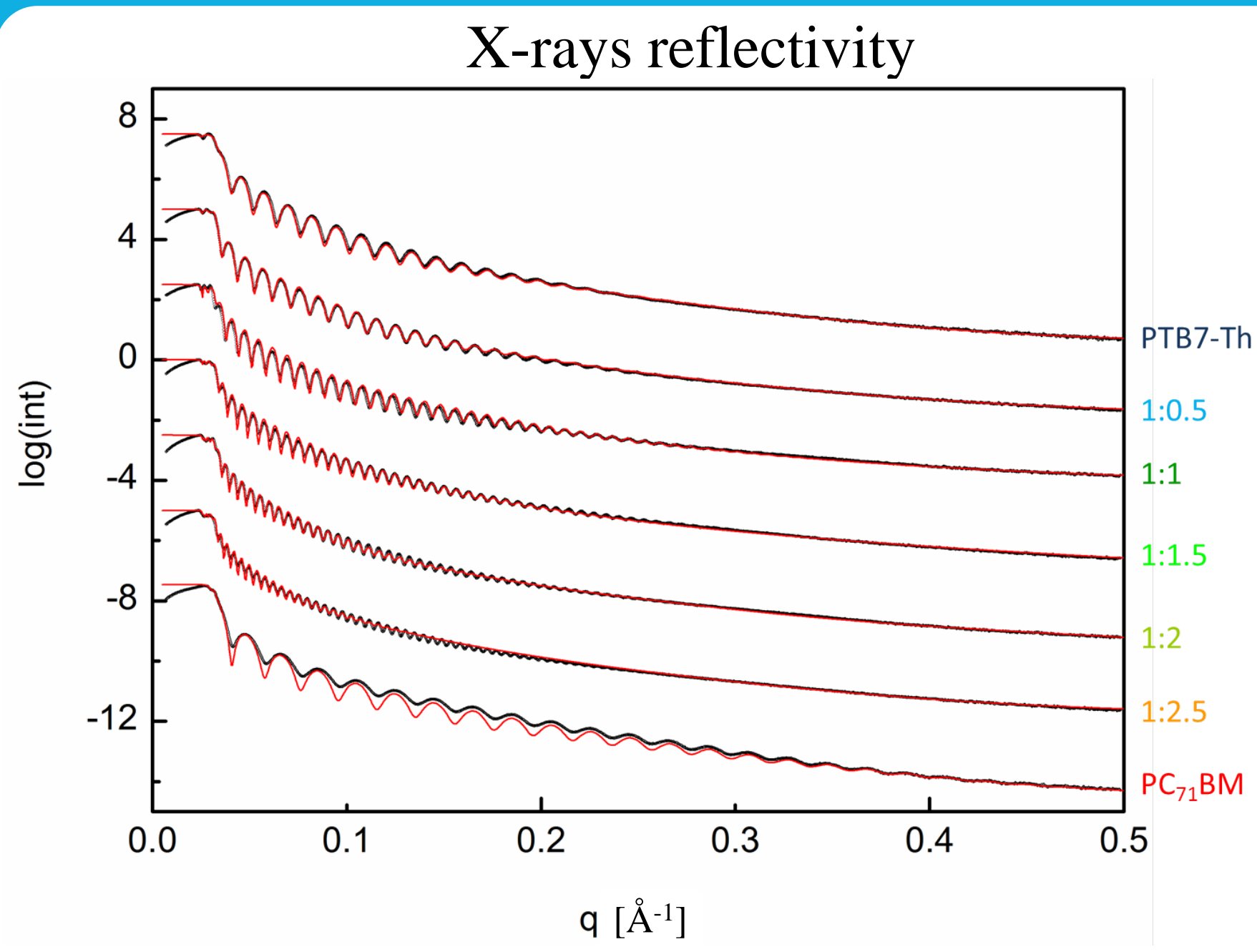
- FTO substrate, etching, organic solvent - O₂ plasma cleaning
- TiO₂ sol-gel solution spin coating + calcination
- TiCl₄ bath for compact Ti layer deposition + calcination
- active layer spin coating (24h stirring at 60°C in glovebox)
- MoO₃ evaporation
- Au electrode evaporation

5. Surface investigation

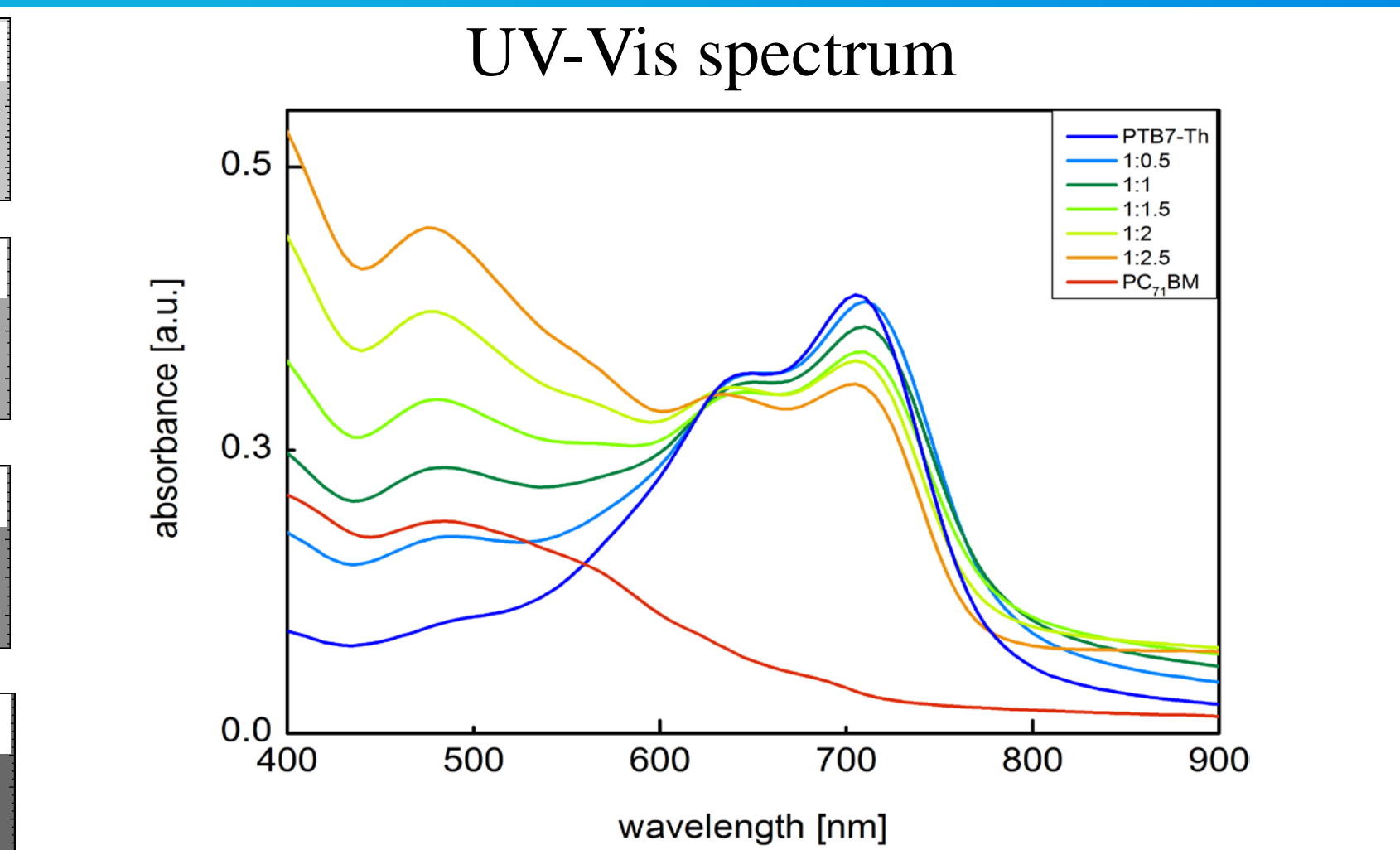


- both AFM topography and phase images show uniform and homogeneously formed films
- no defined structures or aggregates are highlighted

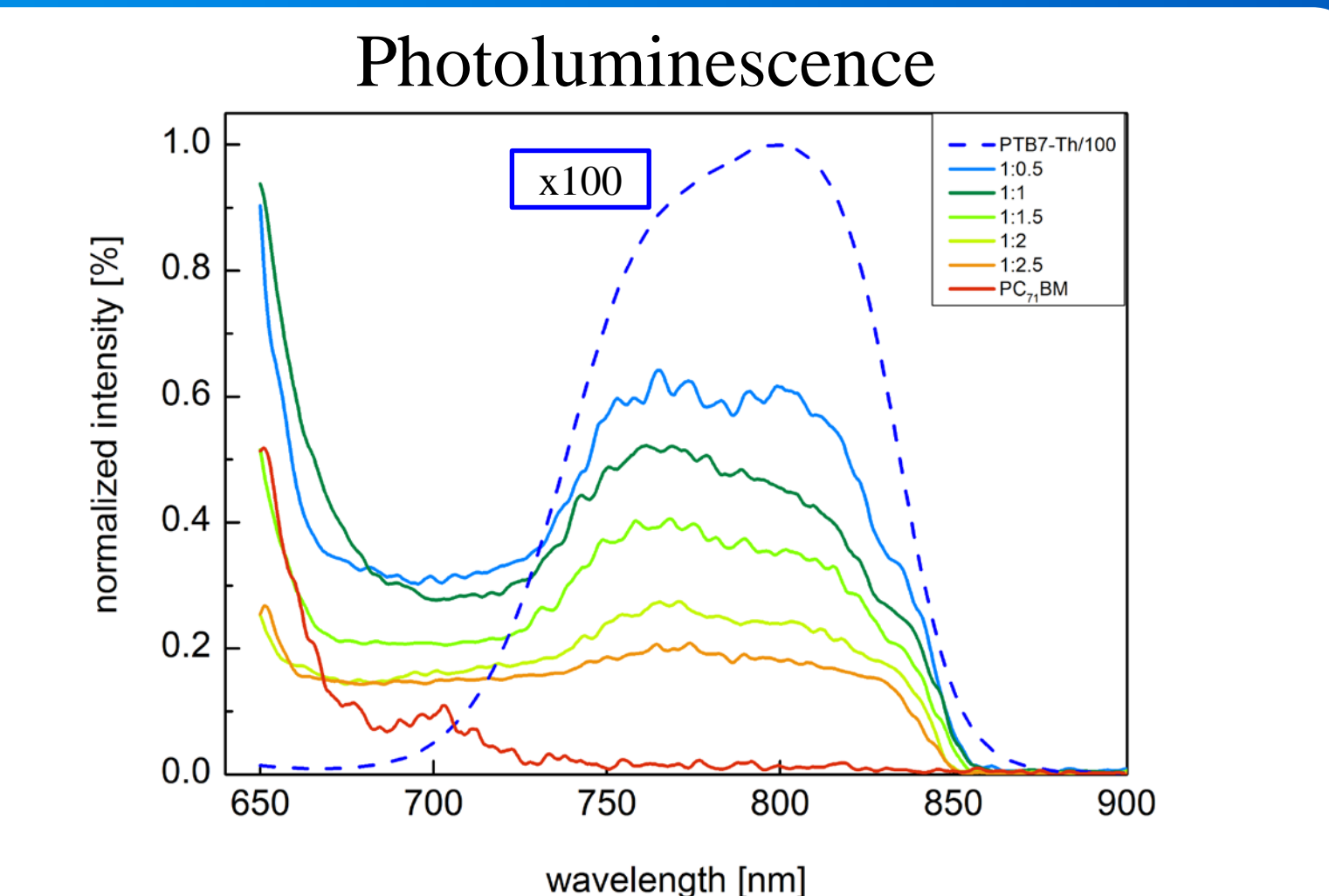
6. Structural and optical characterization



- thickness increases with higher PC₇₁BM content
- SLD increases according to theoretical values and PC₇₁BM content
- PC₇₁BM enrichment layer arises for 1:2 (2.2 nm) and 1:2.5 (4.5 nm) ratios

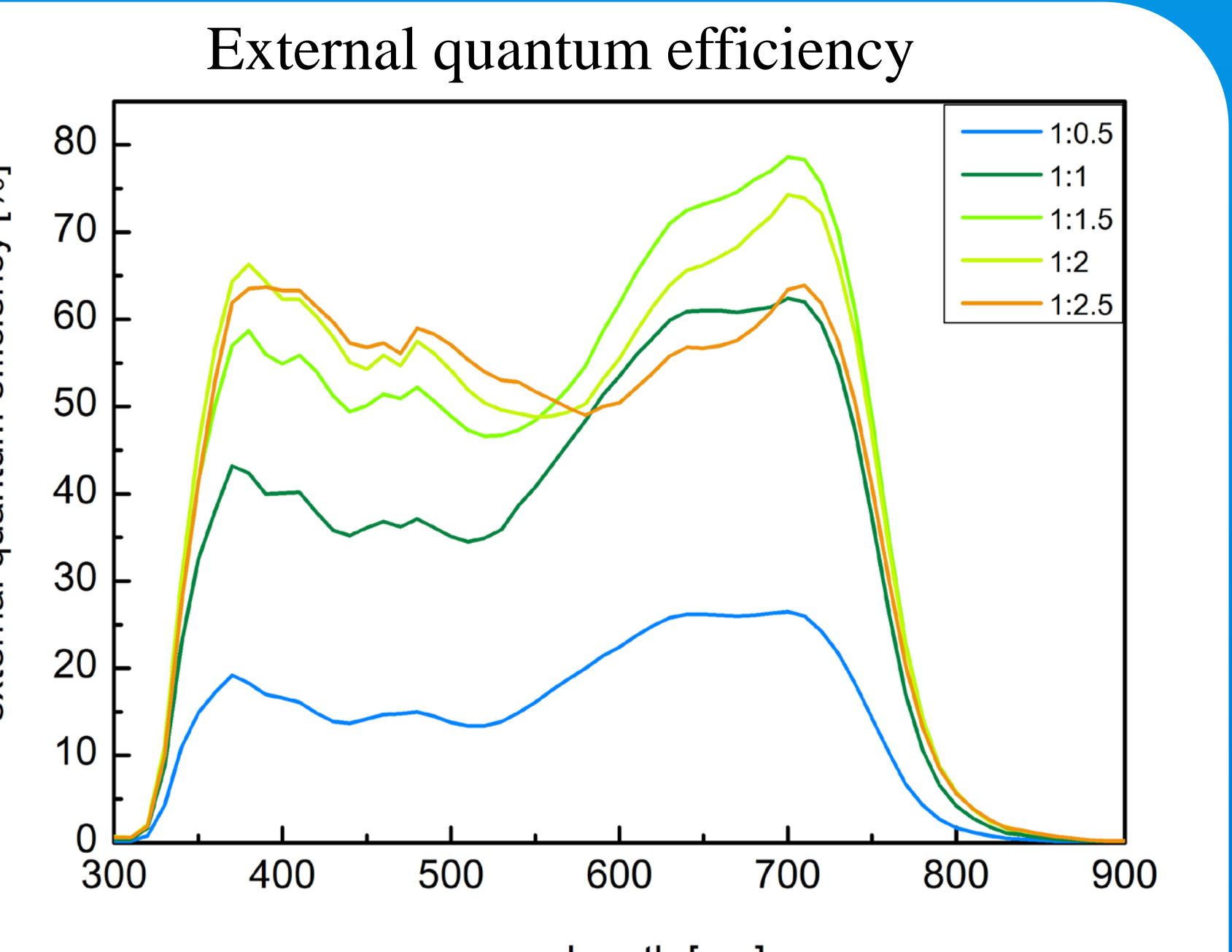
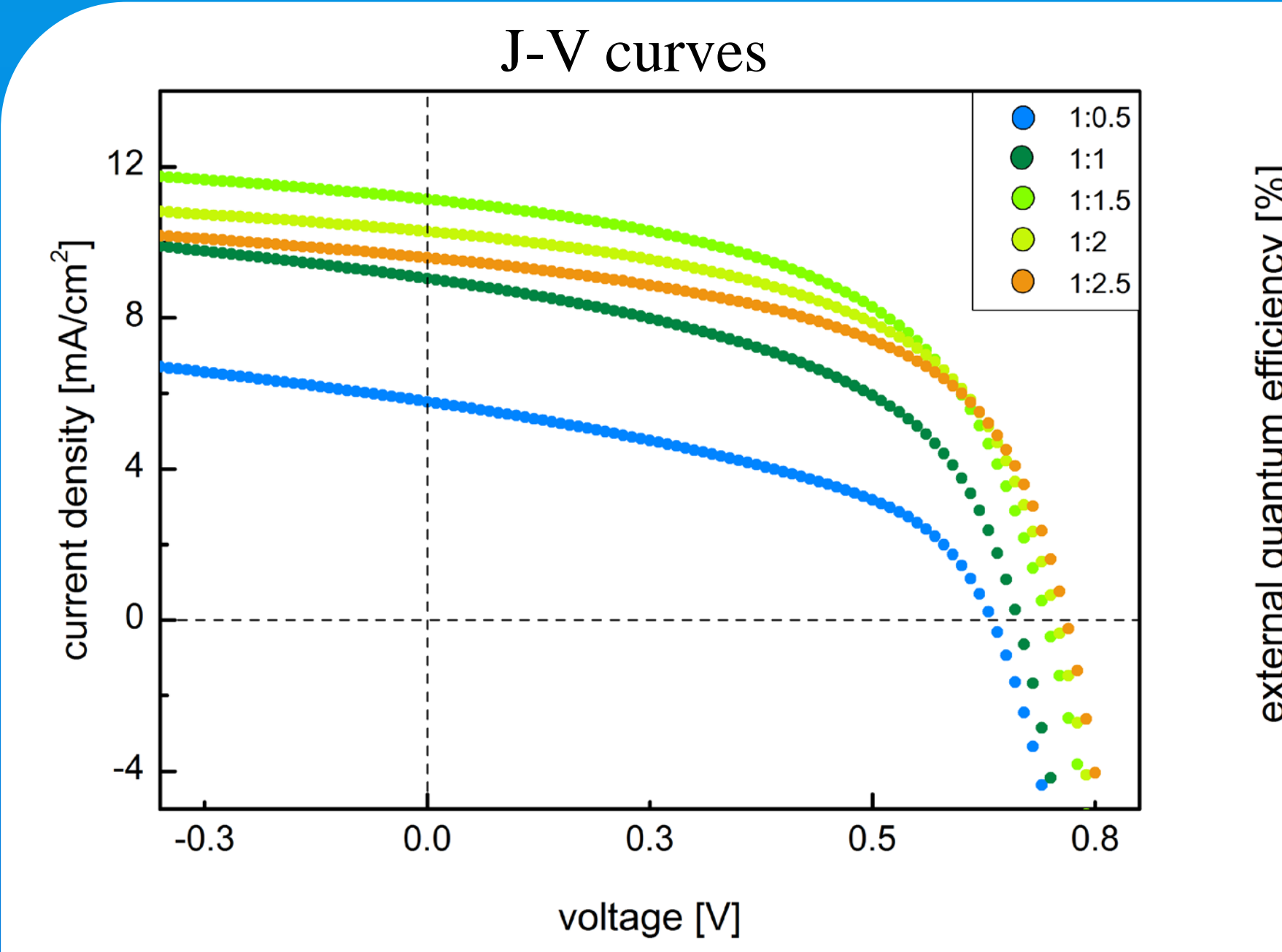


- increasing absorbance at range 400-500 nm → higher PC₇₁BM content
- decreasing absorbance at range 500-800 nm → lower PTB7-Th content



- excitation wavelength 630 nm
- high quenching ratio → high phase separation
- higher PC₇₁BM concentration → lower exciton recombination and better charges separation

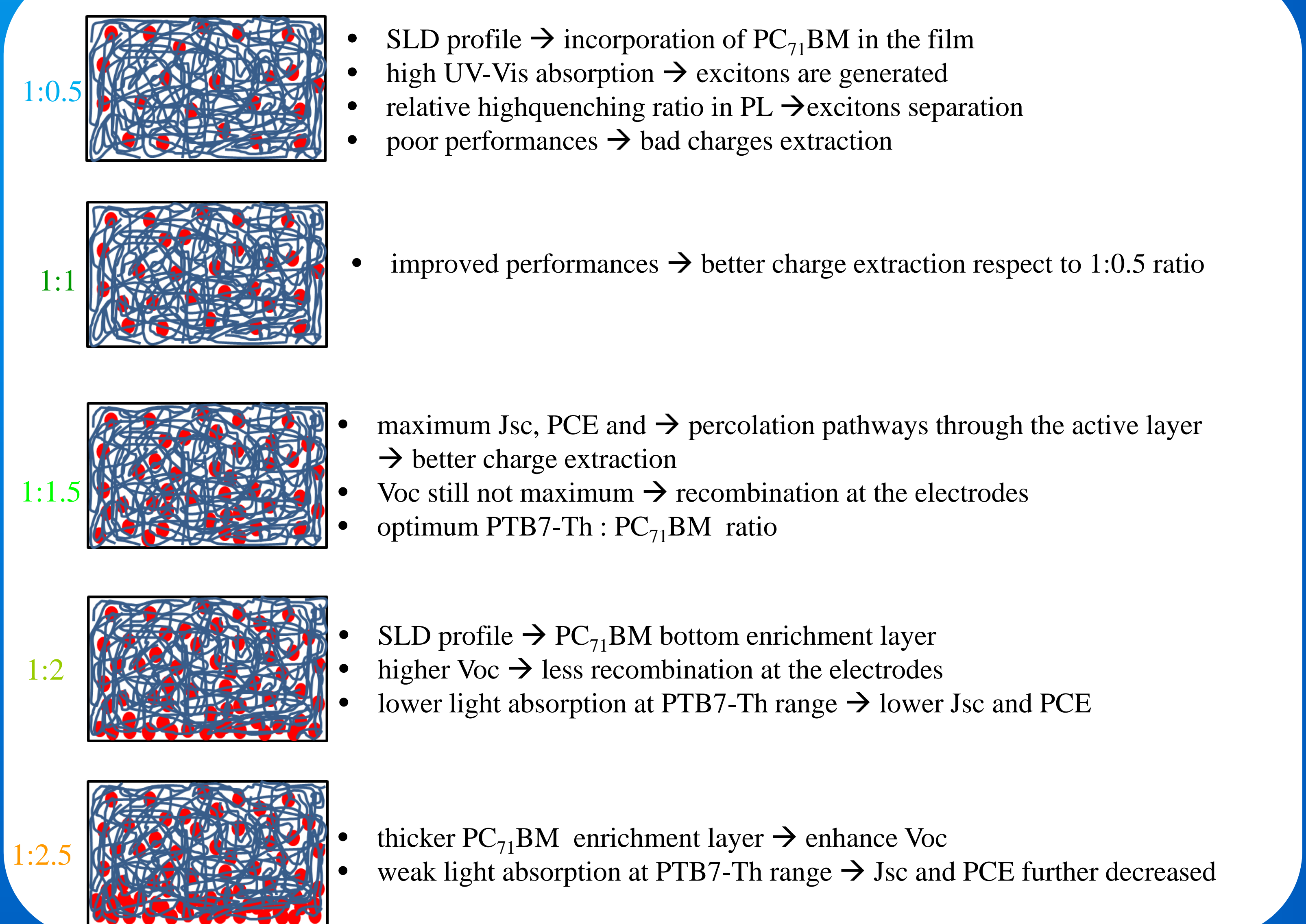
7. Solar cells performances



- maximum J_{sc} and PCE: ratio PTB7-Th:PC₇₁BM of 1:1.5
- Voc maximum for 1:2 and 1:2.5 ratios: films with the bottom enrichment layer
- the fill factor stays stable after 1:1.5 ratio
- 300-500 nm range: PC₇₁BM contribution
- 500-800 nm range: PTB7-Th contribution
- good agreement with UV-Vis absorbance
- 1:0.5 and 1:1 ratio low EQE but highest UV-Vis absorbance

ratio	J _{sc} J-V [mA/cm ²]	J _{sc} EQE [mA/cm ²]	V _{oc} [V]	fill factor [%]	PCE [%]
1:0.5	5.78	4.33	-0.63	44.5	1.62
1:1	9.67	10.50	-0.69	49.7	3.34
1:1.5	11.14	13.22	-0.70	53.6	4.15
1:2	10.29	12.95	-0.71	54.7	3.97
1:2.5	9.58	12.14	-0.72	54.5	3.77

8. Conclusion



9. References & Contact