

# Profile



## Jungmin Park

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### Education

**B.A. in Applied Chemistry**, Dongduk Women's University (Feb 2025)

- GPA 3.89/4.5

### Work experience

Jun 2024 – Aug 2024 **Adolphe Merkle Institute (AMI)**

Project 4: QD-Spiropyran/Polymer matrix for FRET-Based Fluorescence Imaging — **p.7**

Aug 2023 – May 2024 **Max-Planck-Institute for Polymer research (MPI-P) - Prof. Mischa Bonn's group**

Project 1-2 : Ultrafast Spectroscopy on Metal-Halide Perovskites — **pp.2-5**

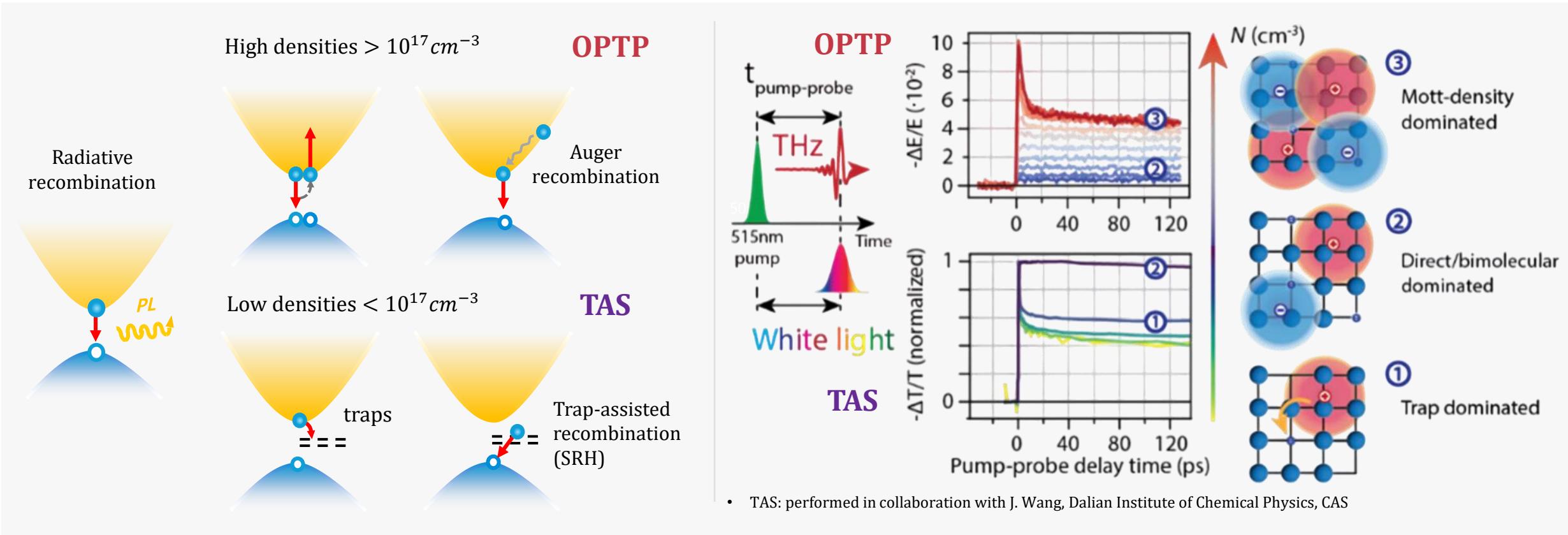
Mar 2023 – Jun 2023 **Korean Institute of Science and Technology (KIST)**

Project 3: Synthesis of Mechanophore Crosslinkers — **p.6**

# Project 1.

## Temperature-dependent Carrier Dynamics in Photoexcited Metal-Halide Perovskites

\* Published in J. Phys. Chem. Lett. (2025)



### Motivation

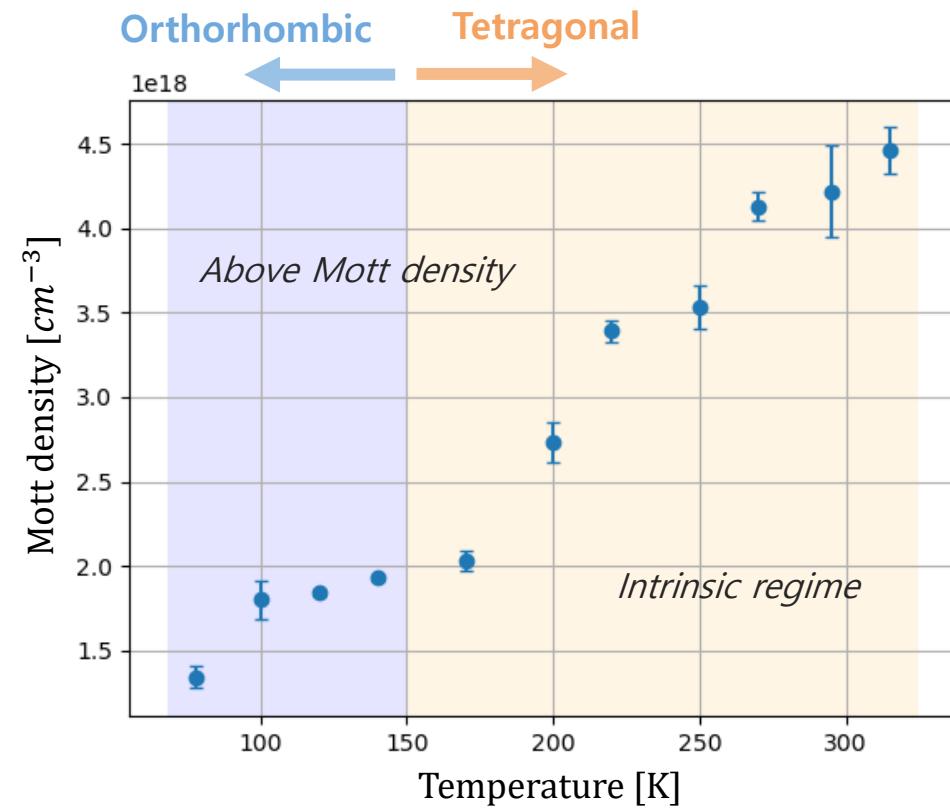
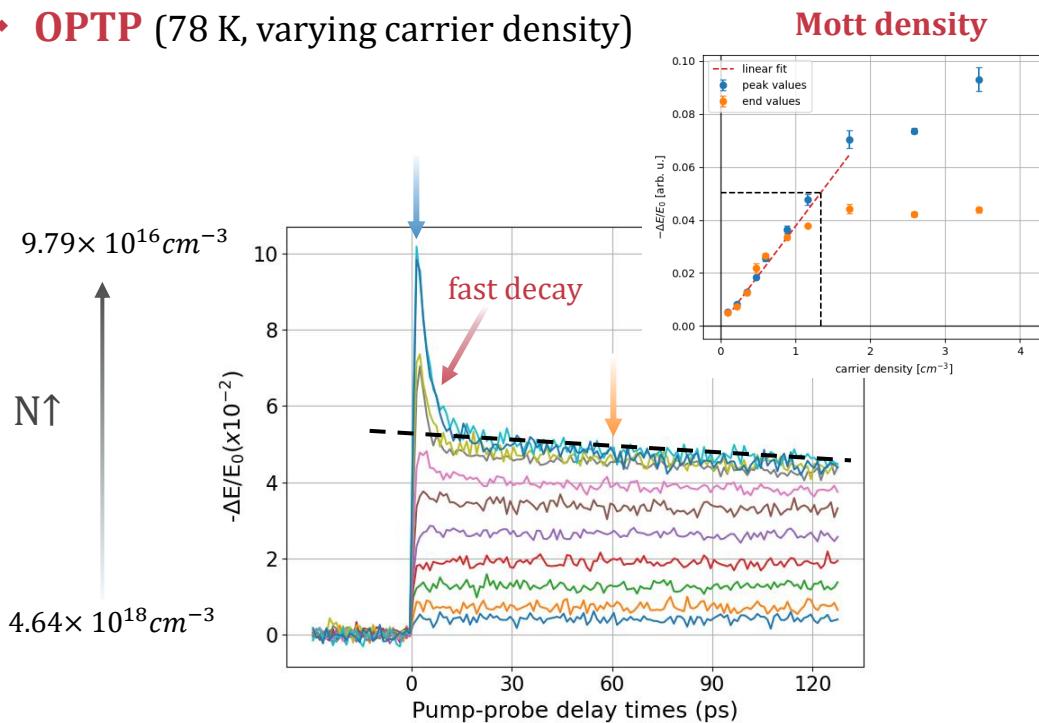
: recombination pathways in perovskites depend on carrier density and temperature, yet the transitions between **trap-, intrinsic bimolecular-, and Mott-dominated** regimes are not clearly established.

### Outline

: map density-dependent recombination pathways in photoexcited  $\text{MAPbI}_3$  by combining **TAS** and **OPTP** spectroscopy to construct an **electronic polaron phase diagram**.

# Project 1. Experiment – OPTP analysis & T-dept Mott density

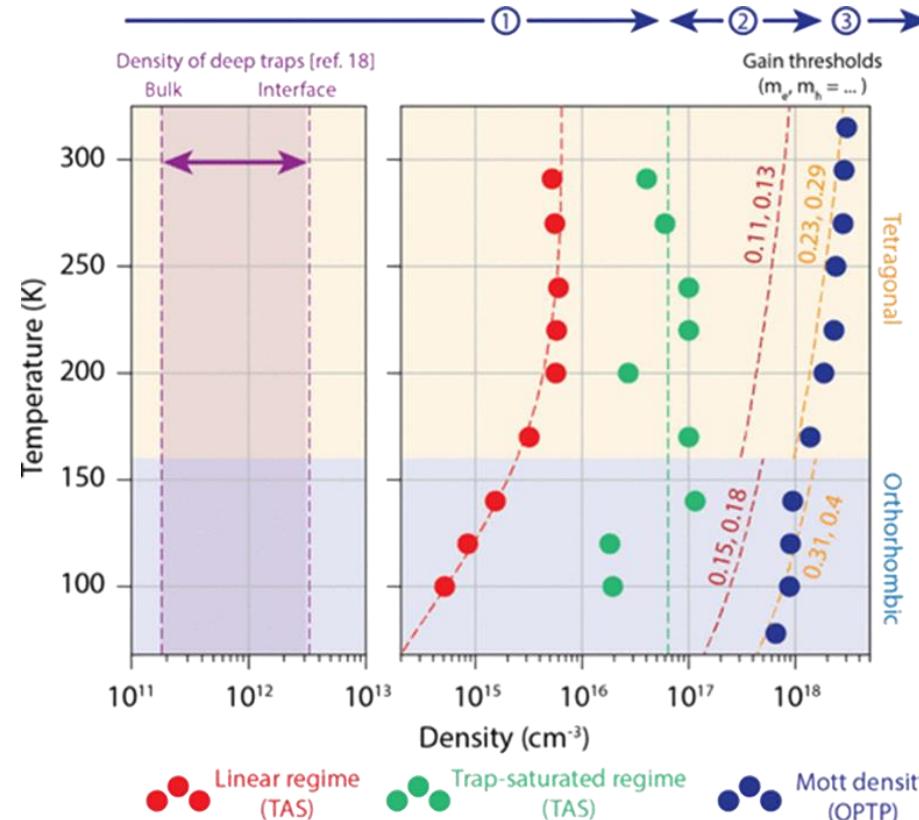
## ❖ OPTP (78 K, varying carrier density)



## Key Results

- Quantified the temperature-dependent Mott density ( $N_{\text{mott}}$ ) from OPTP measurements across 78–315 K.
- Observed rapid carrier decay above  $N_{\text{mott}}$ , consistent with polaron–polaron overlap.
- Identified a density-dependent transition from intrinsic bimolecular recombination to ultrafast many-body decay.

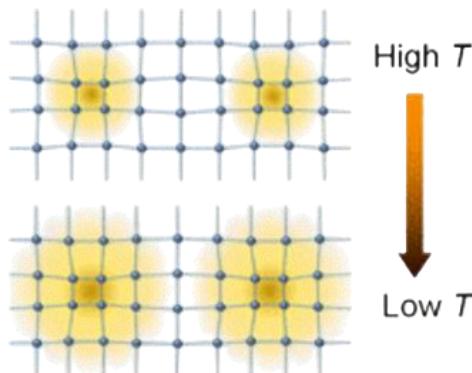
# Project 1. Results – Polaron Phase Diagram



## Polaron phase diagram

- Low densities**  
: ps-scale trapping → ns –  $\mu\text{s}$  trap-assisted recombination dominates.
- Above Mott density**  
: polaron overlap + Auger recombination → ultrafast decay. (fs – tens ps)

OPTP-derived  $N_{\text{mott}}$  + TAS regimes map the full density–temperature landscape.



### Temperature effect

- : higher lattice vibrations reduce the polaron radius → requiring higher  $N_{\text{mott}}$  for overlap.

Heng Zhang et al. ACS Energy Lett. 2023, 8, 420–428.

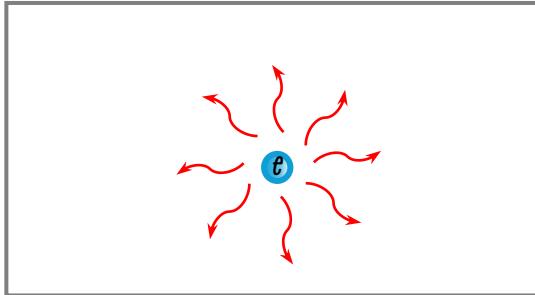
# Project 2.

## THz Photoconductivity Modelling in Lead-Halide Perovskites

### ❖ Models for THz Conductivity

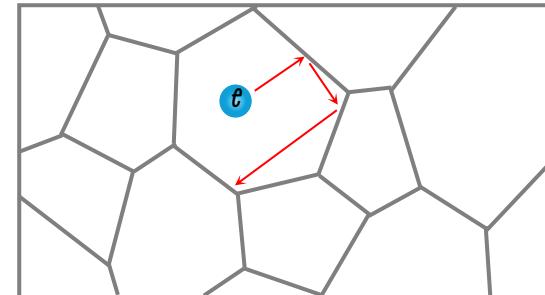
#### Drude

: no localization (free-carrier response).



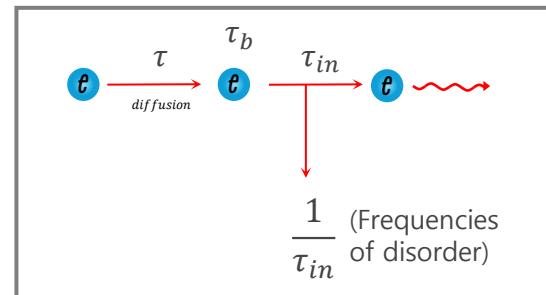
#### Drude-Smith (DS)

: static disorder + backscattering



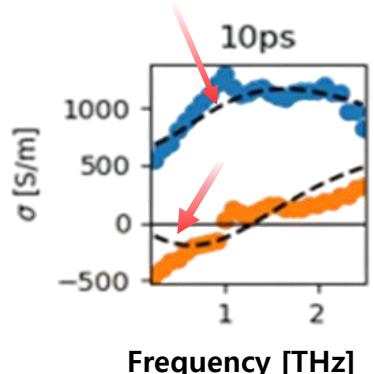
#### Drude-Anderson (DA)

: dynamic disorder + electron–phonon coupling.

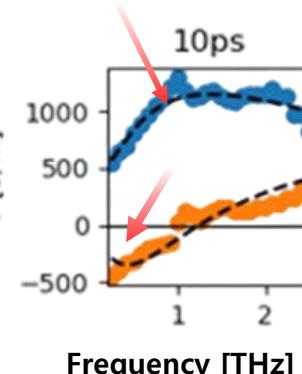


### ❖ THz Photoconductivity spectra of $FAPbI_3$

DS model fit



DA model fit



#### Motivation

: to clarify how static and dynamic disorder shape early-time carrier localization.

#### Key Results

##### DA model fits the data best

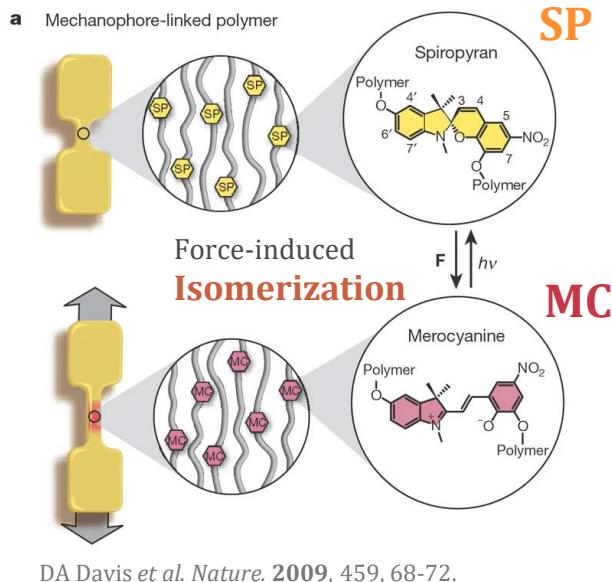
- Captures **dynamic disorder-induced localization**.
- Provides more reliable transport parameters (mobility,  $\tau_b$ ,  $\tau_{in}$ ).

- DS model misses low-frequencies  $\sigma$ .
- DA model captures sub-THz roll-off and localization effects.

# Project 3.

## Spiropyran Mechanophore for Stimuli-Responsive Polymer Matrices

(Synthesis, Characterization, and Monomer Optimization)

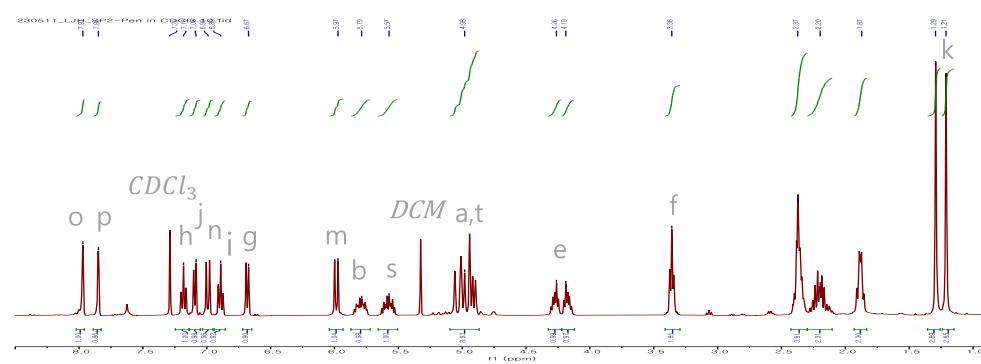
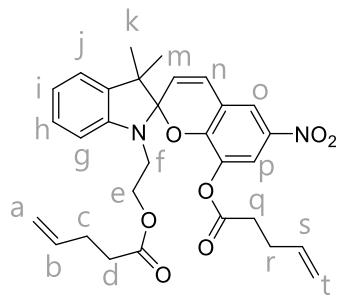


DA Davis *et al.* *Nature*. 2009, 459, 68-72.



Jonghwa Park *et al.* *Adv. Mater.* 2019, 1808148.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)

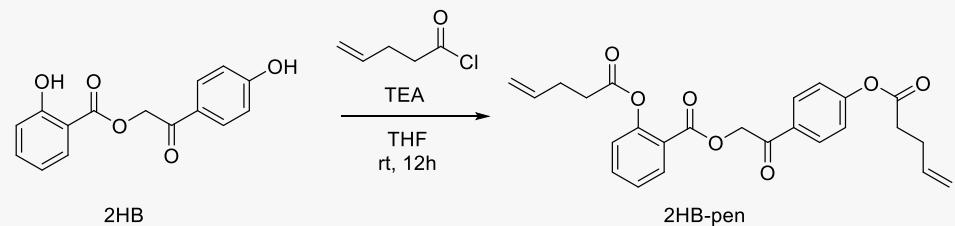


### Outlines

- Synthesized a **spiropyran (SP)** crosslinker with reversible **mechano-/photochromic response**.
- Application: mechanochromic polymers for damage monitoring.

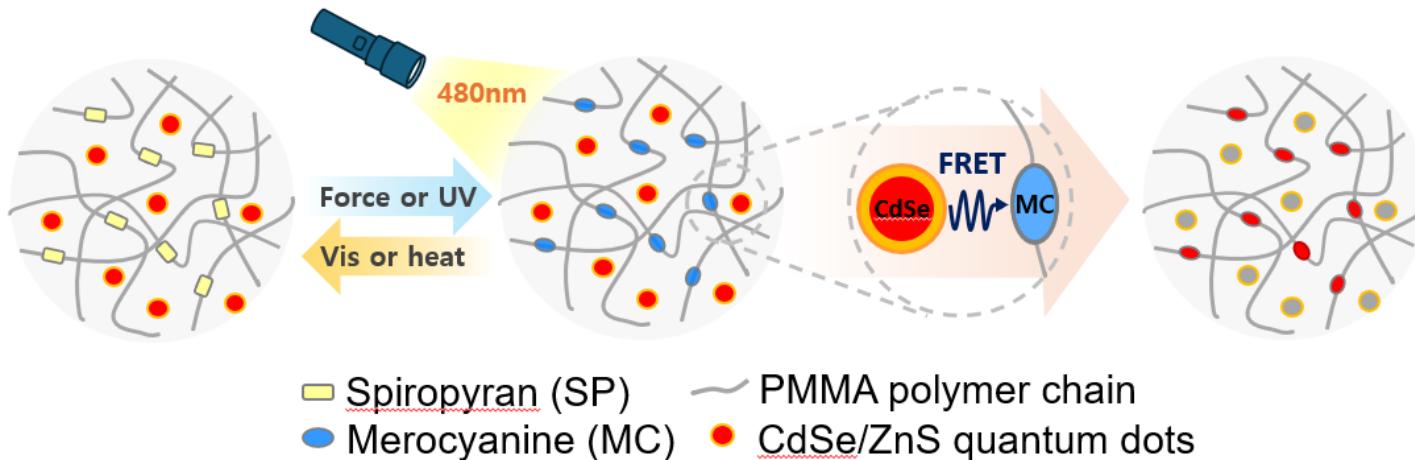
### Achievement

- Observation:** A low yield (22%) and anomalous R<sub>f</sub> behavior on TLC (counter-intuitive polarity)



- Approach:** Hypothesizing solvent-dependent H-bonding effects modulate effective molecular polarity. (EA:Hex → DCM:Hex)
- Result:** Improved chromatographic separation and increased yield from 22% → ~30s%

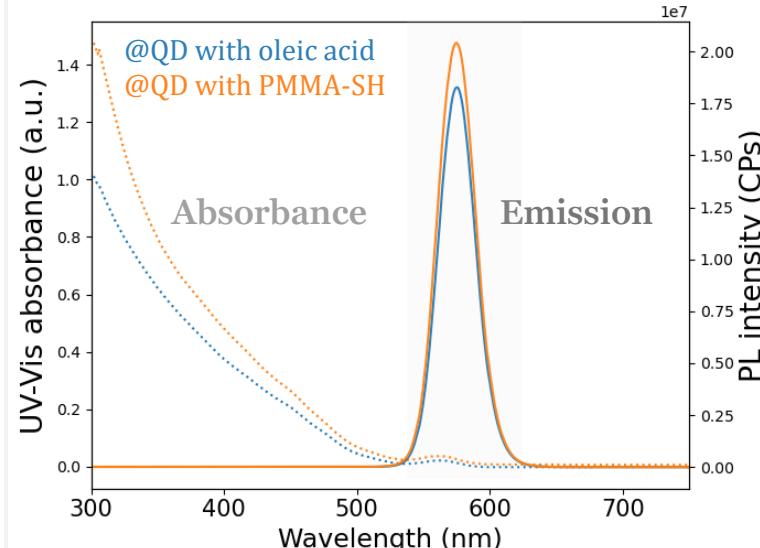
# Project 4. Super-Resolution Mechano-imaging of SP-QD polymer Matrices via FRET



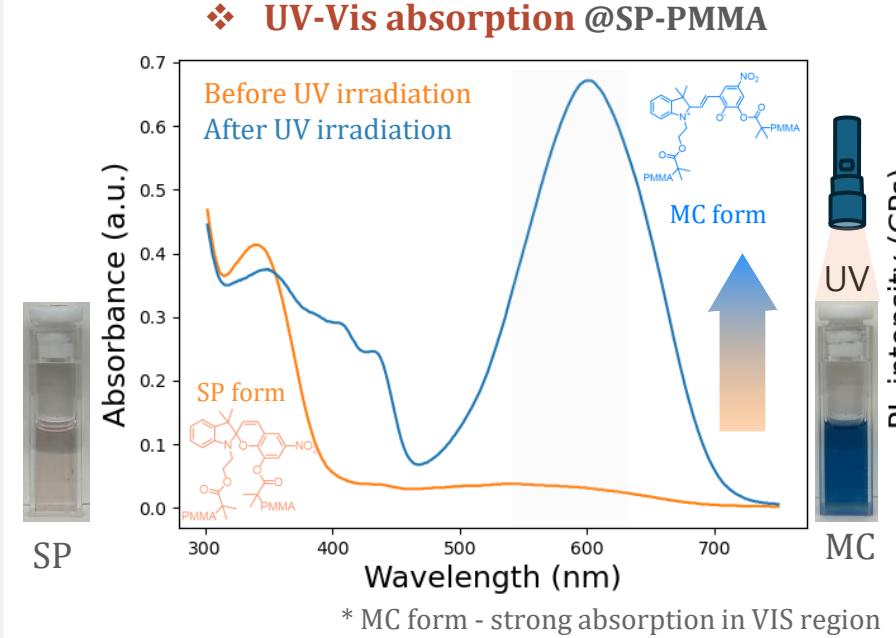
## Outlines

- Motivation: Spectral overlap between QD emission and merocyanine absorption enables **QD→MC FRET** for mechano-responsive imaging.
- Synthesized SP-PMMA and PMMA-SH polymer ligands, followed by QD ligand exchange to improve dispersion & FRET compatibility.

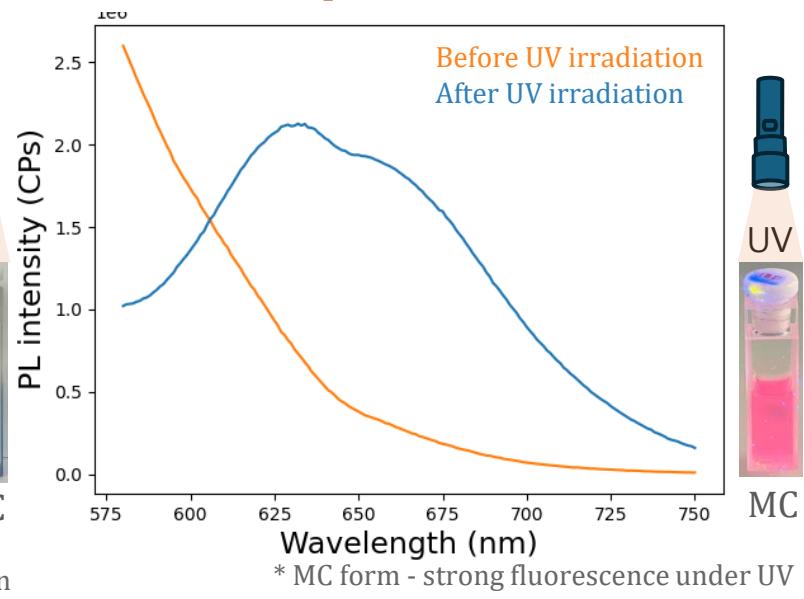
### UV-Vis absorption & PL @QDs-polymer



### UV-Vis absorption @SP-PMMA



### PL spectra @SP-PMMA



*Thank you for your attention.*

*Jungmin Park*

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