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

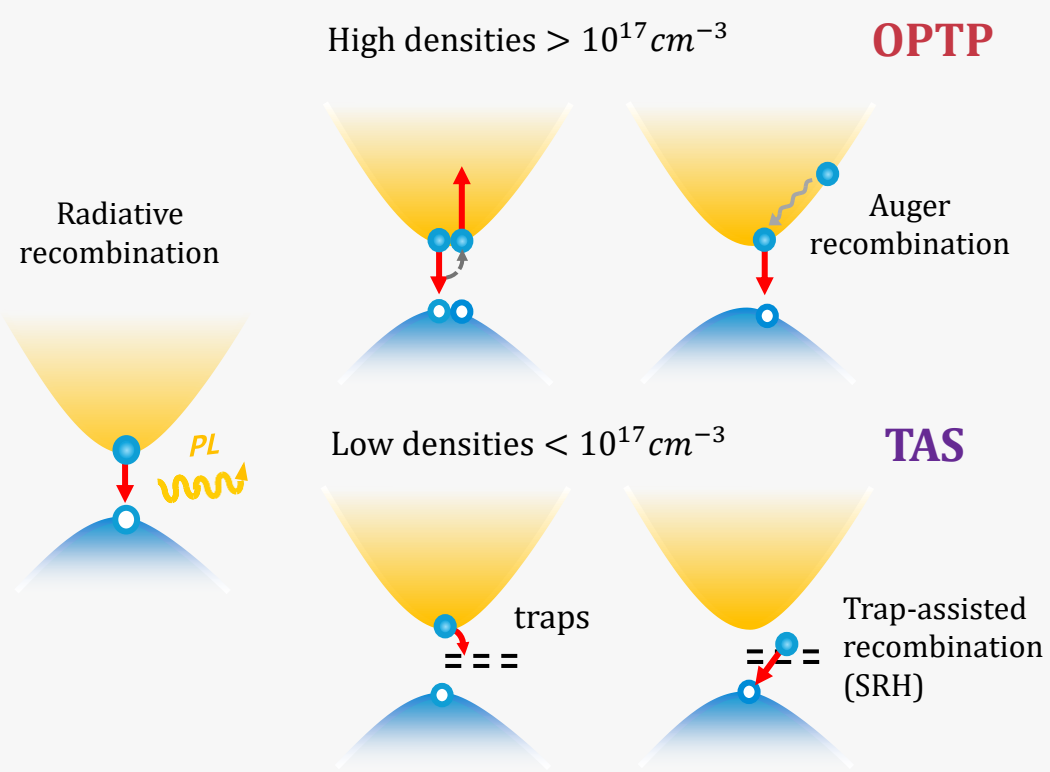
Mar 2023 – Jun 2023 **Korean Institute of Science and Technology (KIST)**
Project 3: Synthesis of Mechanophore Crosslinkers — **p.6**

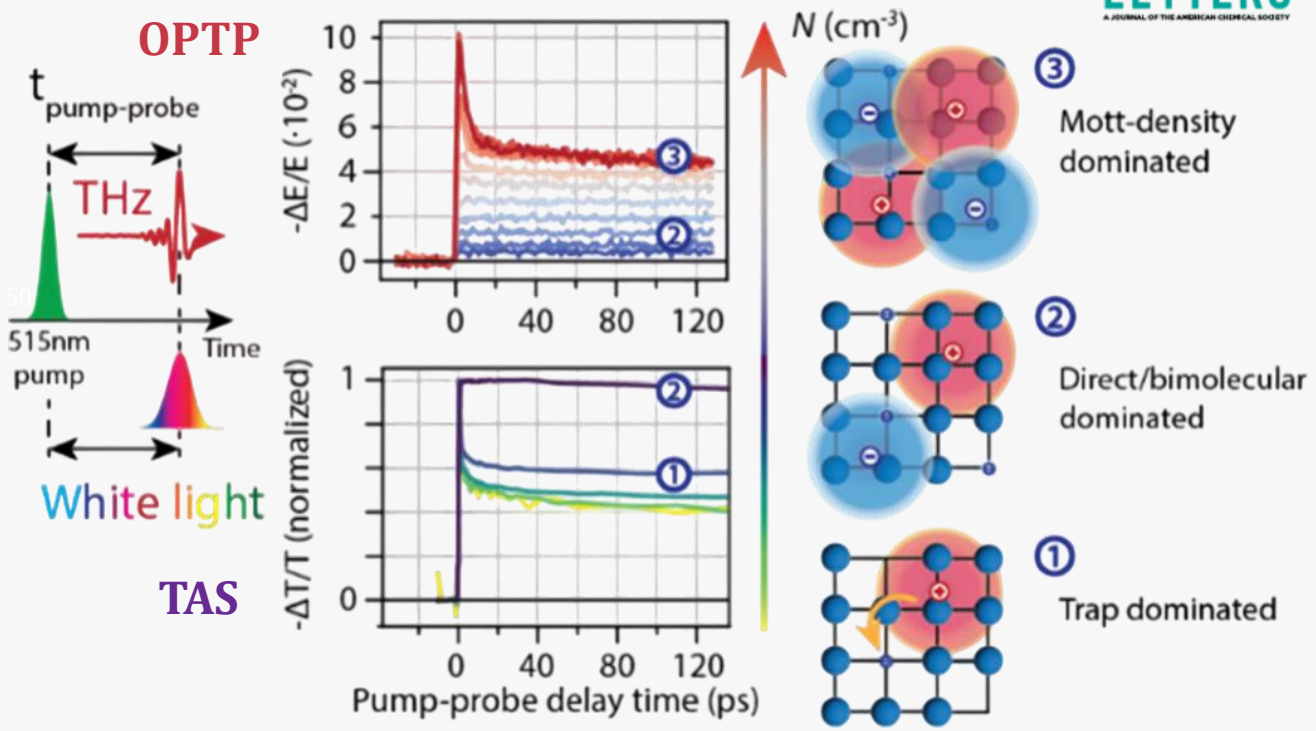
# Project 1.

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

MAX-PLANCK-INSTITUT FÜR POLYMERFORSCHUNG

THE JOURNAL OF PHYSICAL CHEMISTRY LETTERS




- TAS: performed in collaboration with J. Wang, Dalian Institute of Chemical Physics, CAS

## 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 $MAPbI_3$ by combining **TAS** and **OPTP** spectroscopy to construct an electronic polaron phase diagram.

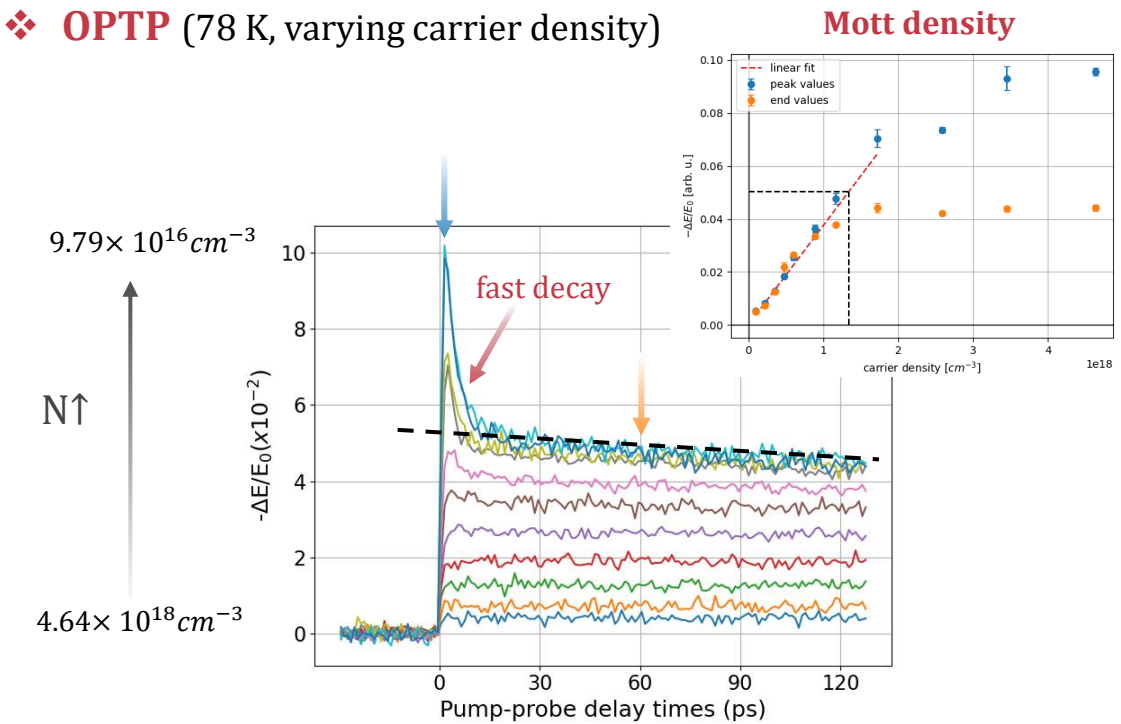
DOI: https://doi.org/10.1021/acs.jpclett.5c02164
J.Phys.Chem. Lett.2025,16,9925−9932

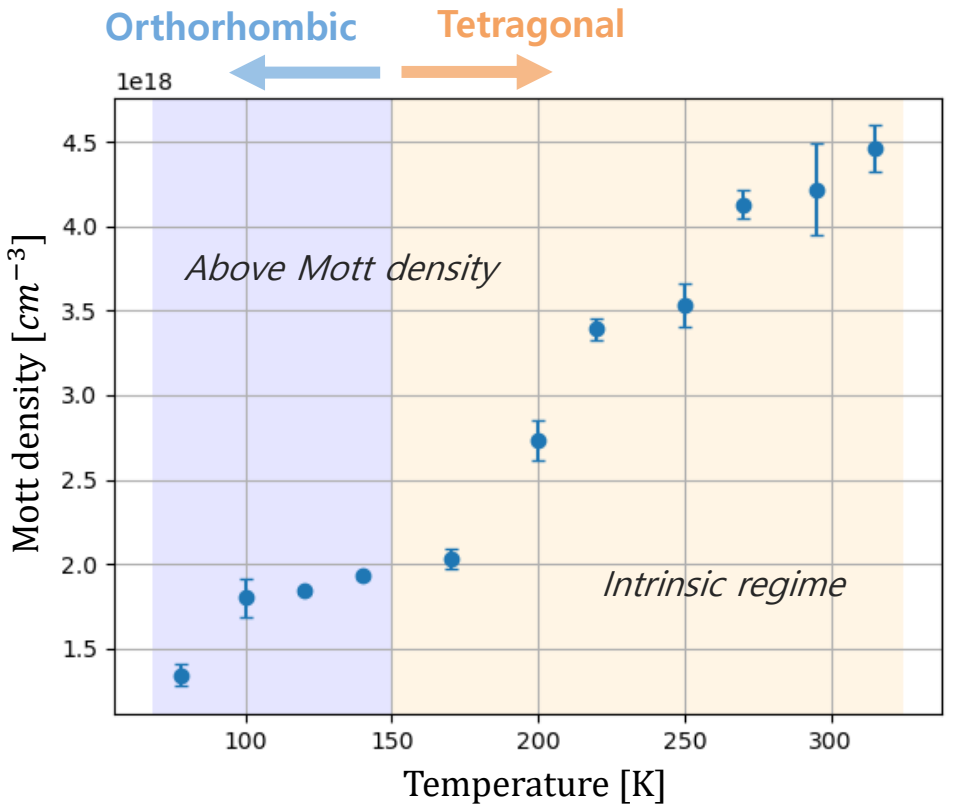


*2023.08 – 2024.05* Max-Planck-Institute for Polymer research (**MPI-P**)

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

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




## Key Results

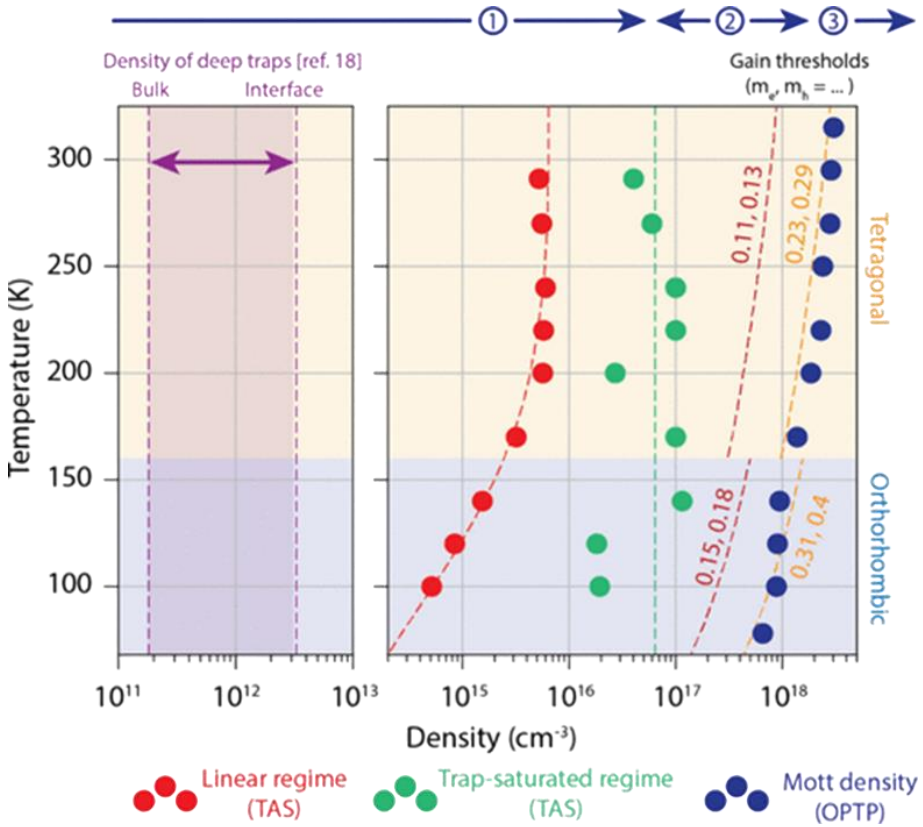
- **Quantified the temperature-dependent Mott density** ($N_{mott}$) from OPTP measurements across 78–315 K.
- **Observed rapid carrier decay** above $N_{mott}$, consistent with polaron–polaron overlap.
- **Identified a density-dependent transition** from intrinsic bimolecular recombination to ultrafast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

DOI: https://doi.org/10.1021/acs.jpclett.5c02164
J.Phys.Chem. Lett.2025,16,9925−9932



*2023.08 – 2024.05* Max-Planck-Institute for Polymer research (**MPI-P**)

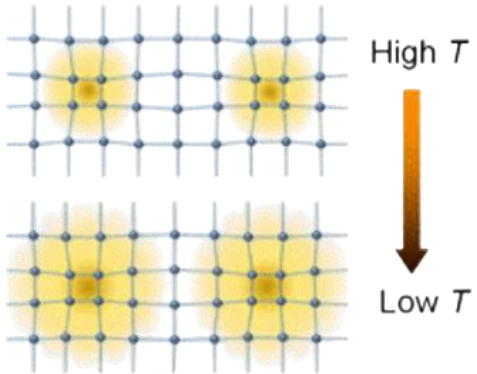
# *Project 1.* Results – Polaron Phase Diagram




## Polaron phase diagram

- **Low densities**
  : ps–scale trapping → ns – μs trap-assisted recombination dominates.
- **Above Mott density**
  : polaron overlap + Auger recombination → ultrafast decay. (fs – tens ps)

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




**Temperature effect**
: higher lattice vibrations reduce the polaron radius
→ requiring higher $N_{mott}$ for overlap.

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

DOI: https://doi.org/10.1021/acs.jpclett.5c02164
J.Phys.Chem. Lett.2025,16,9925−9932

# *Project 2.* THz Photoconductivity Modelling in Lead-Halide Perovskites

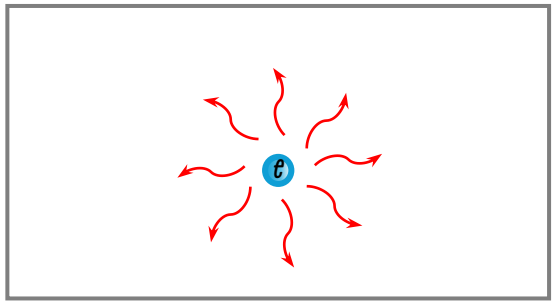
MAX-PLANCK-INSTITUT FÜR POLYMERFORSCHUNG

MPK

## ❖ Models for THz Conductivity

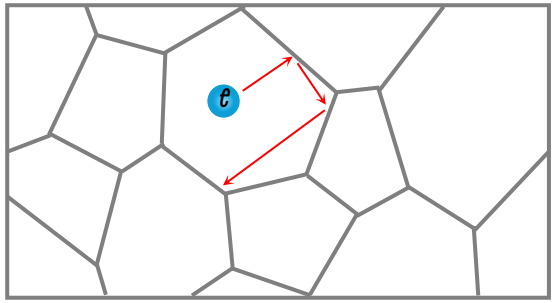
### Drude

: no localization (free-carrier response).



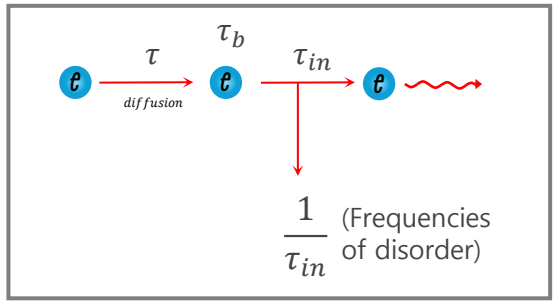
### Drude-Smith (DS)

: static disorder + backscattering



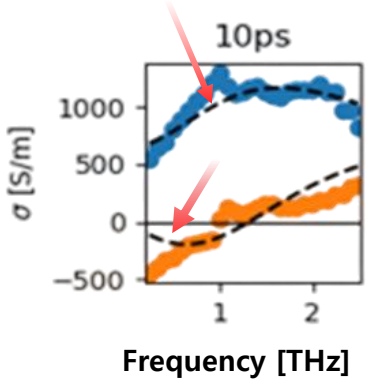
### Drude-Anderson (DA)

: dynamic disorder + electron–phonon coupling.

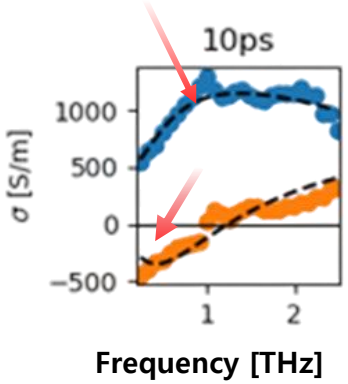



## ❖ THz Photoconductivity spectra of $FAPbI_3$

DS model fit




DA model fit




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

**Motivation**

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

## Key Results

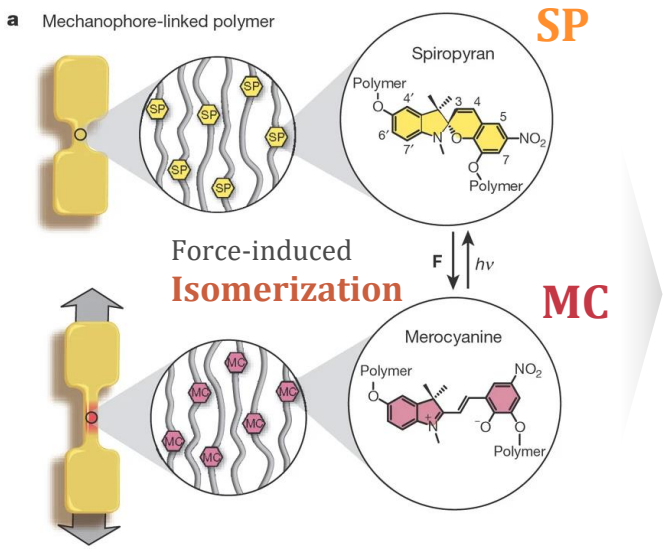
**DA model fits the data best**

→ Captures dynamic disorder–induced localization.

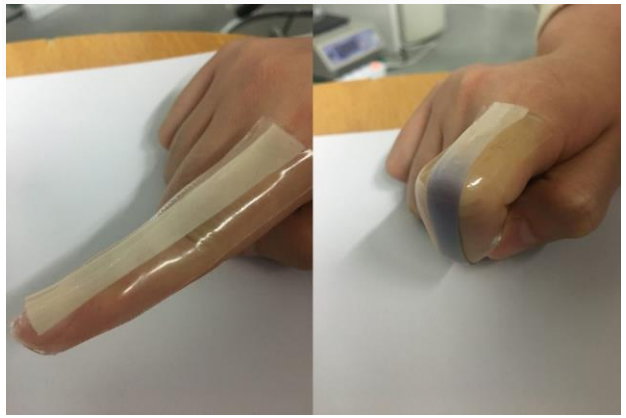
→ Provides more reliable transport parameters (mobility, τ_b, τ_in).

# *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.

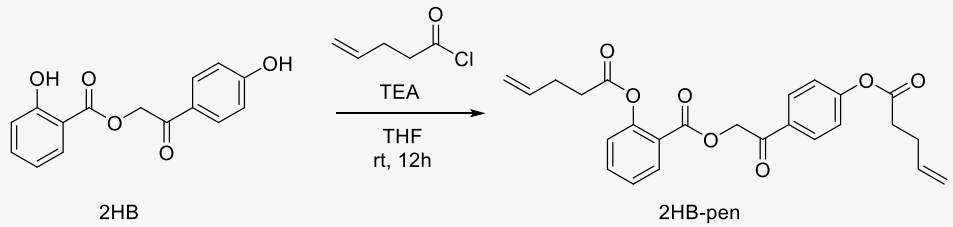
## Outlines

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

## Achievement

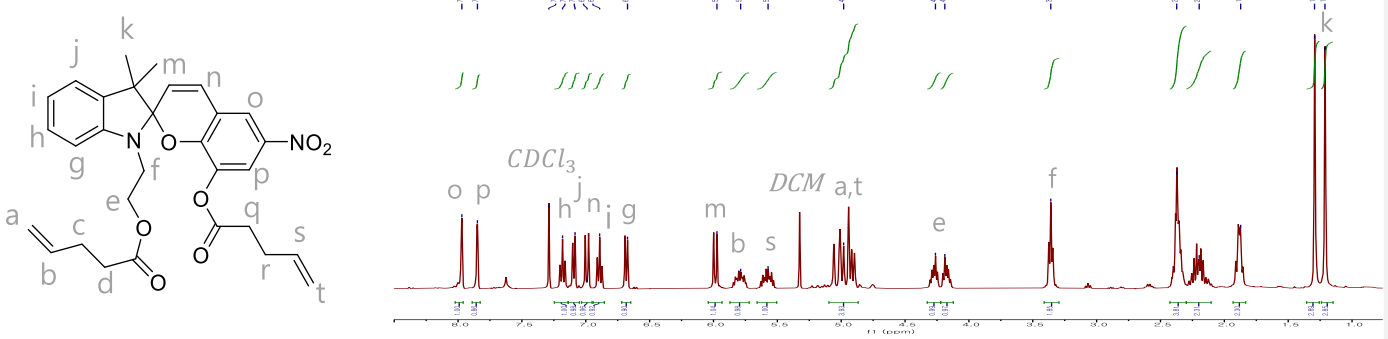
- Motivation : low yield hindered reliable monomer preparation → leading me to identify the main cause using TLC and NMR.

* Acylation step for photodegradable monomer synthesis




- Resolved insufficient chromatographic separation by developing an efficient eluent system, increasing the yield from **22%** → **43%**

$^1$H NMR (400 MHz, $CDCl_3$)



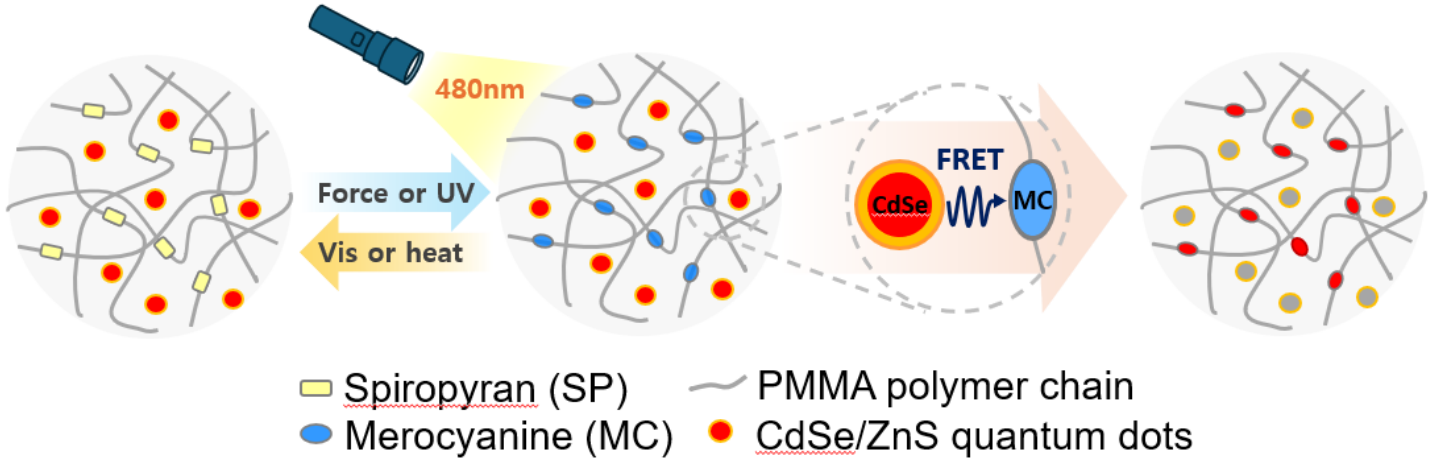



*2023.03 – 2023.06* Korean Institute of Science and Technology (KIST)

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

BIO-INSPIRED MATERIALS
NATIONAL CENTER OF COMPETENCE IN RESEARCH
Swiss National Science Foundation

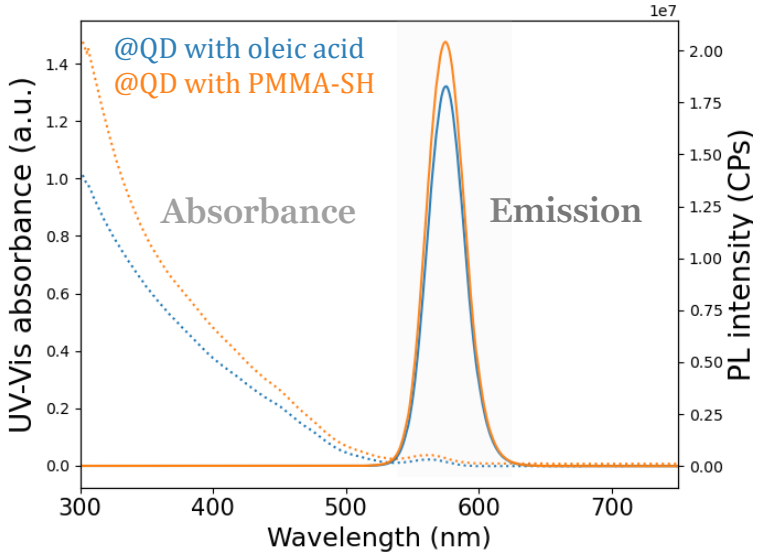
Poster available here: [SP–QD FRET Poster (Google Drive)]



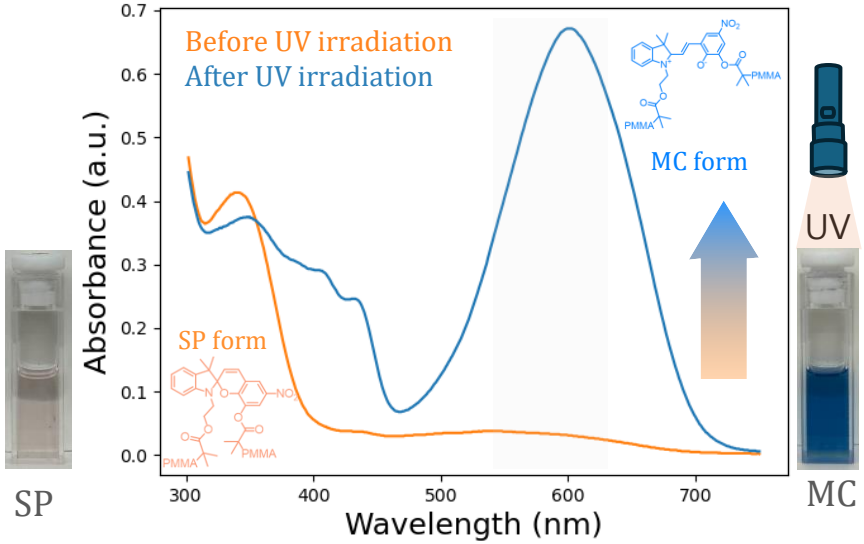

## Outlines

- 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

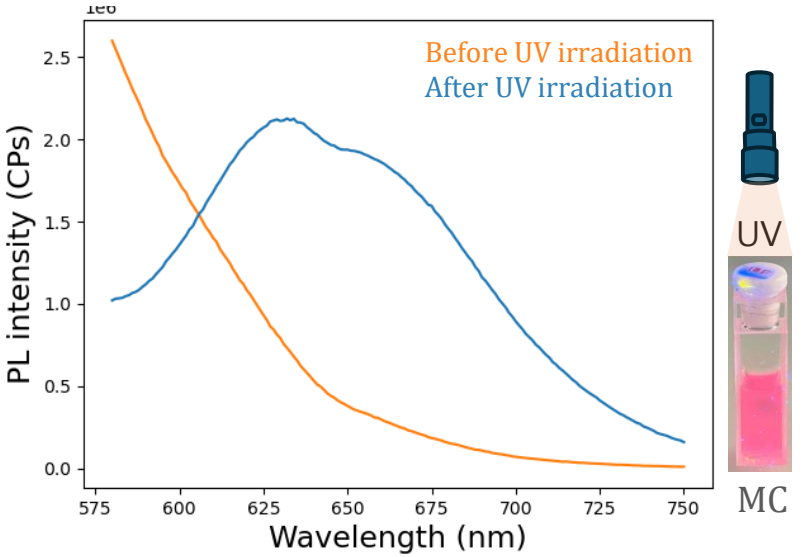



### ❖ UV-Vis absorption @SP-PMMA




* MC form - strong absorption in VIS region

### ❖ PL spectra @SP-PMMA




* MC form - strong fluorescence under UV



*2024.06 – 2024.08* Adolphe Merkle Institute (AMI)

# *Thank you for your attention.*

***Jungmin Park***

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