F-127 as Coating Polymer of Conjugated Polymer for PDT Application

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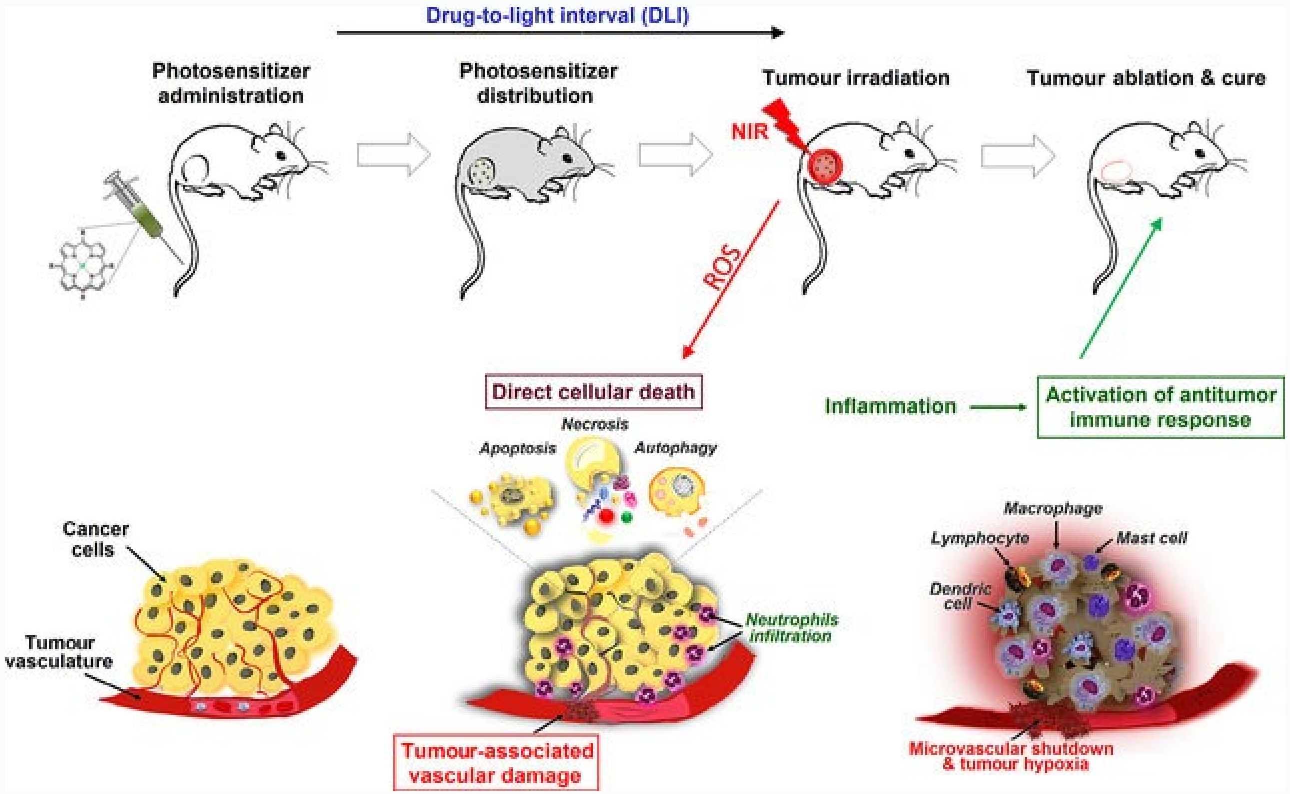
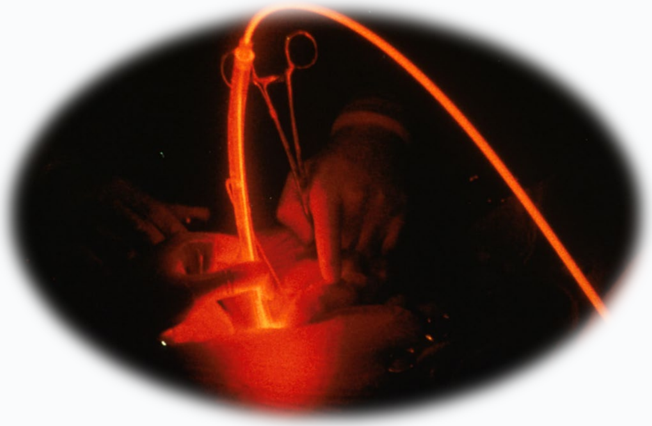
Introduction-Photodynamic Therapy (PDT)



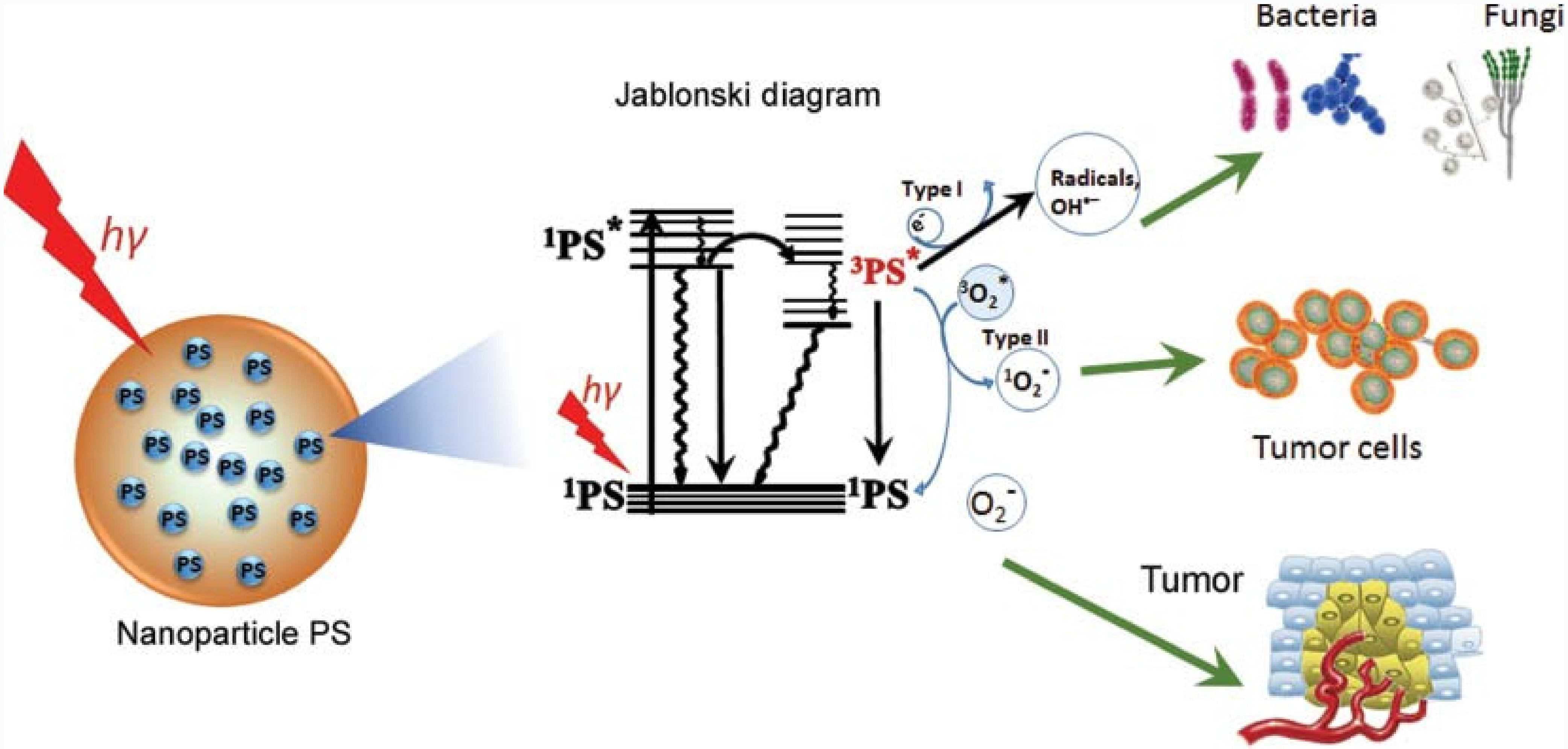
Main advantages
- Spatiotemporal selectivity
- Limited or no potential for resistance
- Immunogenic
- Compatible with endoscopy

Main disadvantages
- Limited light penetration
- Oxygen dependent



[1] Janusz M. Dąbrowski et al. Coord. Chem. Rev. 2016

Generation of ROS



[1] Michael R. Hamblin et al. Nanotechnol. Rev. 2015

CPNs for PDT

- Light-harvesting capabilities
- Effective intra- and intermolecular energy transfer between CPs and traditional PSs

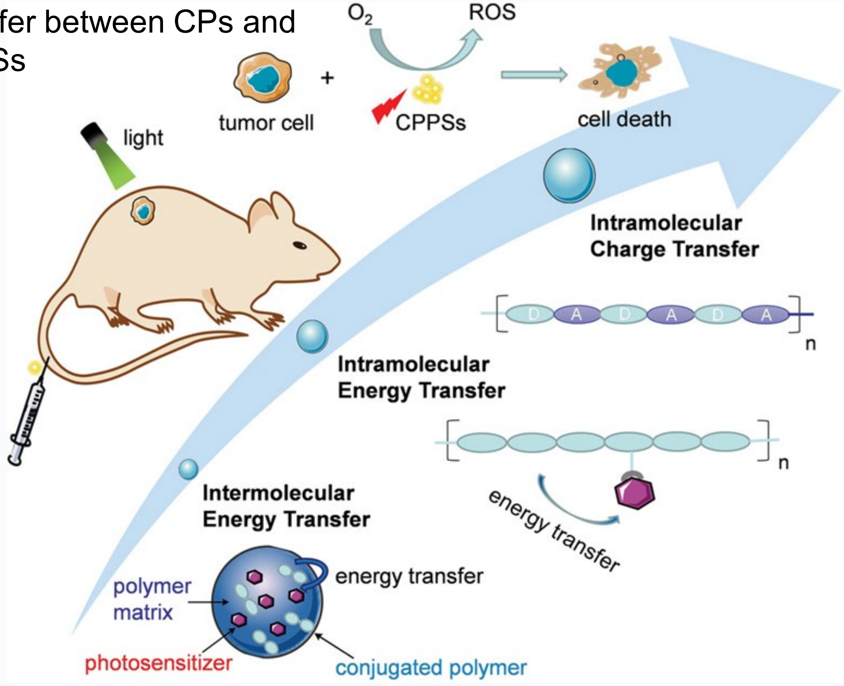


Figure 1 Roles of CPs in PDT.[1]

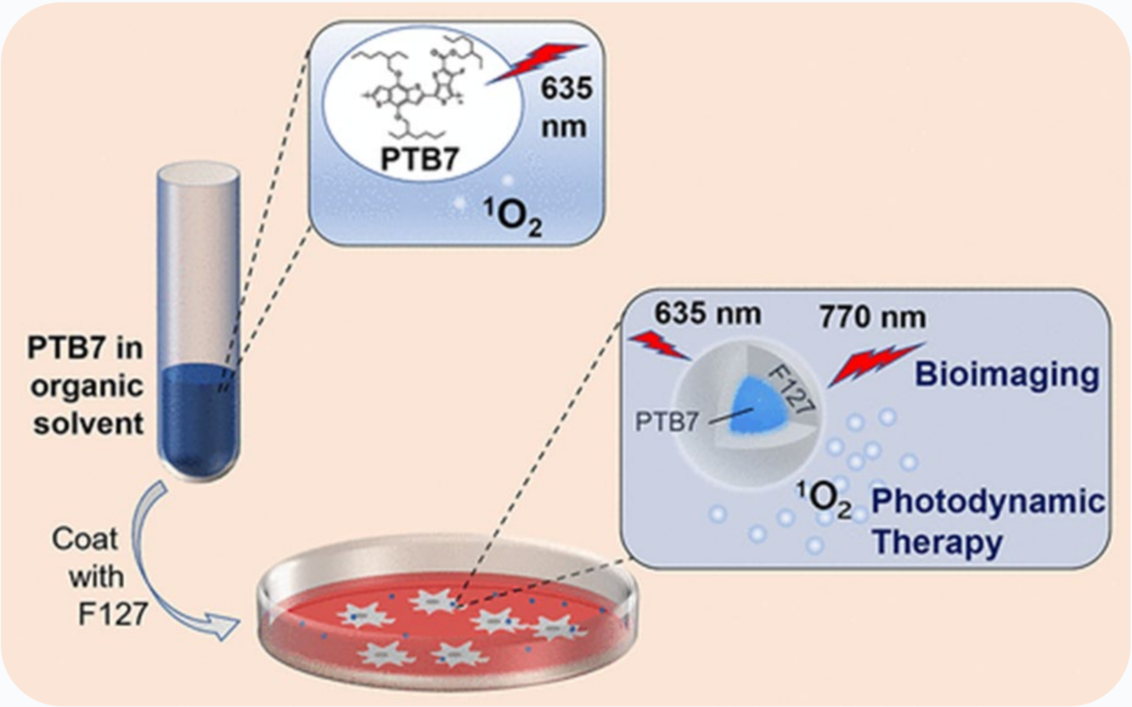
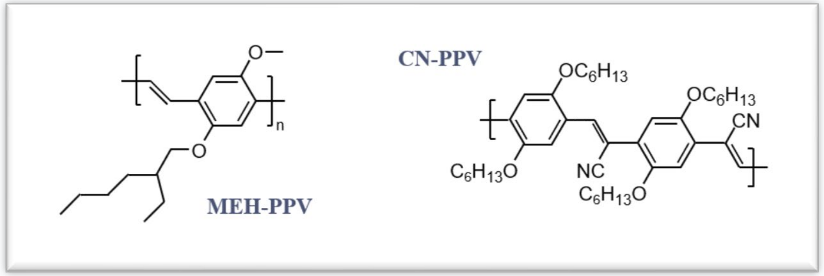


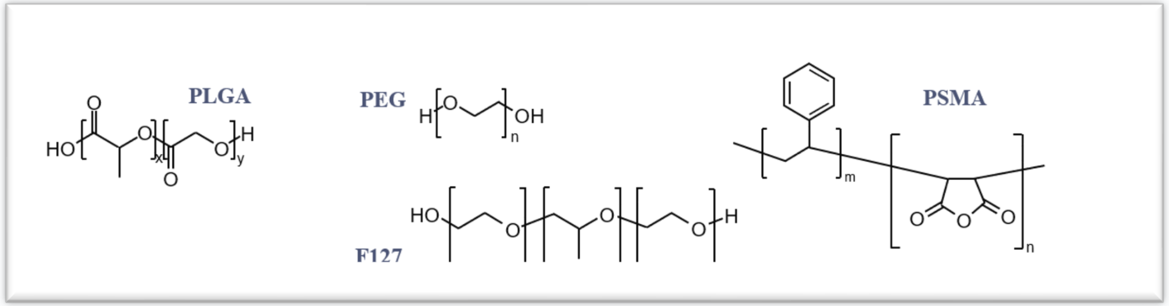
Figure 2 Development of CPs as photosensitiser.[2]

[1] Yaru Lu et al. Adv. Therap.2022
[2] Miao Zhao et al. ACS Nano.2021

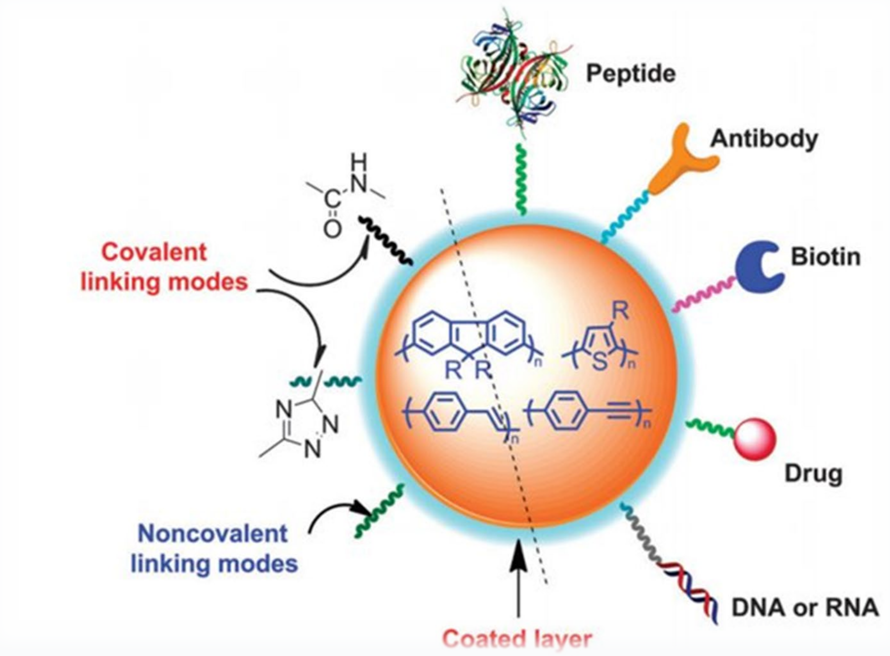
CPs and Copolymers



(Conjugated polymer)

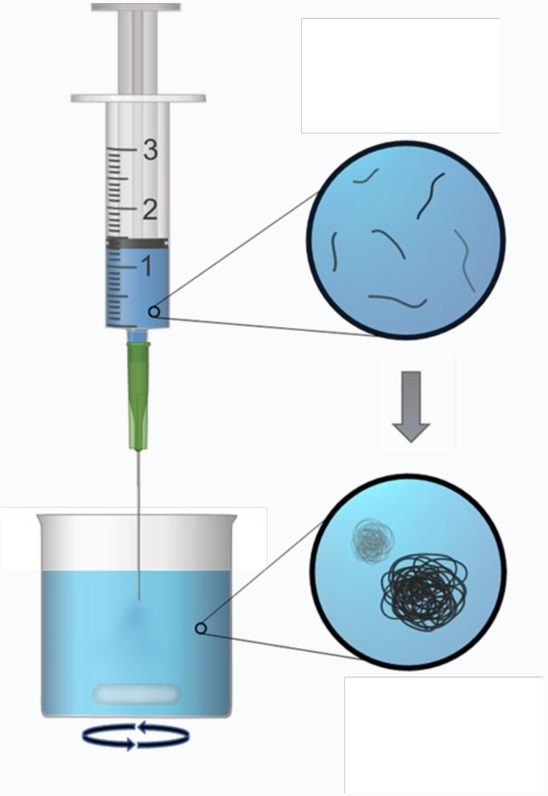


(Coating polymer)

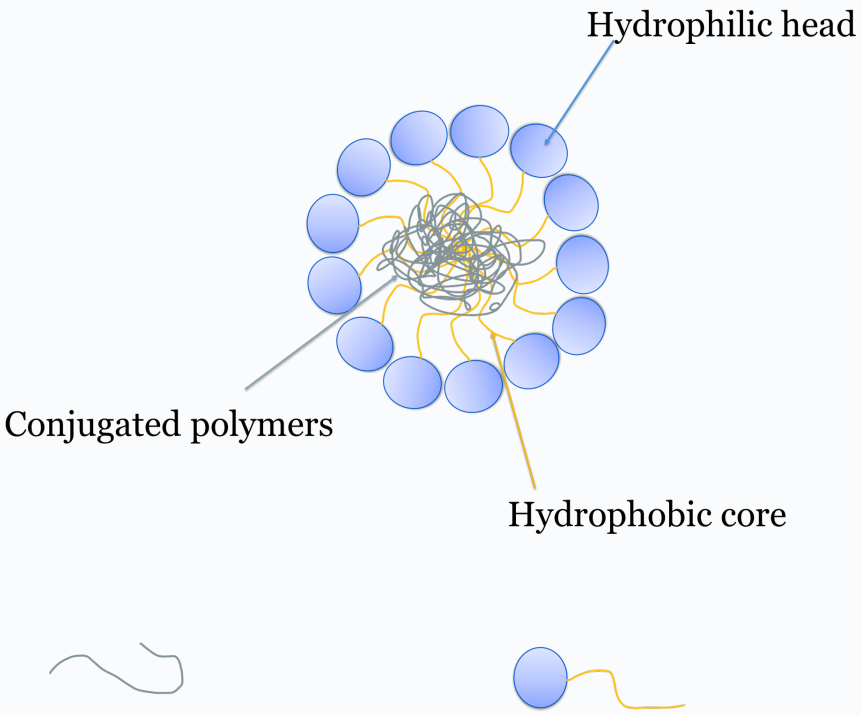


[1] Liheng Feng et al. Chem Soc Rev. 2016

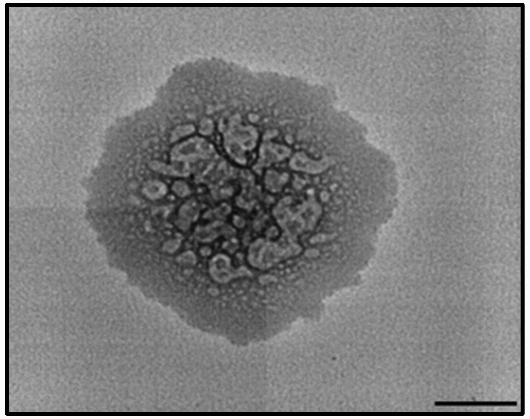
Fabrication of CPNs



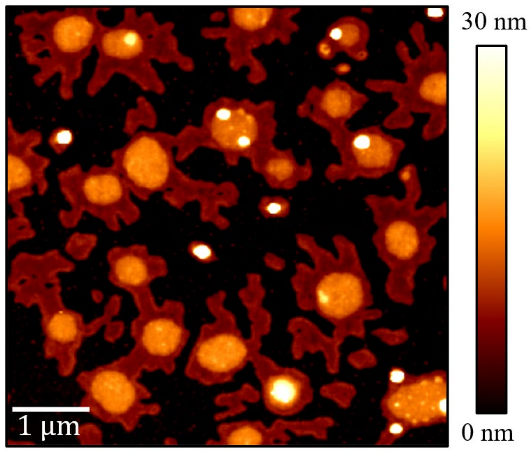
(Nanoprecipitation methods)



(Conjugated polymer) (Amphiphilic copolymer)



(TEM of CPs@F127)



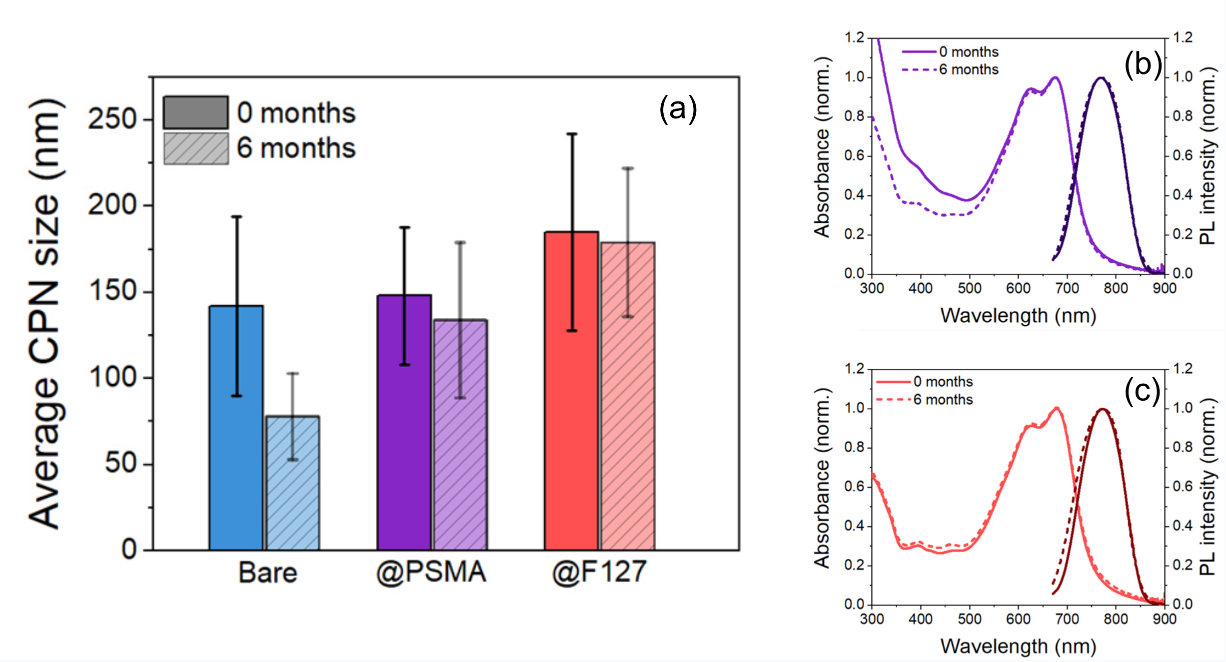
(AFM of CPs@F127)

[1] Miao Zhao et al. ACS Nano.2021

Role of Co-polymer in CPNs for PDT[1]

- Aqueous solubility and colloidal stability of CPNs (co-polymer, zeta potential)
- Cell targeting and uptake (PEG, PSMA, PLGA, F127)
- Biocompatibility and cytotoxicity (MEH-PPV@F127 vs MEH-PPV@PSMA)
- PDT application:

  F127: PTB7/PBTB
  PEG: PTPEDC/ PFVBT
  PSMA: NA
  PLGA: NA



Stability of the CPNs upon sample aging[2]

[1] Miao Zhao et al. Nanomaterials. 2023
[2] Miao Zhao et al. ACS Nano.2021

Optical properties of CPNs

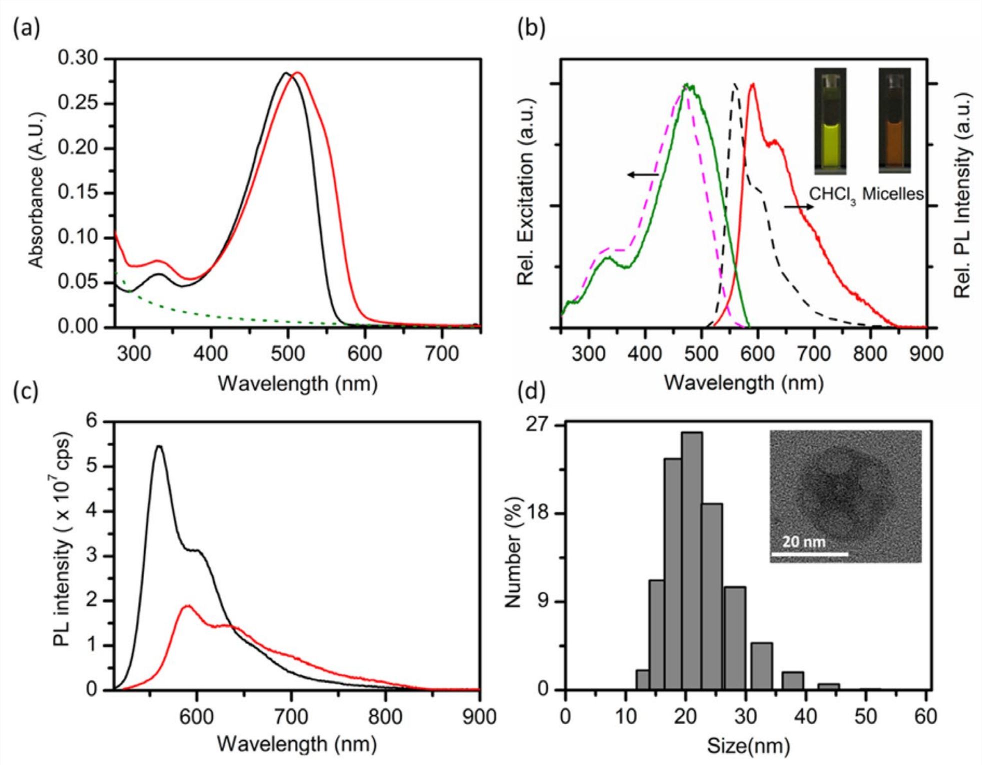


Figure 1 MEH-PPV@F127.[1]

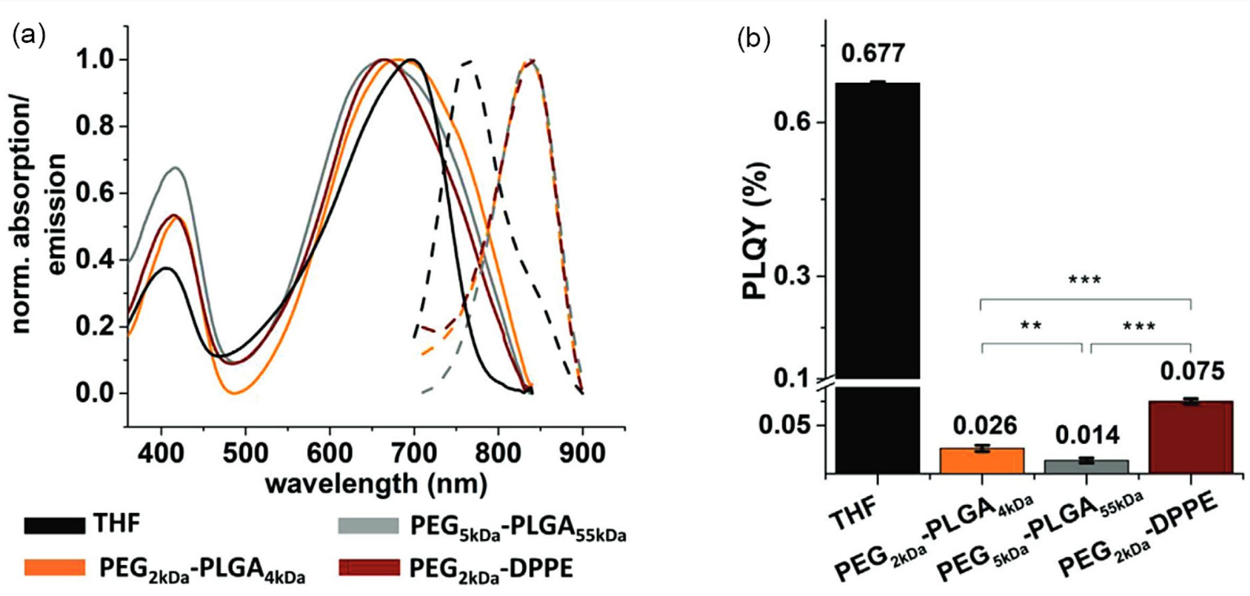


Figure 2 PCPDTBT @ different co-polymer.[2]

(a) Absorption spectra of MEH-PPV in chloroform and as CPNs in aqueous solution.

(b) Intensity-normalized excitation and emission spectra of MEH-PPV solution (dashed lines) and micelles (solid lines).

(c) Emission spectra of MEH-PPV in chloroform (black) and aqueous nanomicellar suspension (red).

(d) Number-average hydrodynamic size distribution of MEH-PPV micelles.

(a) Normalized absorption (solid lines) and emission spectra (dashed lines) of PCPDTBT in THF and 5% PCPDTBT CPN dispersions.

(b) PLQY of PCPDTBT in THF and 5% dispersions of PCPDTBT CPNs.

[1] Suxiao Wang et al. Langmuir. 2016
[2] Paul Robert Neumann et al. Adv Healthc Mater. 2021

Why choose F127 as co-polymer for PDT

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- ◆PSMA quenches the photo-induced generation of singlet oxygen by CPs, making them non-toxic. It is a suitable choice as a stabilizing copolymer for imaging purposes.
- ◆PEG doesn't quench reactive oxygen species production by CPs, making it suitable for PDT-based applications.
- ◆F127 offers good biocompatibility and enhances charge and energy transfer processes for PDT applications. Its low unspecific cellular affinity limits general imaging use but allows for target-specific probe development.

Research Objective

To investigate how F127 coatings influence the properties and effectiveness of CPNs in PDT applications.

Experimental Methods

◆Initial Characterization of CPNs:

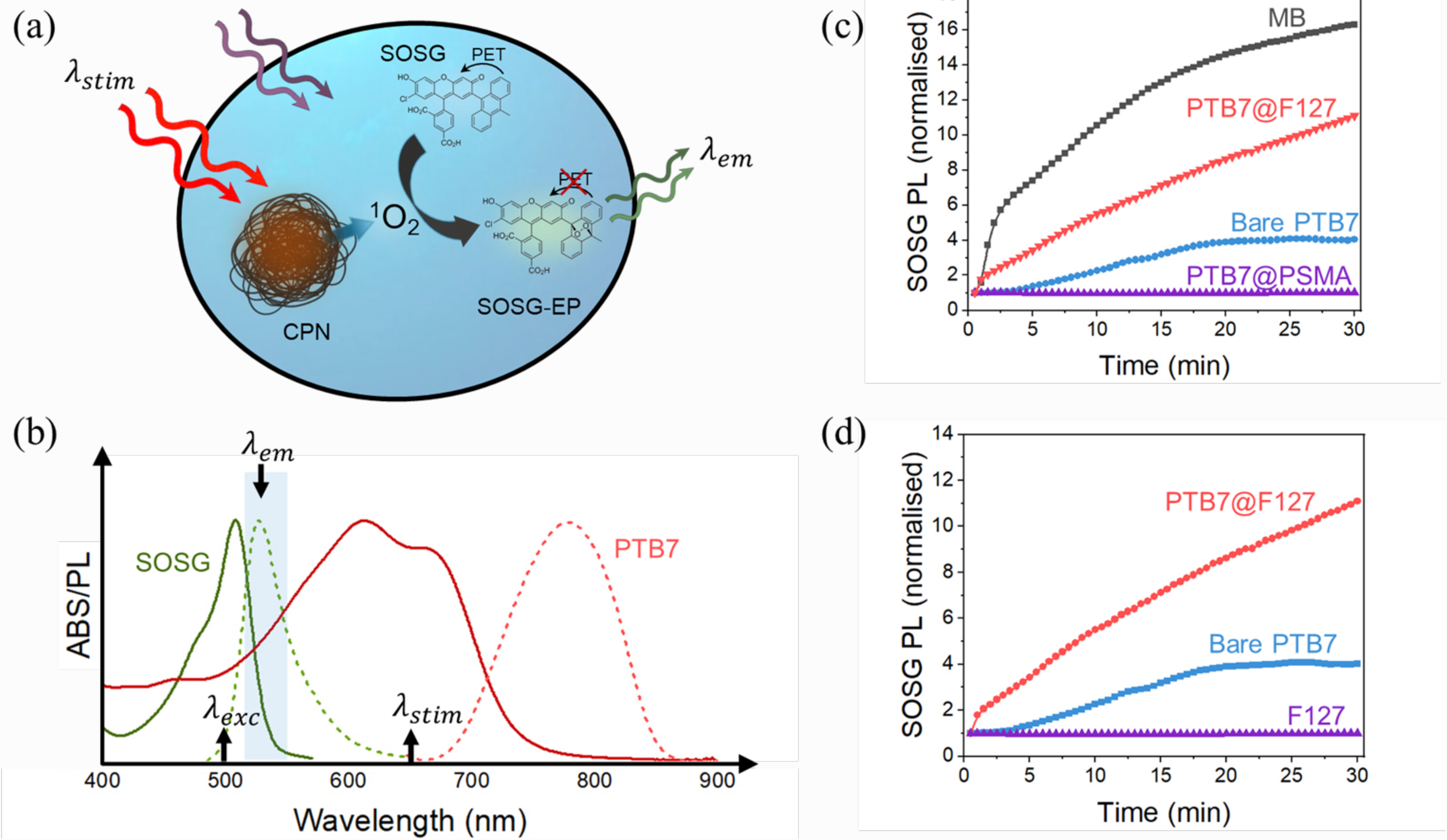
- Hydrodynamic size and stability were assessed using dynamic light scattering (DLS) and zeta-potential measurements.

◆Optical Properties of CPNs:

- Absorption and photoluminescence spectra were obtained.
- Fluorescence quantum yield (QY) was measured.

◆Singlet Oxygen Production by CPNs:

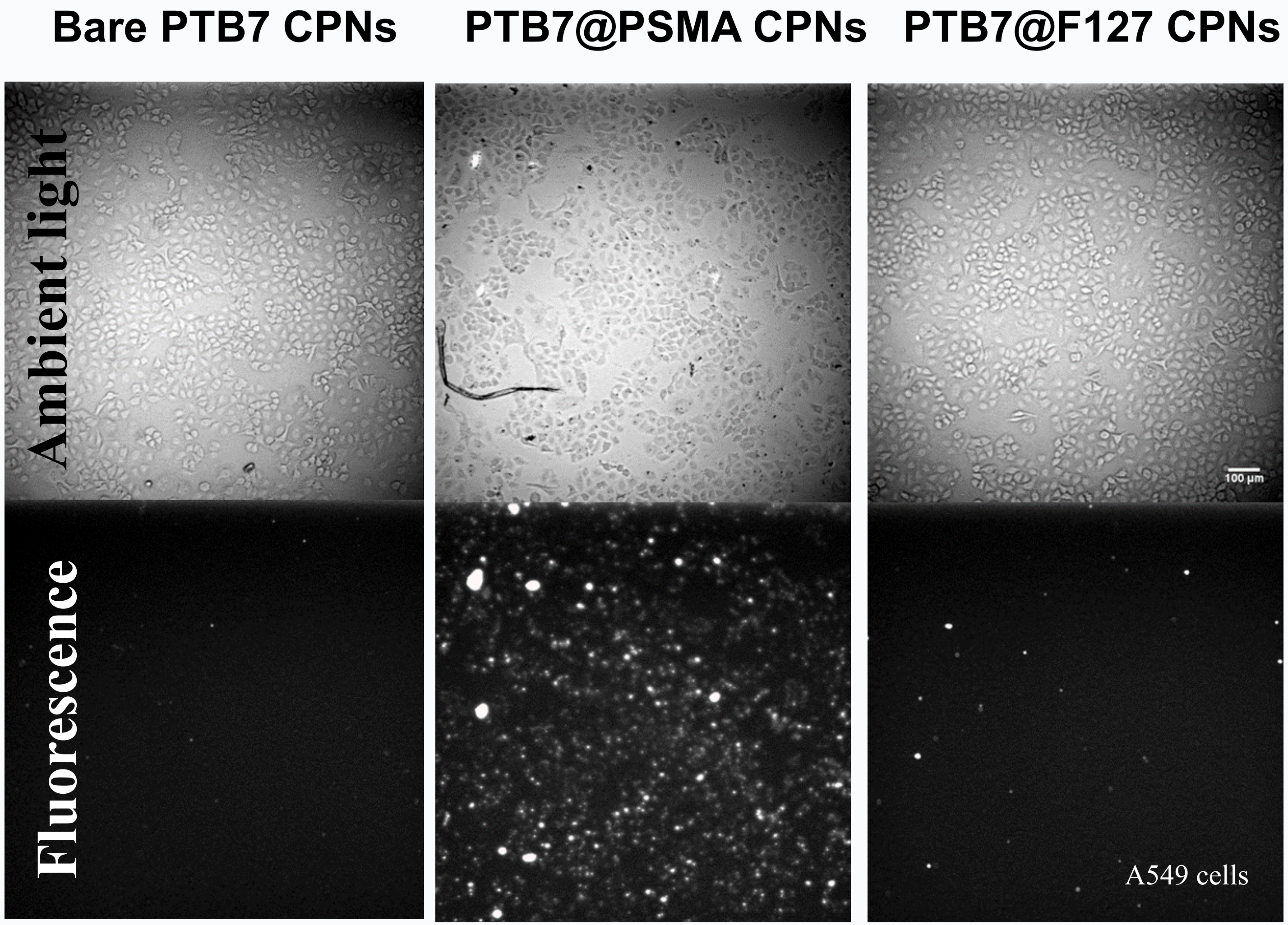
- Evaluated using Singlet Oxygen Sensor Green (SOSG).

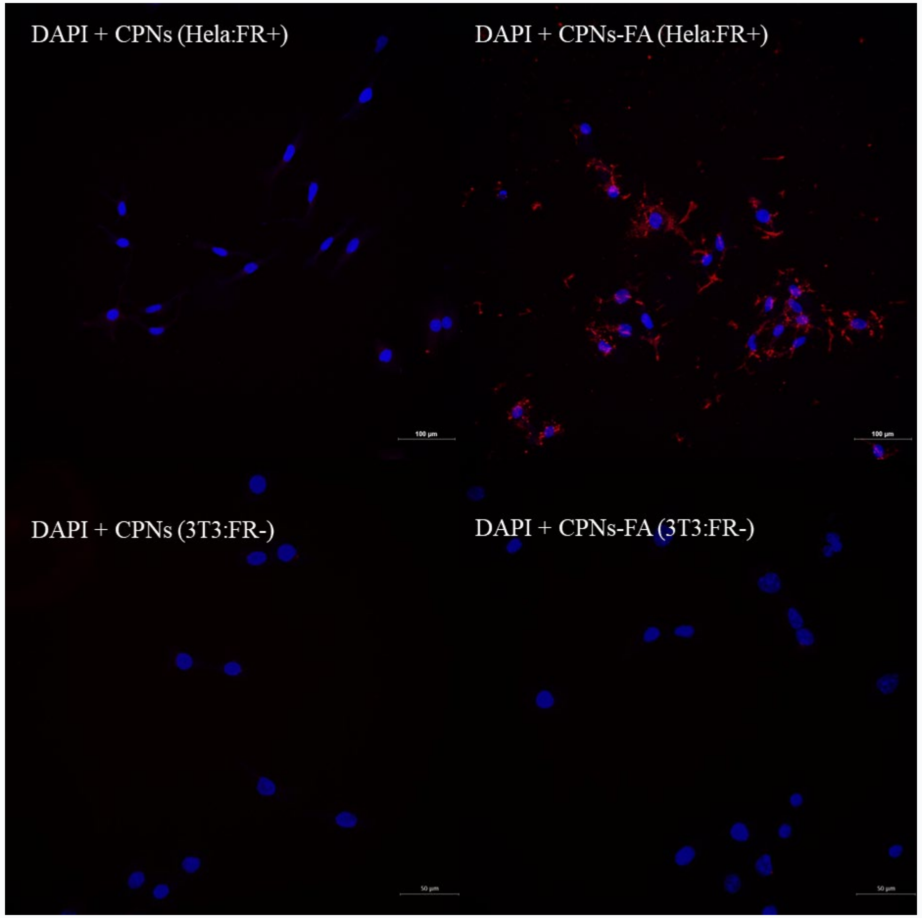


Measurements of singlet oxygen production by PTB7 CPNs using the SOSG chemical sensor. [1]

[1] Miao Zhao et al. ACS Nano.2021

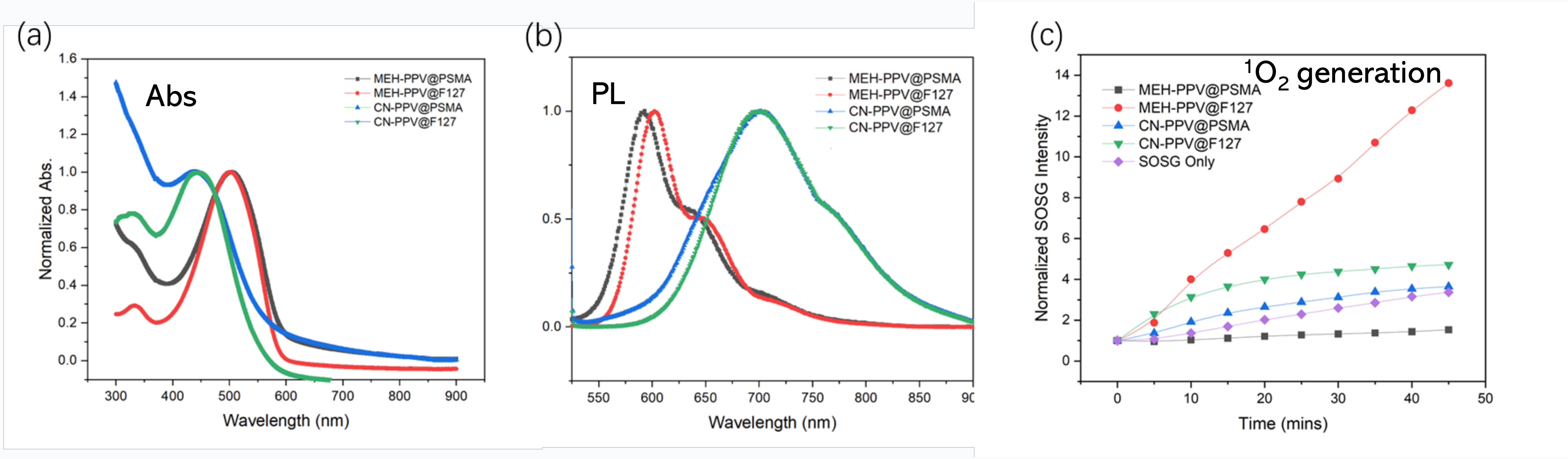
NIR Cell Imaging





Miao Zhao et al. in preparation

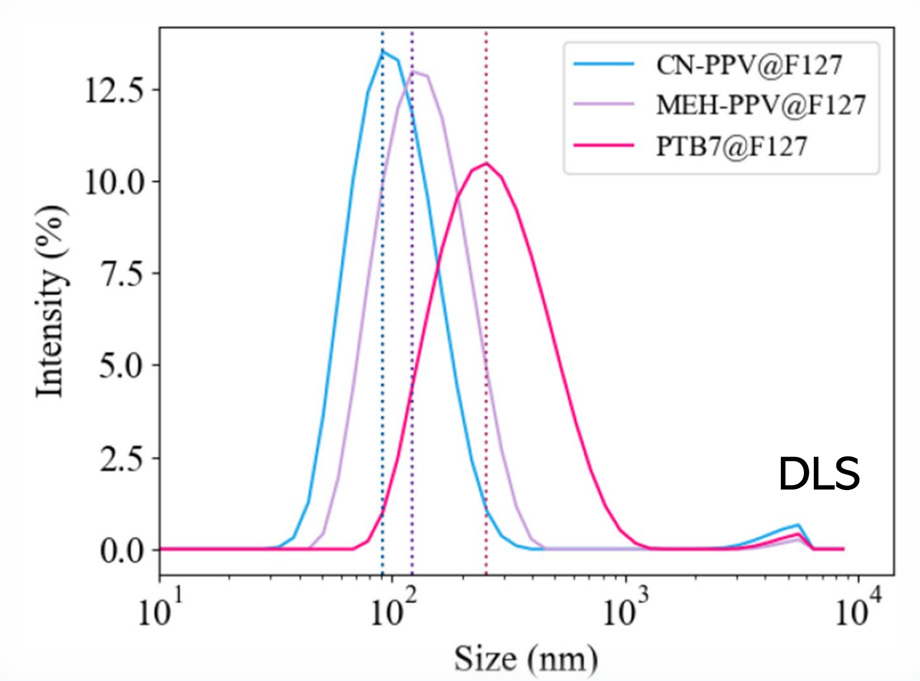
Exploring the Potential of F127 as a Copolymer in PDT

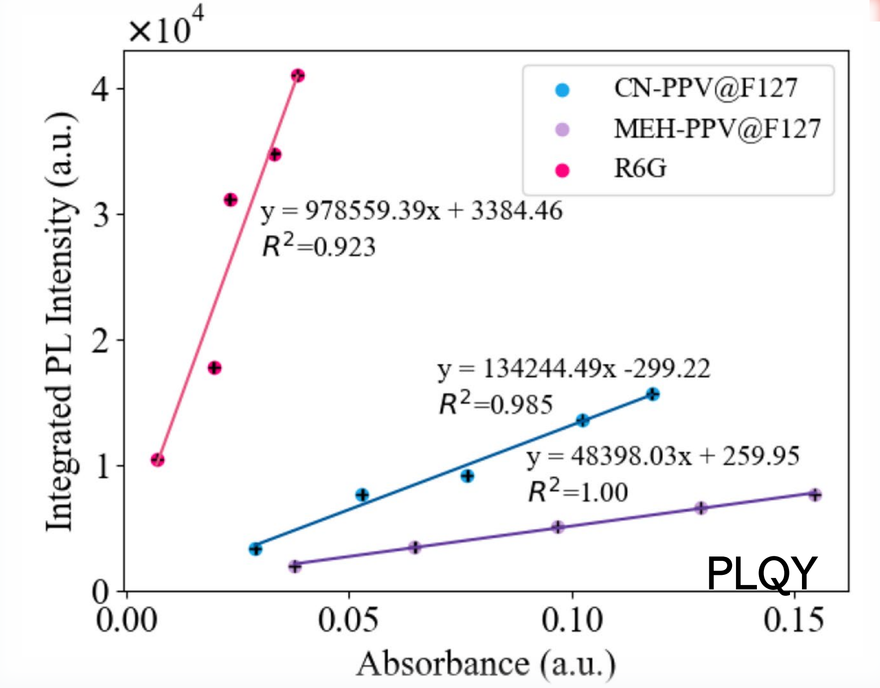


Properties of CPNs. (a) Steady-state absorption, (b) steady-state emission and (c) photoinduced singlet oxygen generation of MEH-PPV@PSMA (black), MEH-PPV@F127 (red), CN-PPV@PSMA (blue), CN-PPV@F127 (green) CPNs. In panel (c), SOSG only solution (purple) was used as a control.

Miao Zhao et al. in preparation

Exploring the Potential of F127 as a Copolymer in PDT





1. CPNs Characterization:

CPNs	DLS	Zeta Potential
MEH-PPV@F127	~ 127 nm	~ -14.8 mV
CN-PPV@F127	~ 97 nm	~ -13.1 mV

2. Optical Performance:

CPNs	PLQY	λ_{ex}
MEH-PPV@F127	~ 5%	488 nm
CN-PPV@F127	~ 12.5%	488 nm

Provided by Wednesday Tarhan-King

Conclusions

F127 proves to be an ideal coating polymer for developing effective CPNs as photosensitizers.

This research guides future advancements in medical nanomaterials.

The findings pave the way for further exploration and optimization of polymer-based nanostructures in medical applications.

Acknowledgement

Undergraduate students:

Wednesday Tarhan-King , Bingchen Wu , Jumainah Abedin , Bingqi Li , Tsz Tsung Jacky Li

Supervisor: Aliaksandra Rakovich

NanoBioPhotonics Group

KCL Women in Physics

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China Scholarship Council

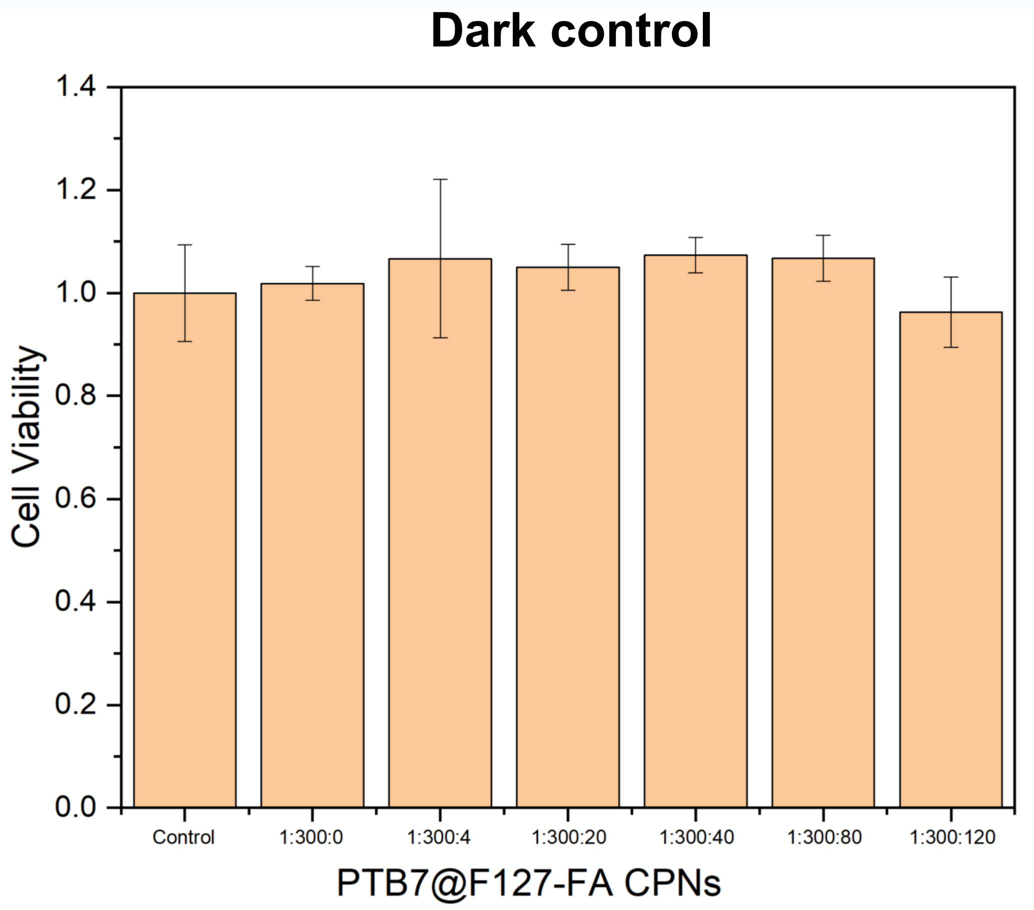
References:

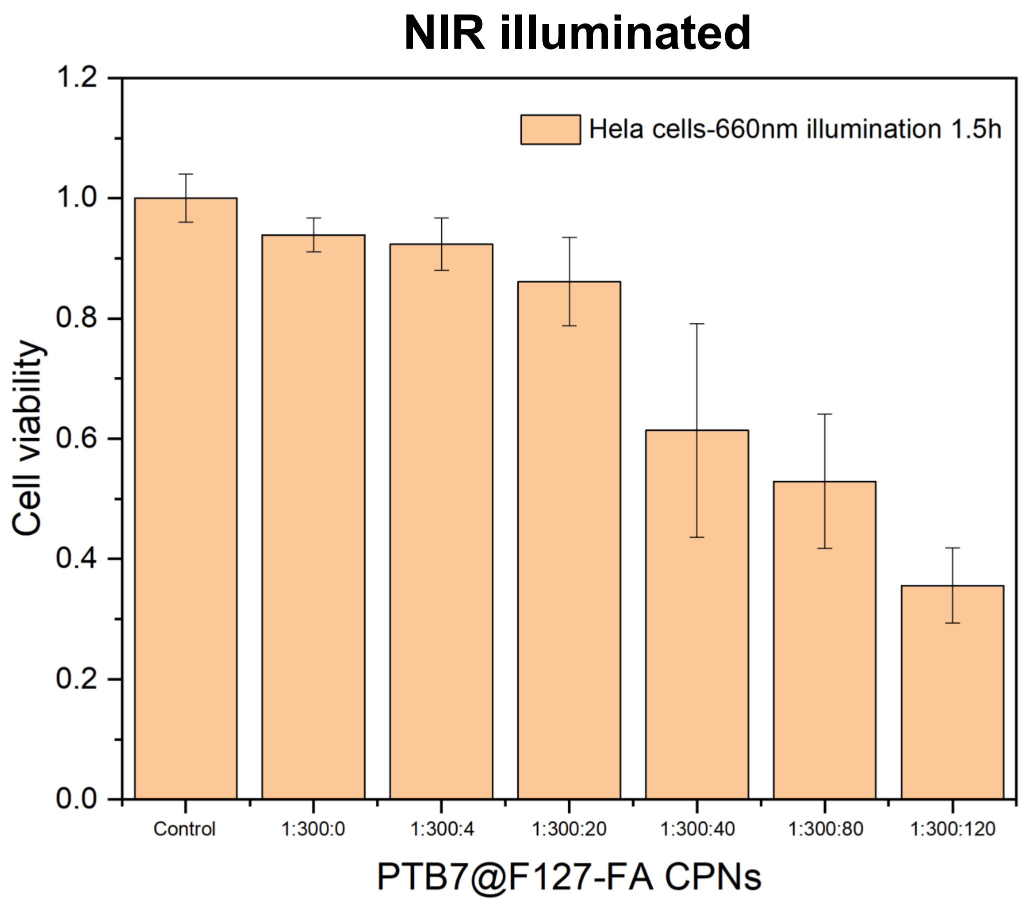
[1] Miao Zhao et al. (2021). Theranostic near-infrared-active conjugated polymer nanoparticles. *ACS nano*, *15*(5), 8790-8802.

[2] Miao Zhao et al. (2023). The Role of Stabilizing Copolymer in Determining the Physicochemical Properties of Conjugated Polymer Nanoparticles and Their Nanomedical Applications. *Nanomaterials*, *13*(9), 1543.

$^1O_2$ production in vitro of PTB7 CPNs-FA

FR+ cell line (HeLa)





CPNs-FA washed before illumination

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