Tetraphenylporphyrin/Polyaniline Complexes as Optic Active Layer in Organic Optoelectronic Applications

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Plan of Presentation

- Introduction
- Experiments
- Results and Discussion
- Conclusions

Tetraphenylporphyrin/Polyaniline Complexes as Optic Active Layer in Organic Optoelectronic Applications

INTRODUCTION

Global Energy Demand

Solar Energy

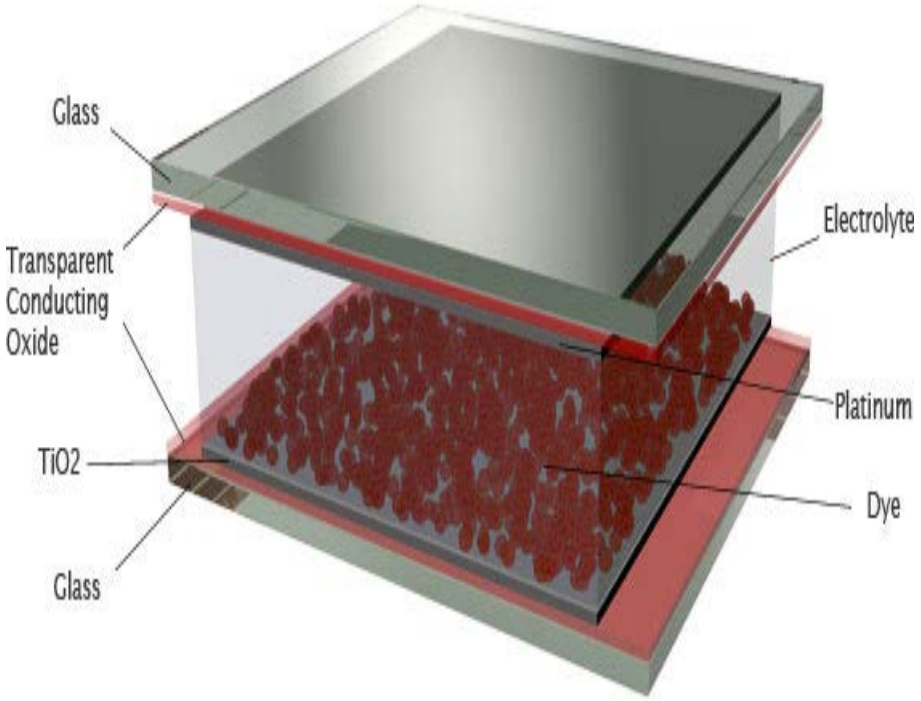
Obstacles :

- High production cost
- Expensive components
- All components are imported

A cheaper photovoltaic technology has to be developed in Indonesia

DSSC (Dye-Sensitized Solar Cell)

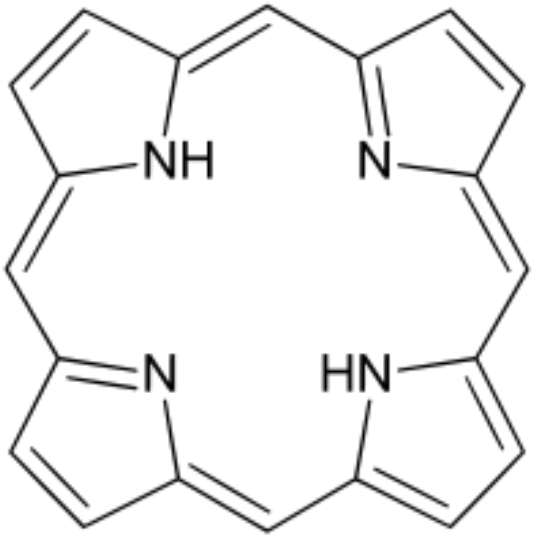
- Simple Fabrication
- Dye/sensitizer can be obtain locally: natural pigments, i.e. photosynthetic pigments from green plants, anthocyanins, etc.
- Very suitable to be implemented in Indonesia.



DSSC components

Porphyrin

- A potential dye/sensitizer for DSSC that covers a certain range of light radiation
- High quantum efficiency
- Has a unique molecular junction with a wide-band gap semiconductor that depends on how it was immobilized
- High molecular symmetry with point group of D_{4h} (metalloporphyrin) or D_{2h} /C_{2V} (free-base porphyrin)



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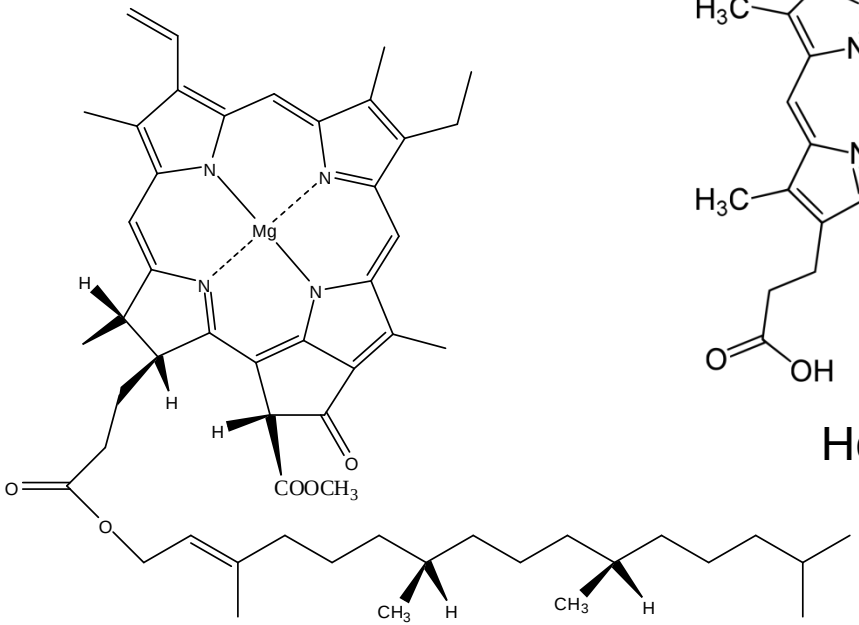
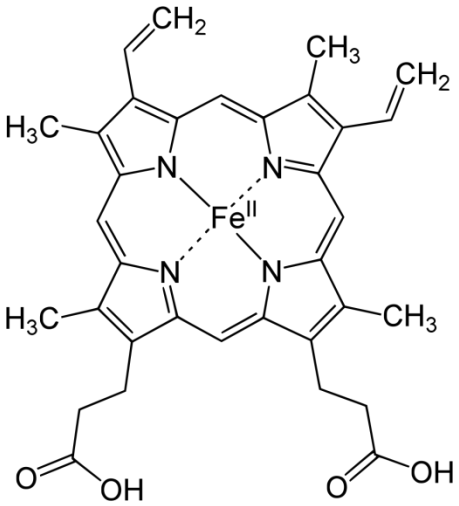
Porphyrin

- Several porphyrins are available abundantly in nature: chlorophyll *a*, heme B (in hemoglobin), heme C (pada *cytochrome c*).

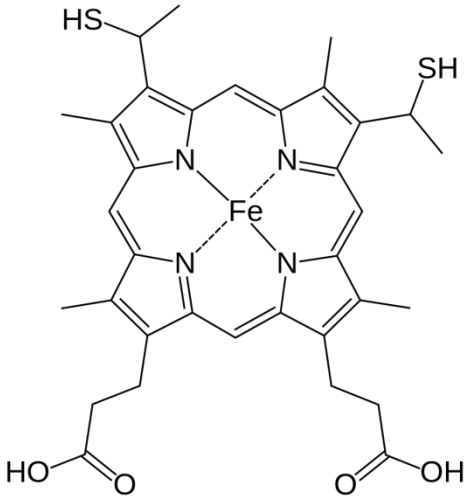
chlorophyll *a*



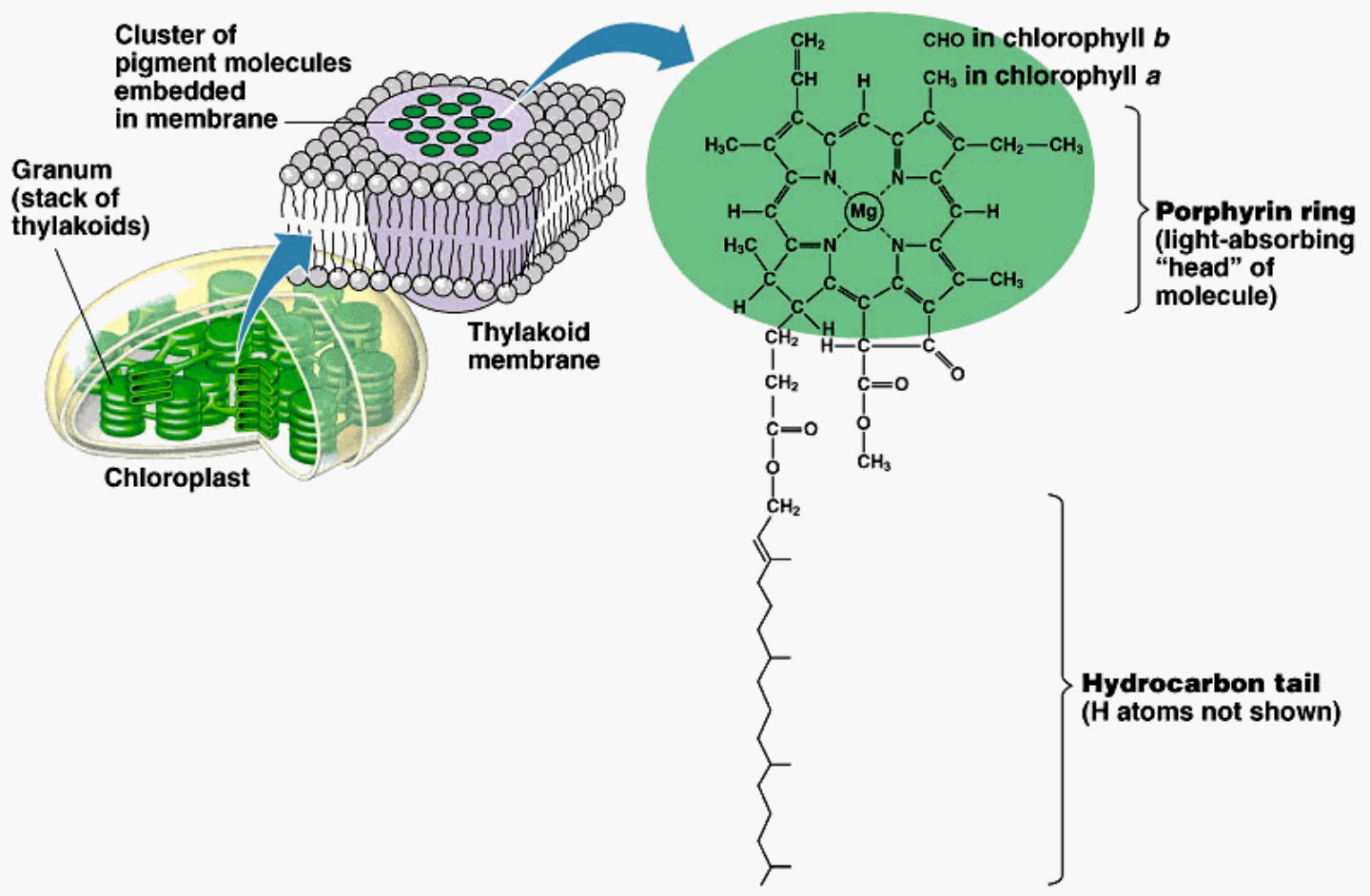


Heme B

Heme C

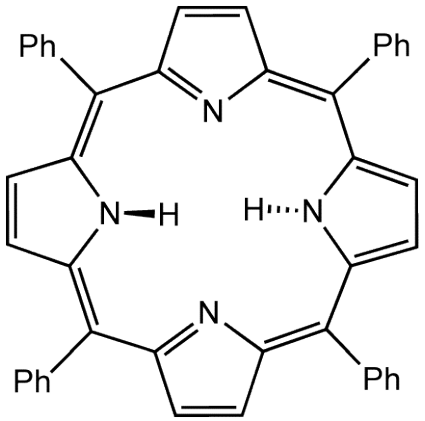


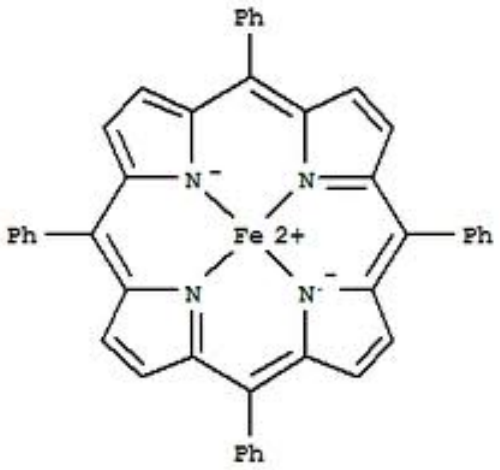
Chlorophyll

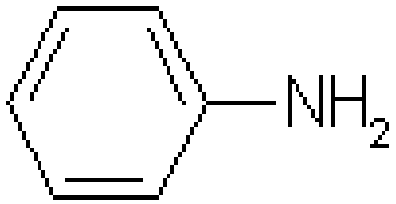


Meso-Tetraphenylporphyrin (TPP)

- Synthetic pigment with a simple synthesis pathway and high yield
- High absorption coefficient in visible light
- Gives a strong photoluminescence in red
- Simple to vary its properties through the insertion of metal ions, protonation and addition of linker molecules







Aniline

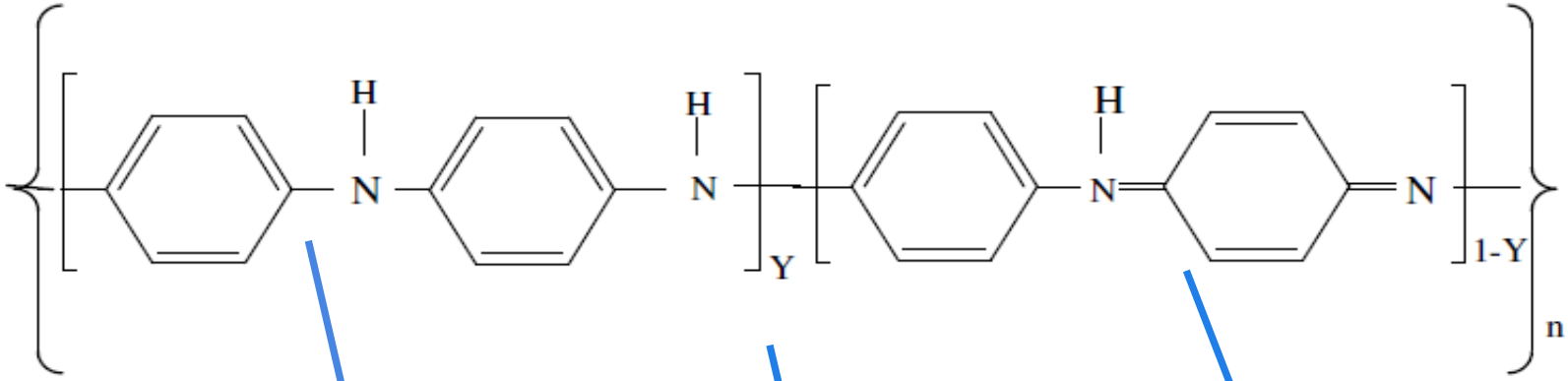
Polyaniline

Conductive polymer

Advantages :

- Low production cost
- Covers a wide range of electrical conductivity (10^{-10} S/cm - 100 S/cm)
- High environmental and thermal stability

POLYANILINE

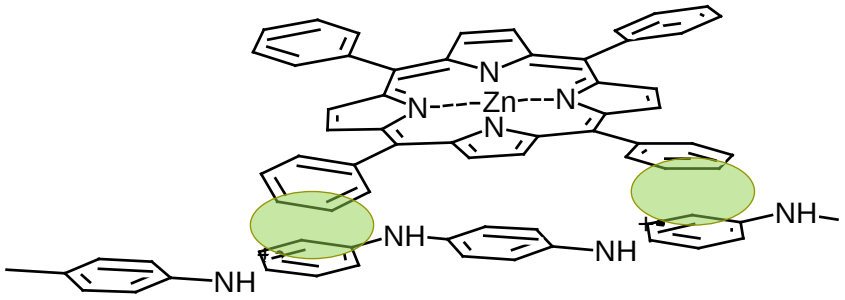


Leucoemeraldine Base (LEB), Y = 1

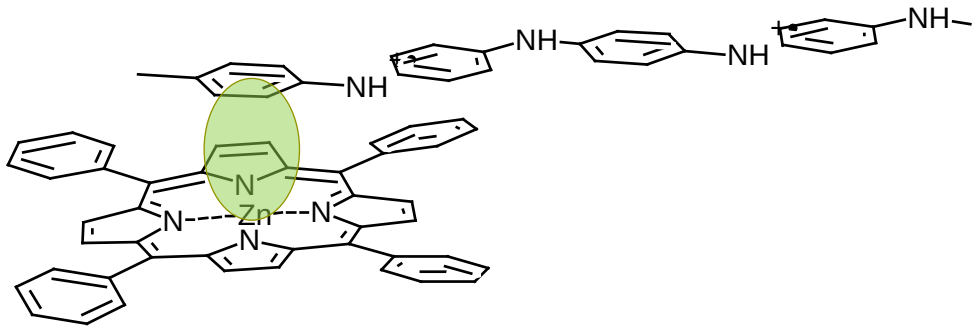
Emeraldine Base (EB), Y = 0.5

Pernigraniline Base (PNB), Y = 0

Molecular Junction in TPP/PANI Blend

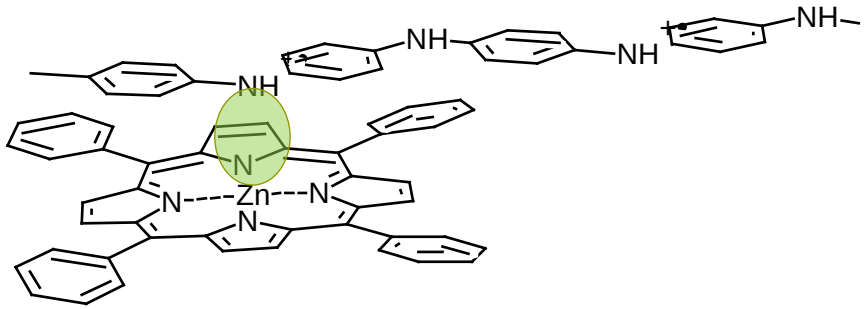


π Stacking interaction

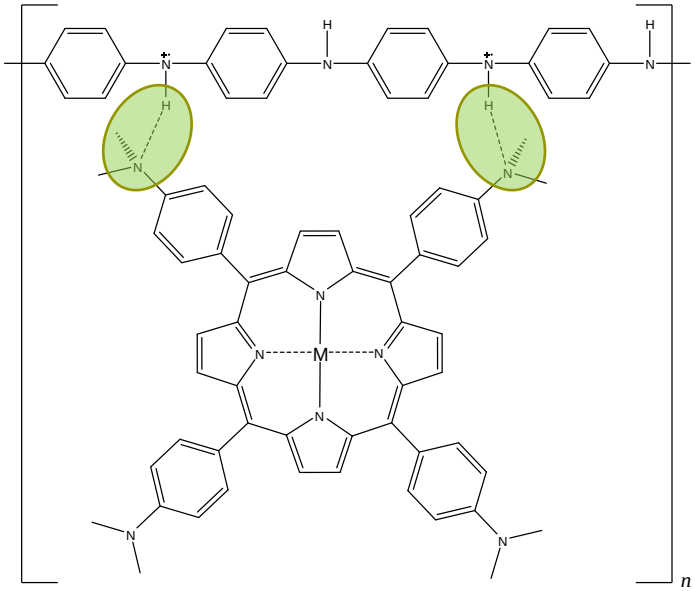


covalent coordination with type (η^6, L_3), (η^4, L_2) or (η^2, L), between π electrons and central metal ion

Molecular Junction in TPP/PANI Blend



covalent coordination with type (η^2, L) between *lone pair* and central metal ion

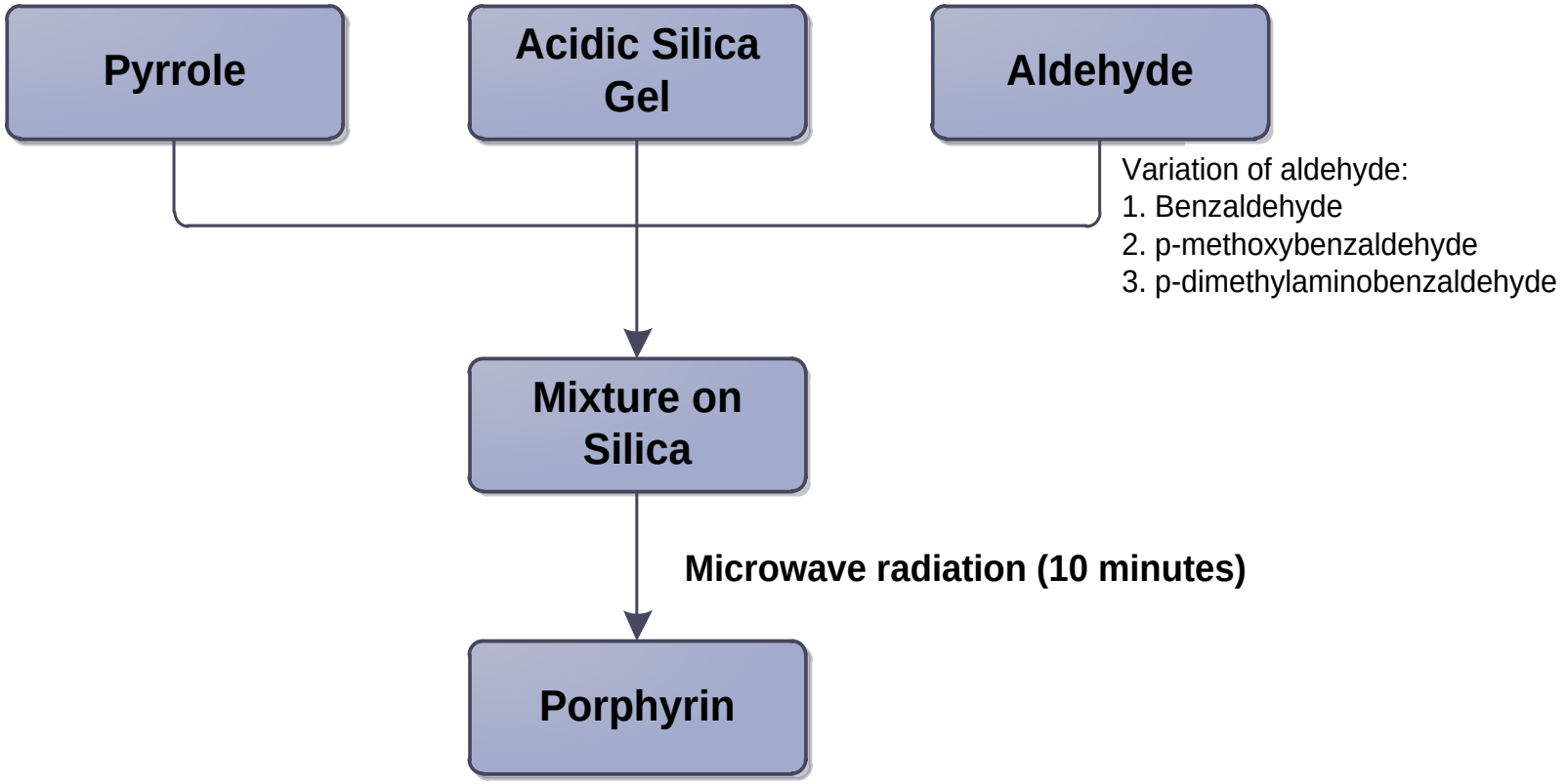


Lewis acid-base interaction

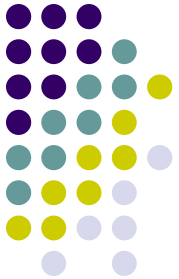
Tetraphenylporphyrin/Polyaniline Complexes as Optic Active Layer in Organic Optoelectronic Applications

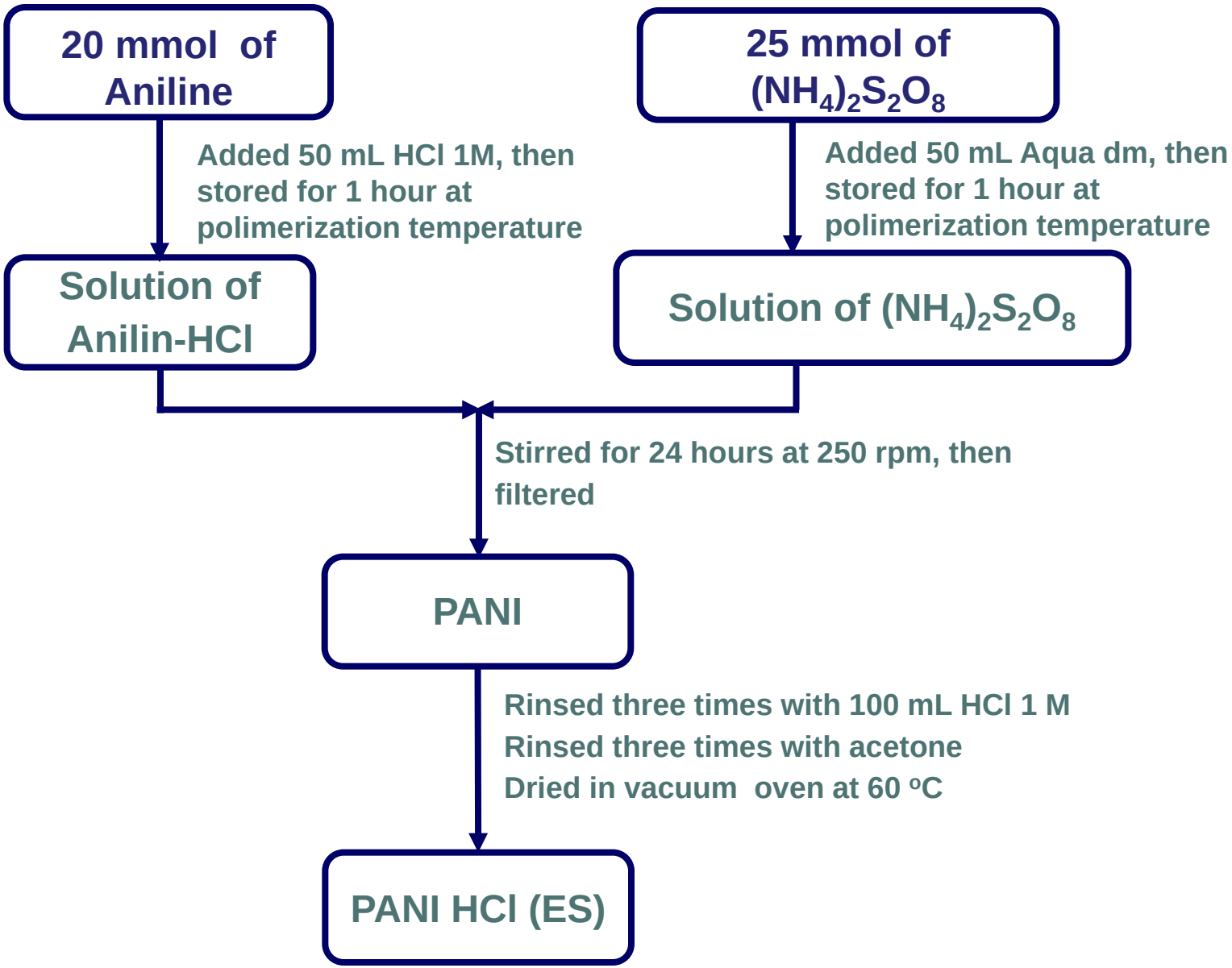
EXPERIMENTS

Synthesis of Porphyrins

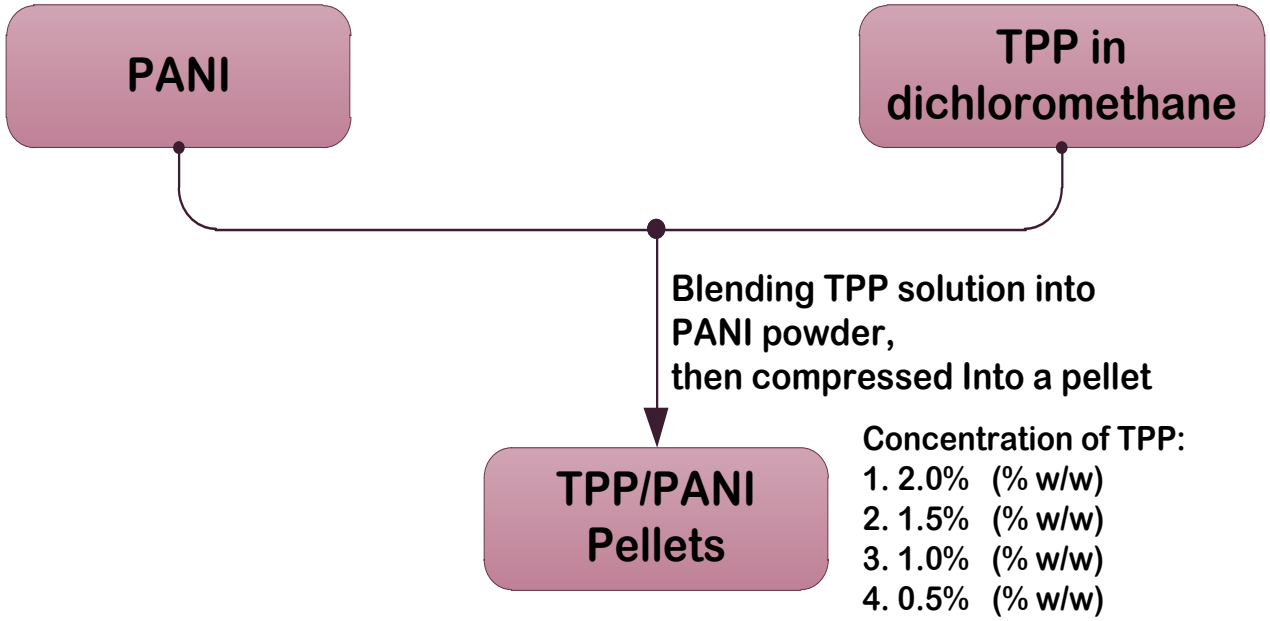


Synthesis of Polyaniline

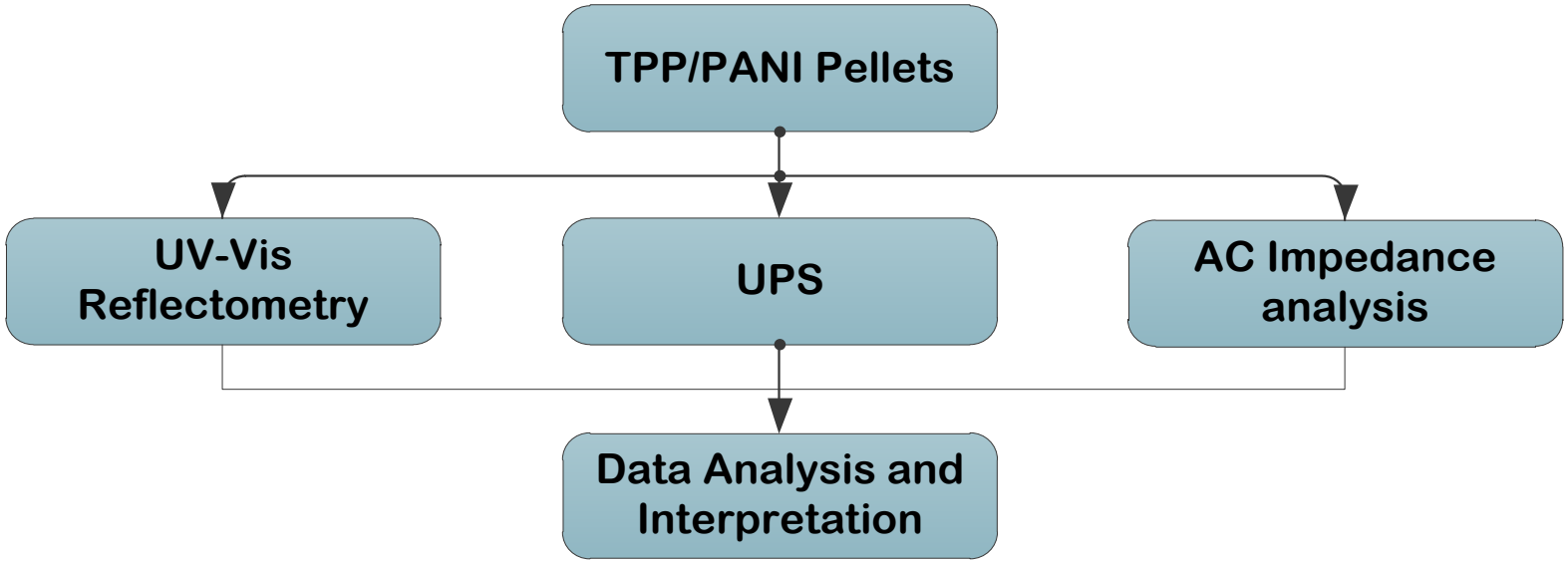




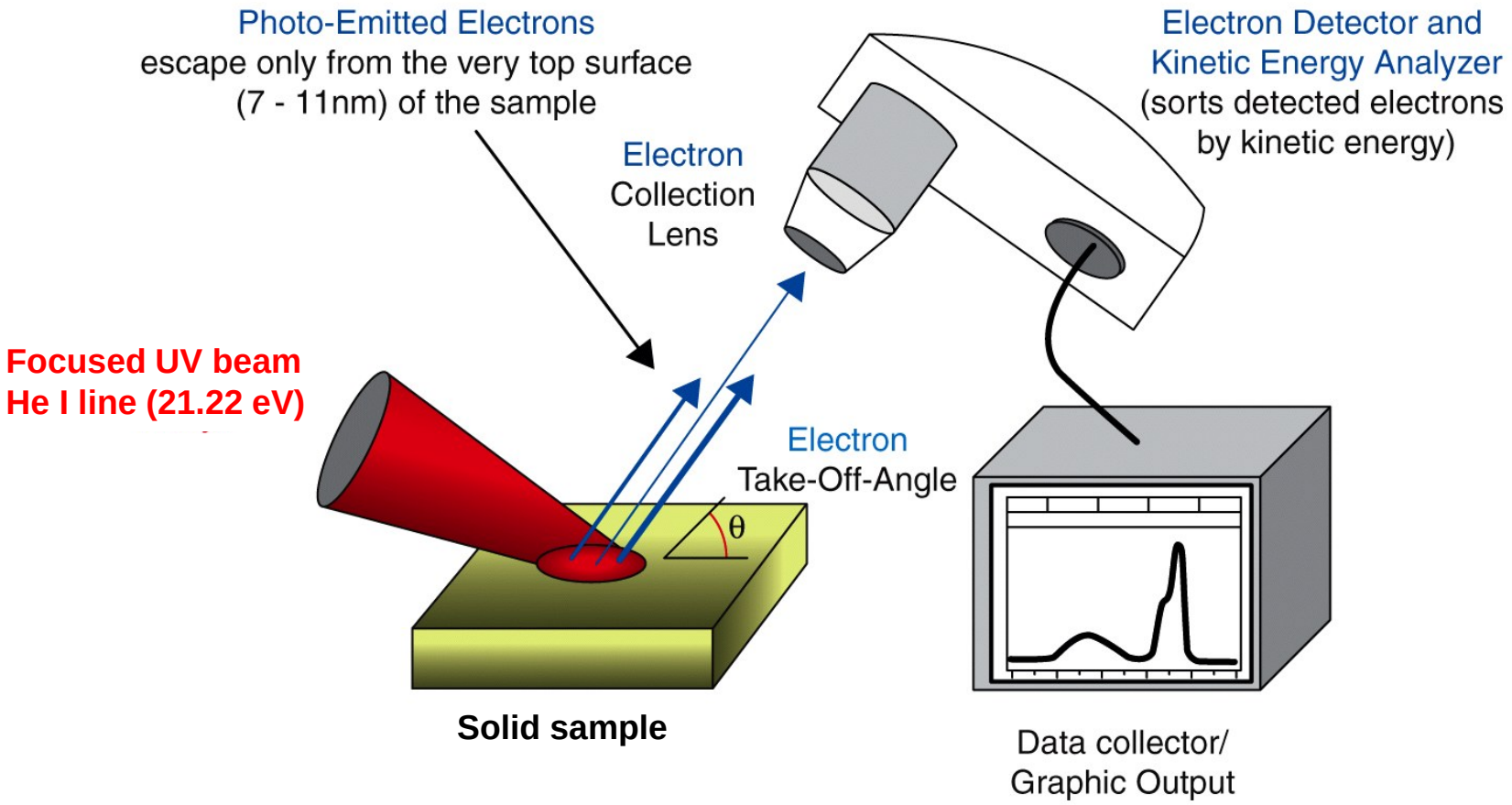
Blending of TPP/PANI



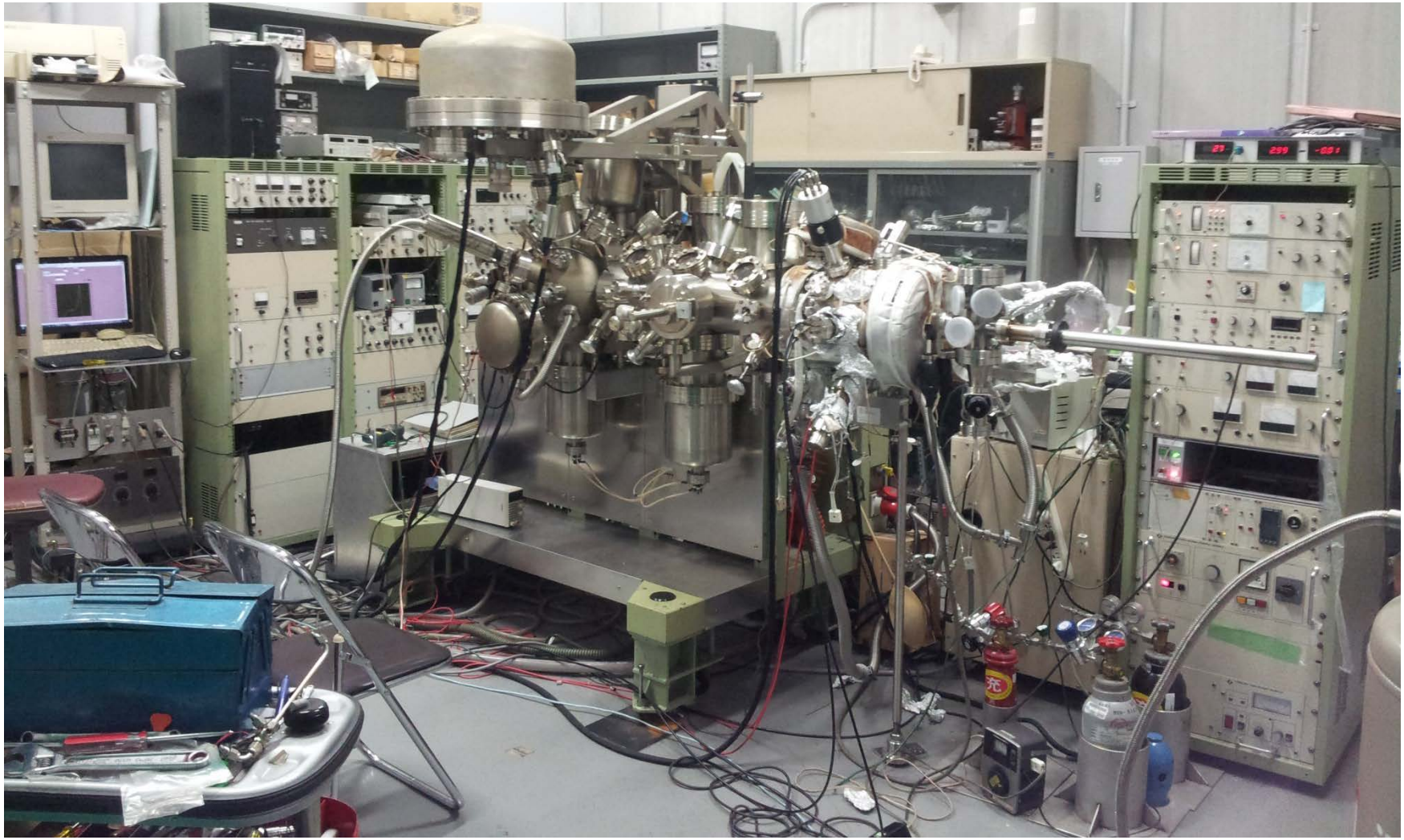
Characterization of TPP/PANI



Schematic of UV Photoelectron Spectroscopy (UPS)



UV Photoemission Spectrometer in IIS/The University of Tokyo



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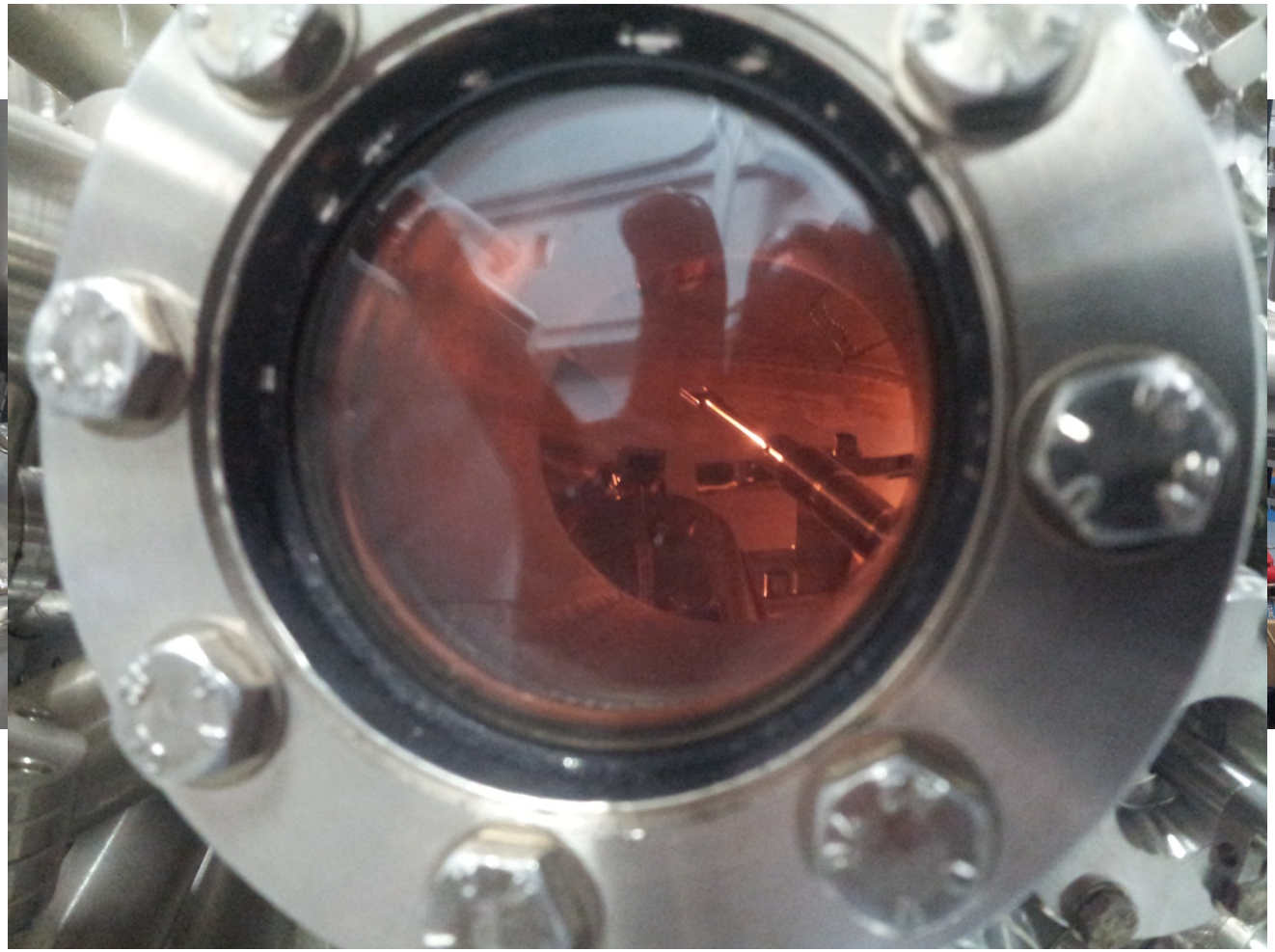
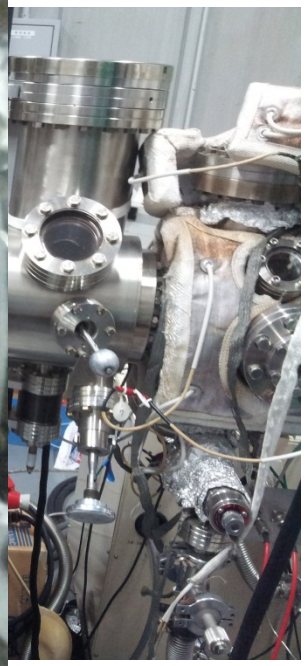
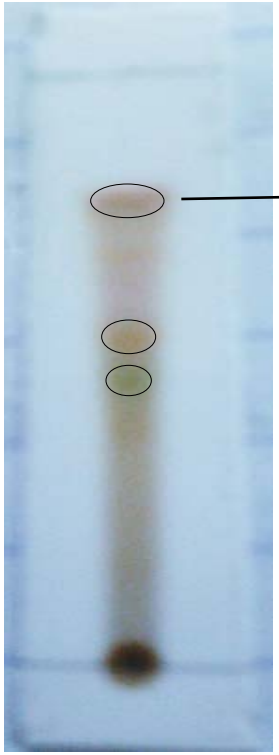




Tetraphenylporphyrin/Polyaniline Complexes as Optic Active Layer in Organic Optoelectronic Applications

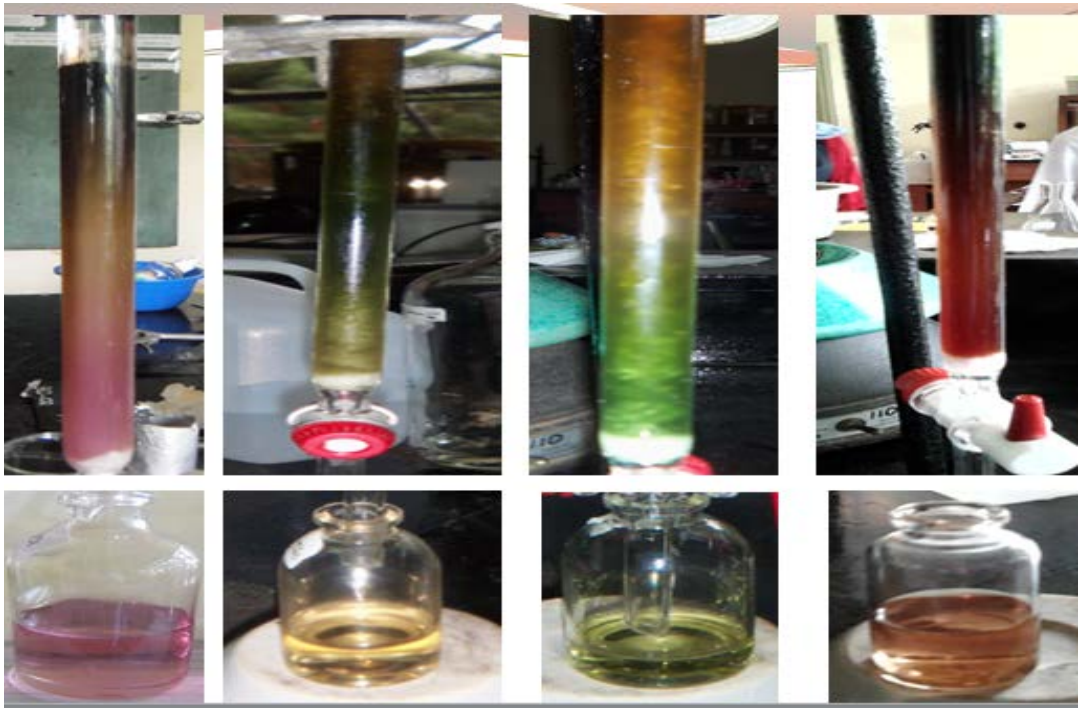
RESULTS AND DISCUSSION

meso-Tetraphenylporphyrin synthesis



TPP spot

$R_f = 0,775$



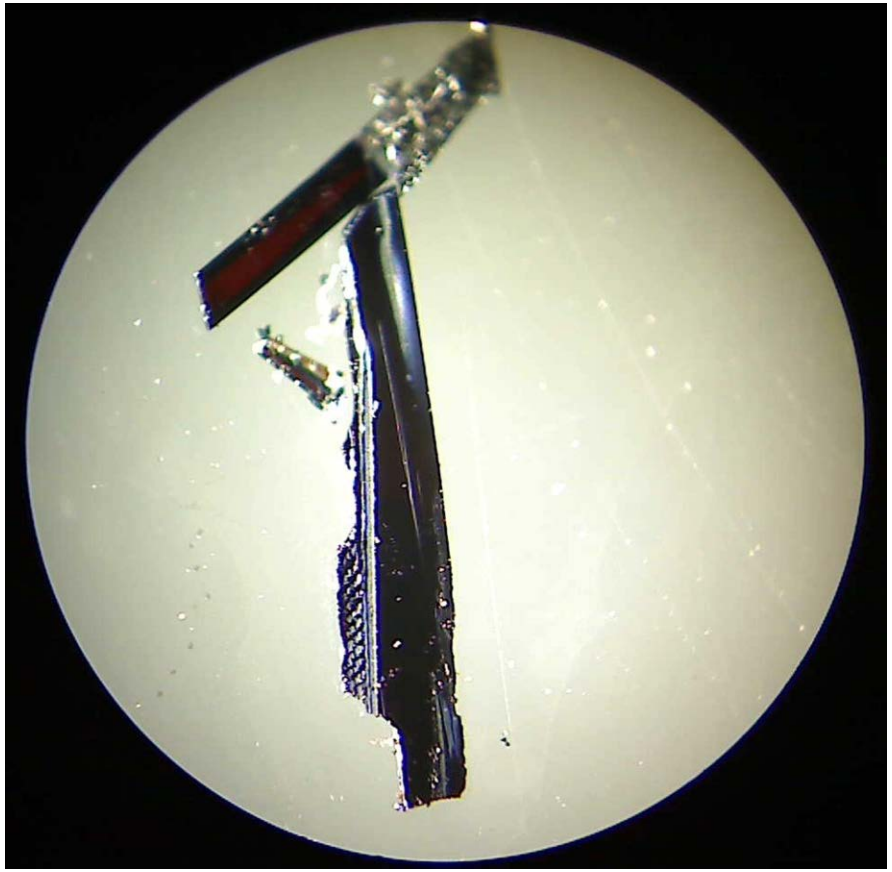
Purple fraction (TPP)

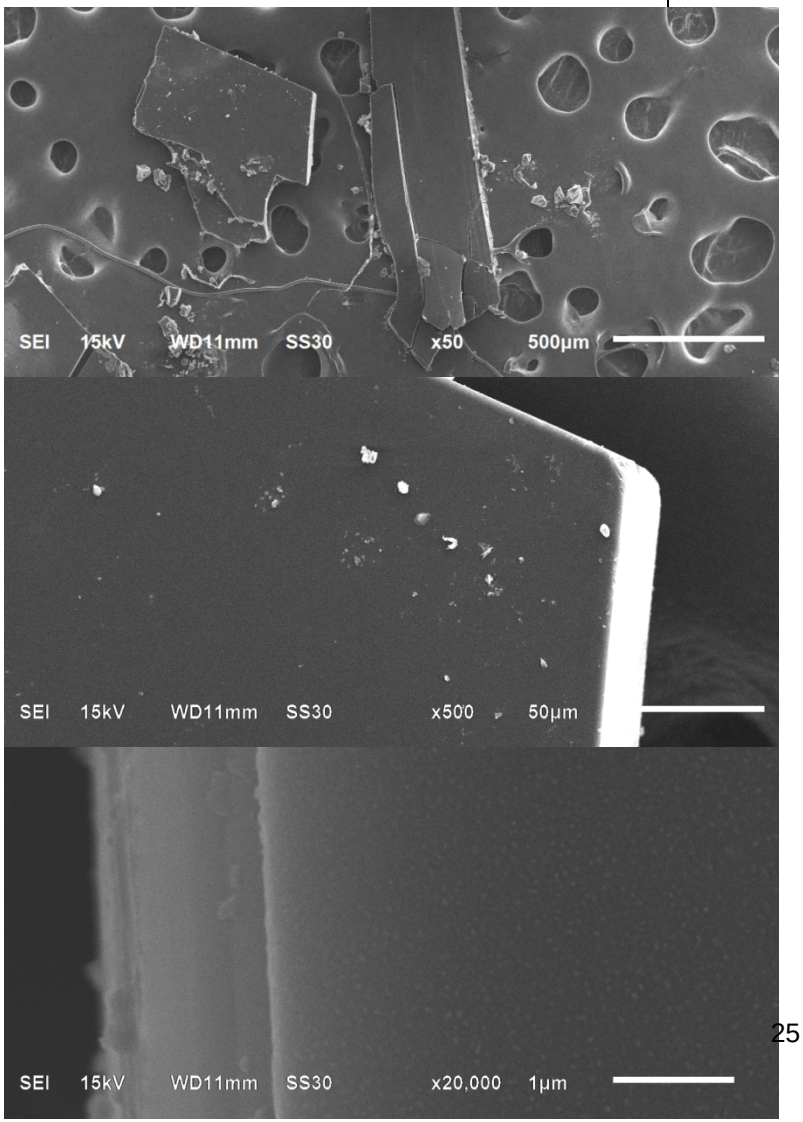
Yellow fraction

Green fraction

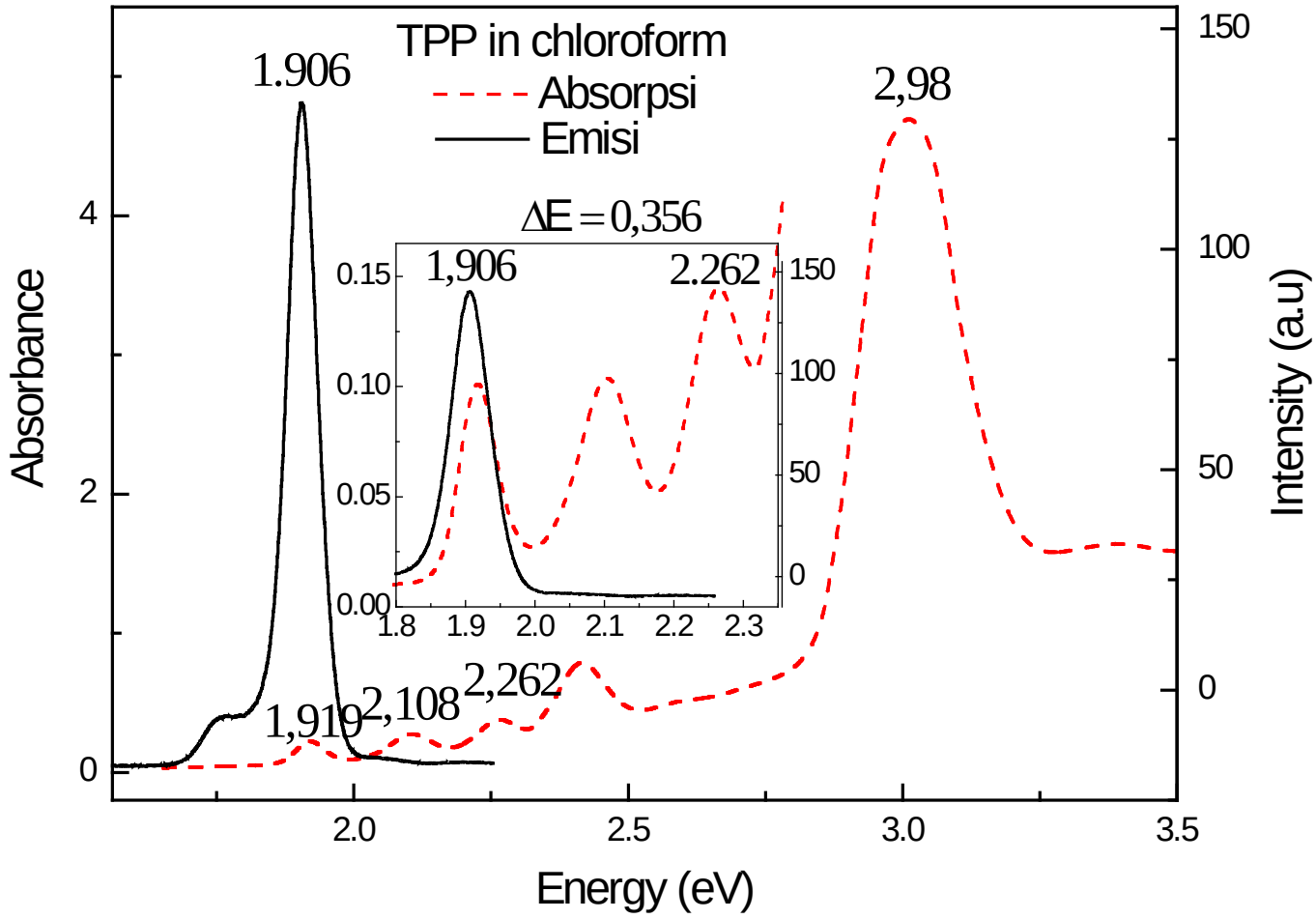
Orange fraction

meso-tetraphenylporphyrin crystals

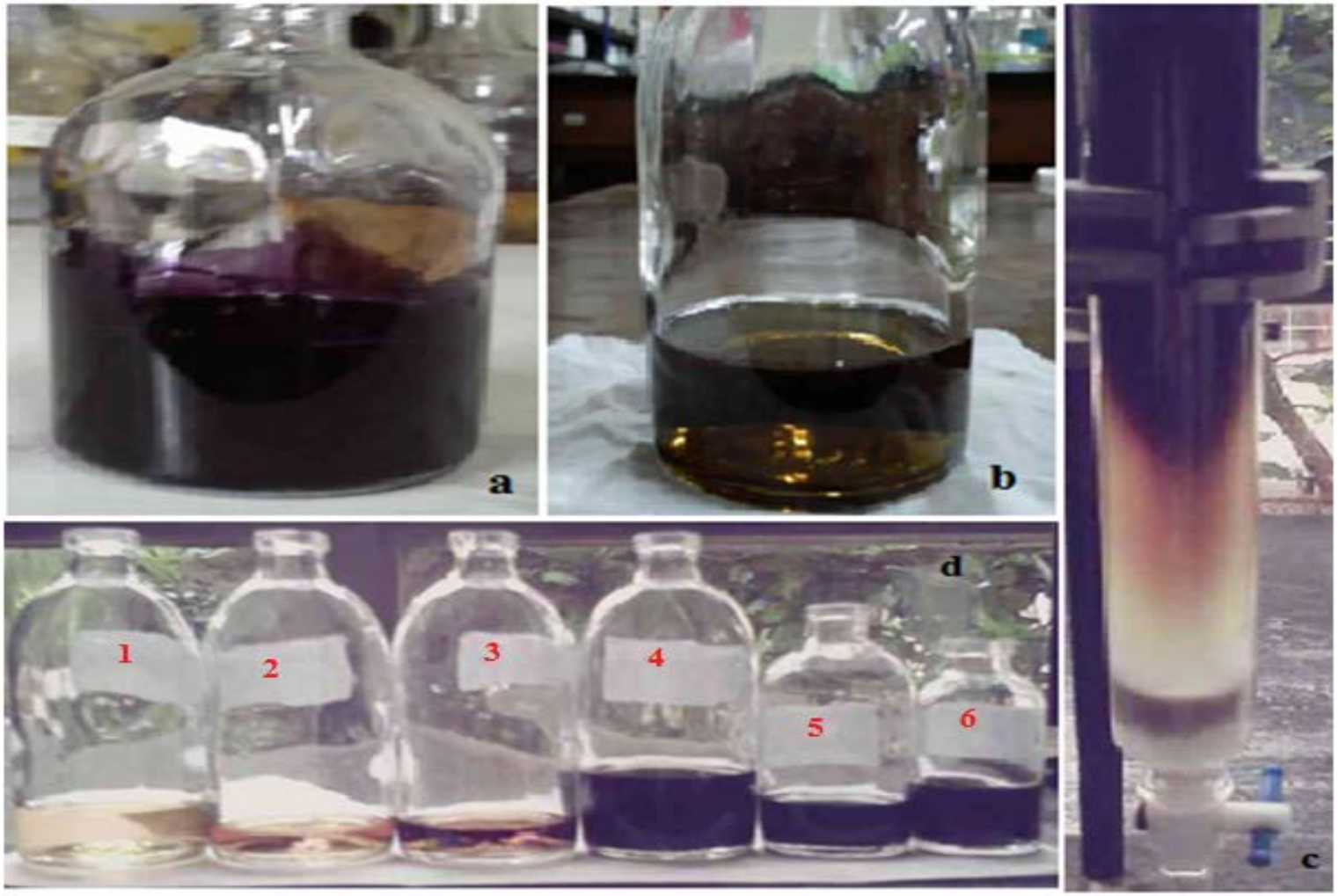




UV-VIS absorption and emission spectra of TPP in chloroform

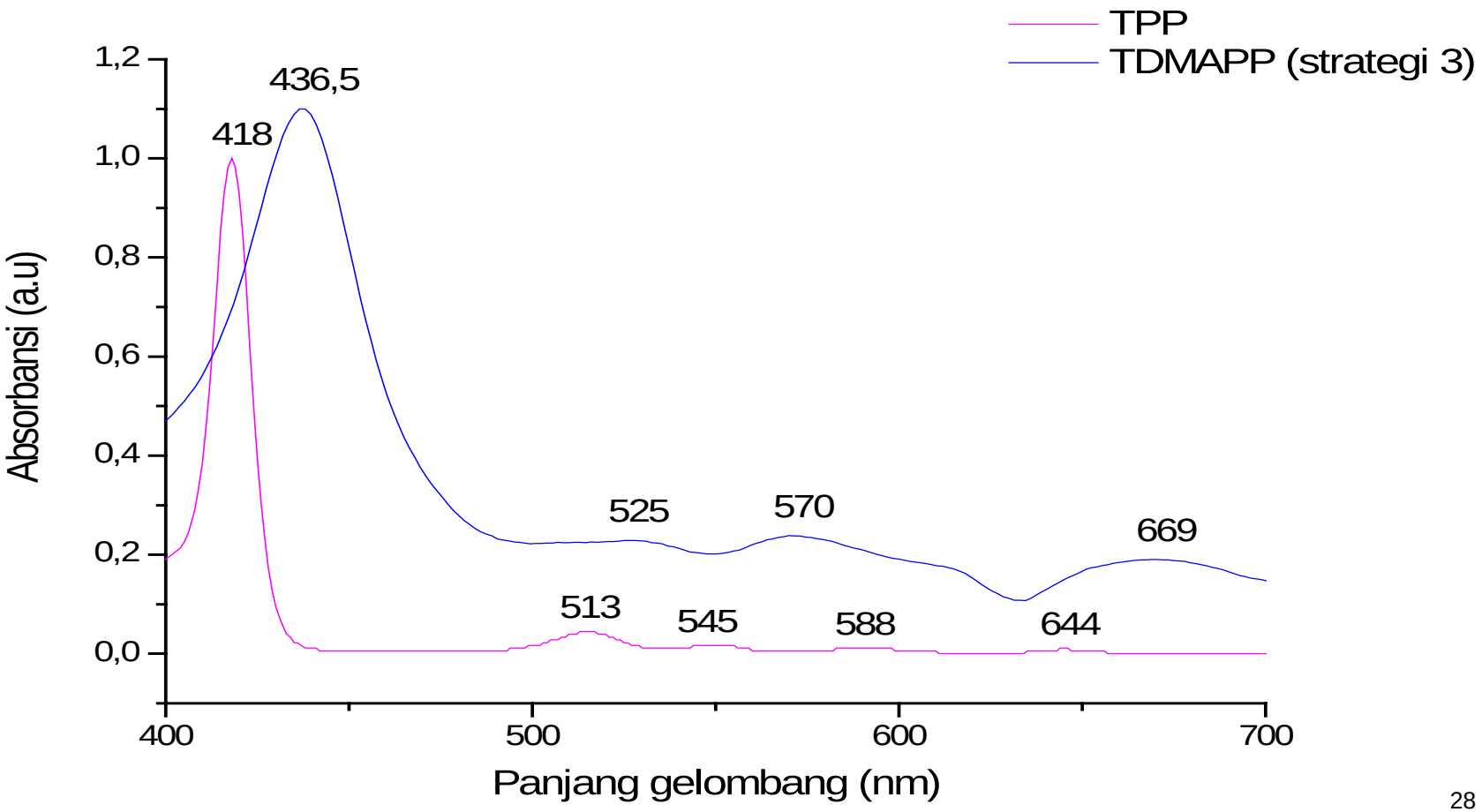


meso-Tetra(*p*-dimethylaminophenyl)porphyrin synthesis

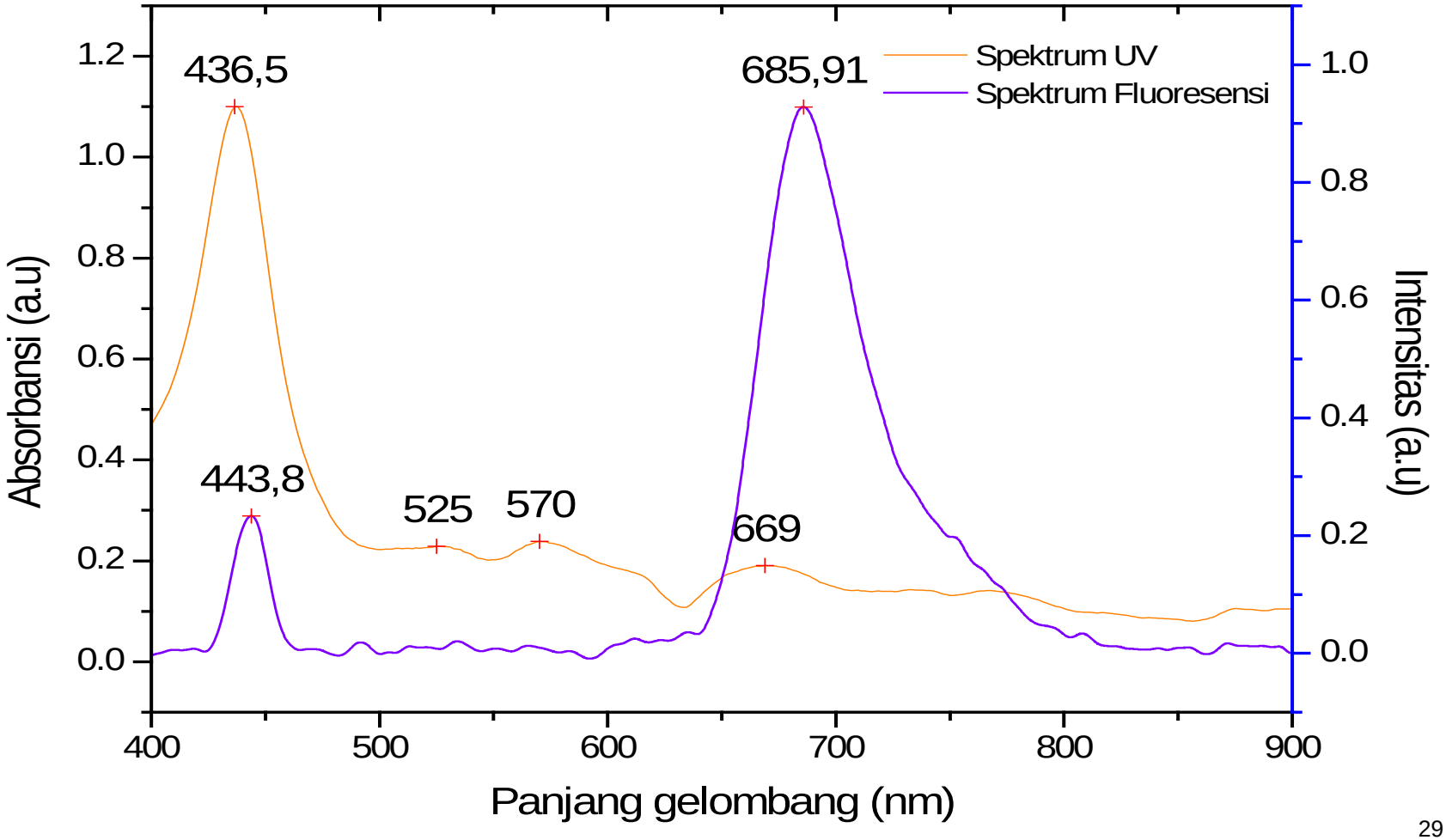


a) As synthesized in silica gel , **b)** crude extract in chloroform, **c)** purification using column chromatography, **d)** several franctions after purification.

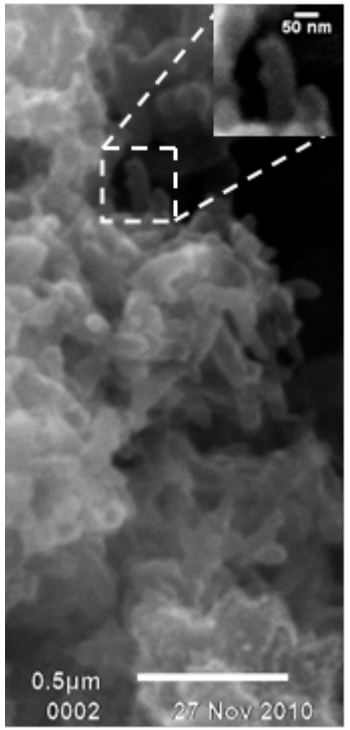
meso-Tetra(*p*-dimethylaminophenyl)porphyrin synthesis



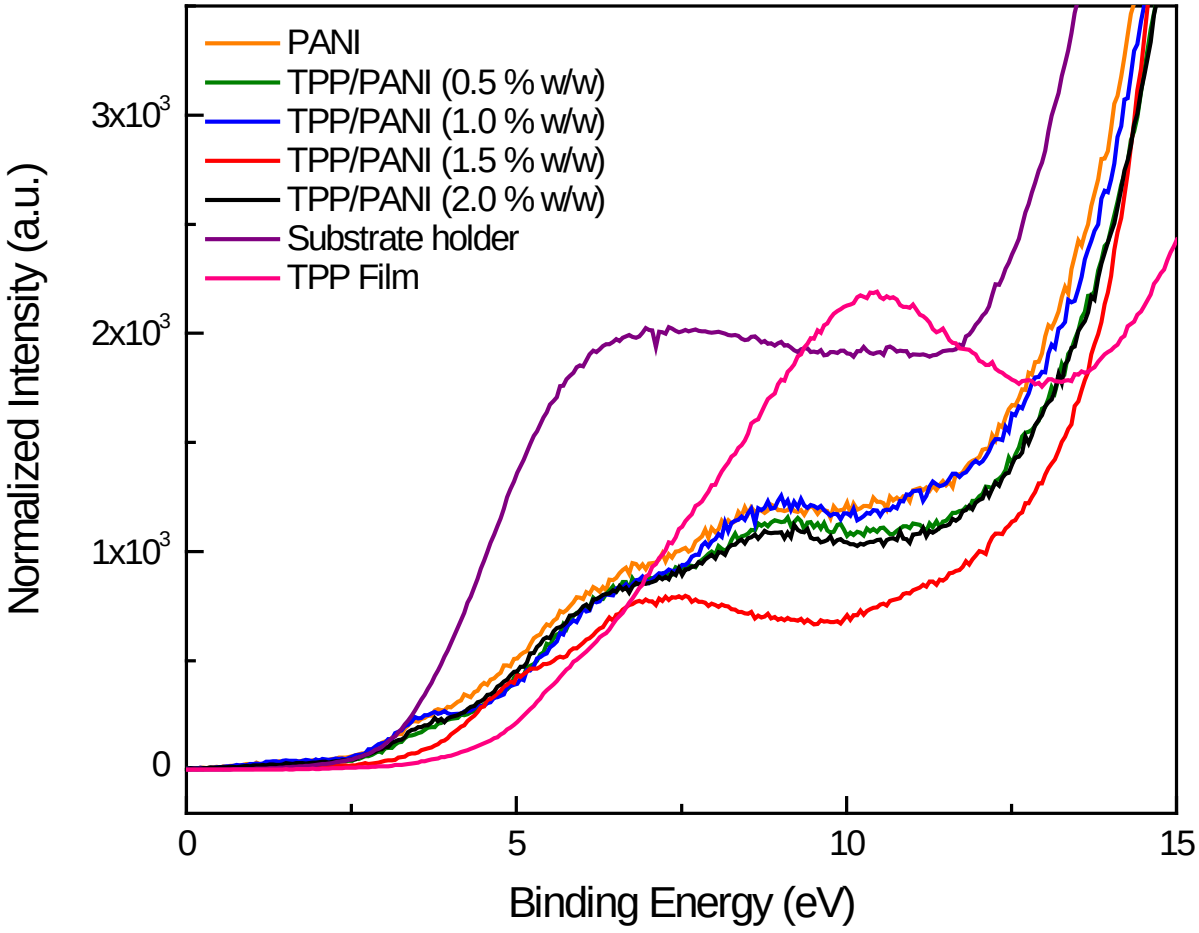
meso-Tetra(*p*-dimethylaminophenyl)porphyrin synthesis



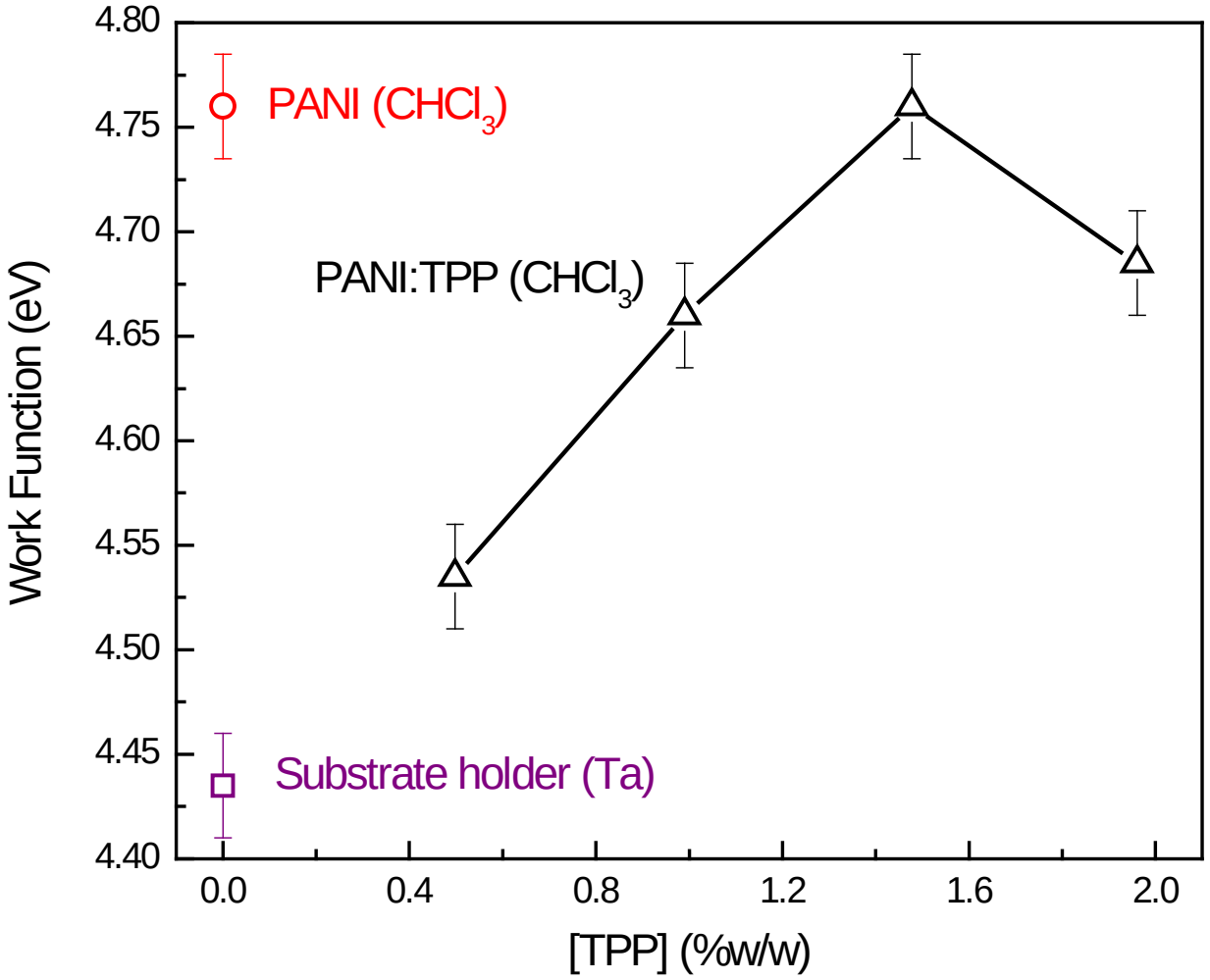
Polyaniline synthesis



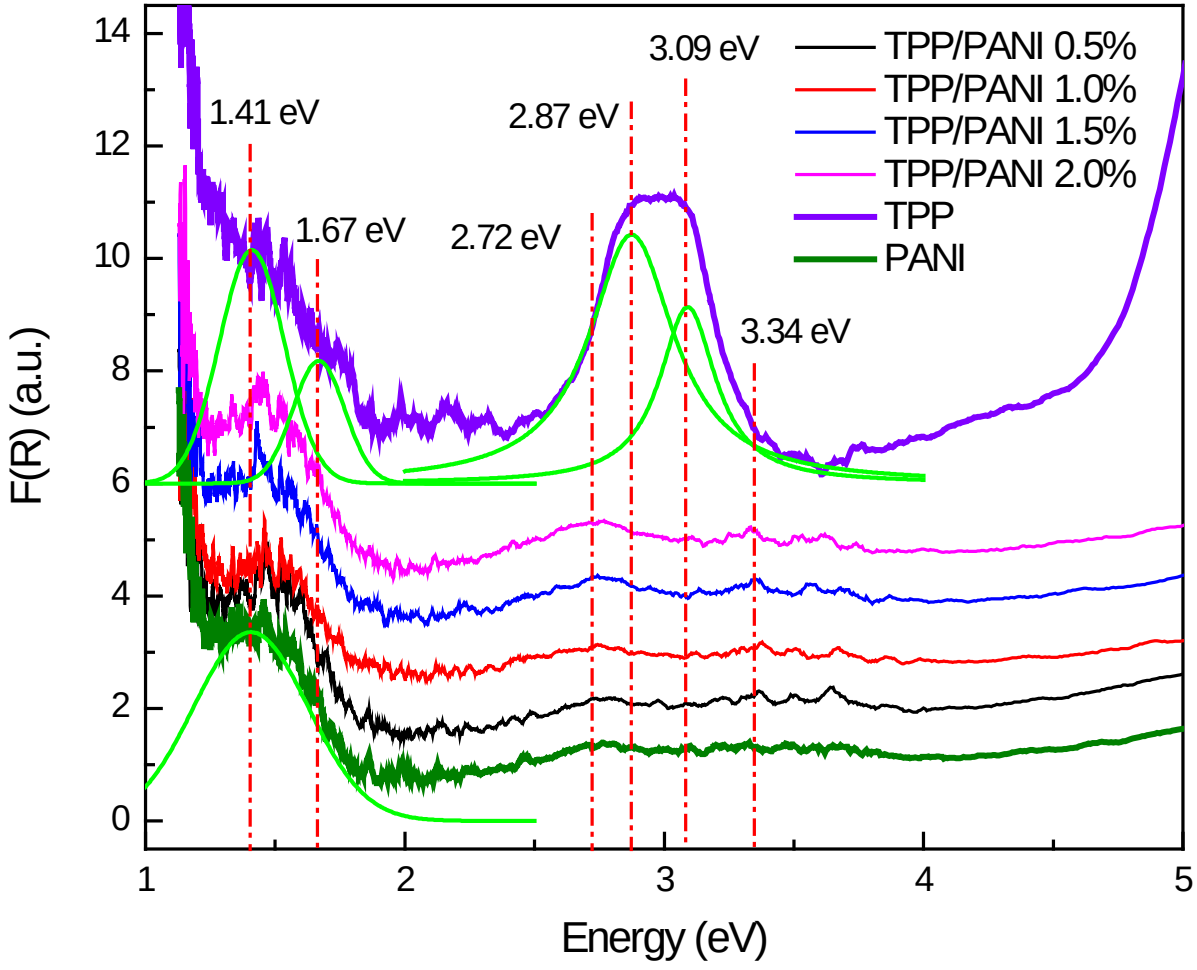
UV Photoelectron spectra



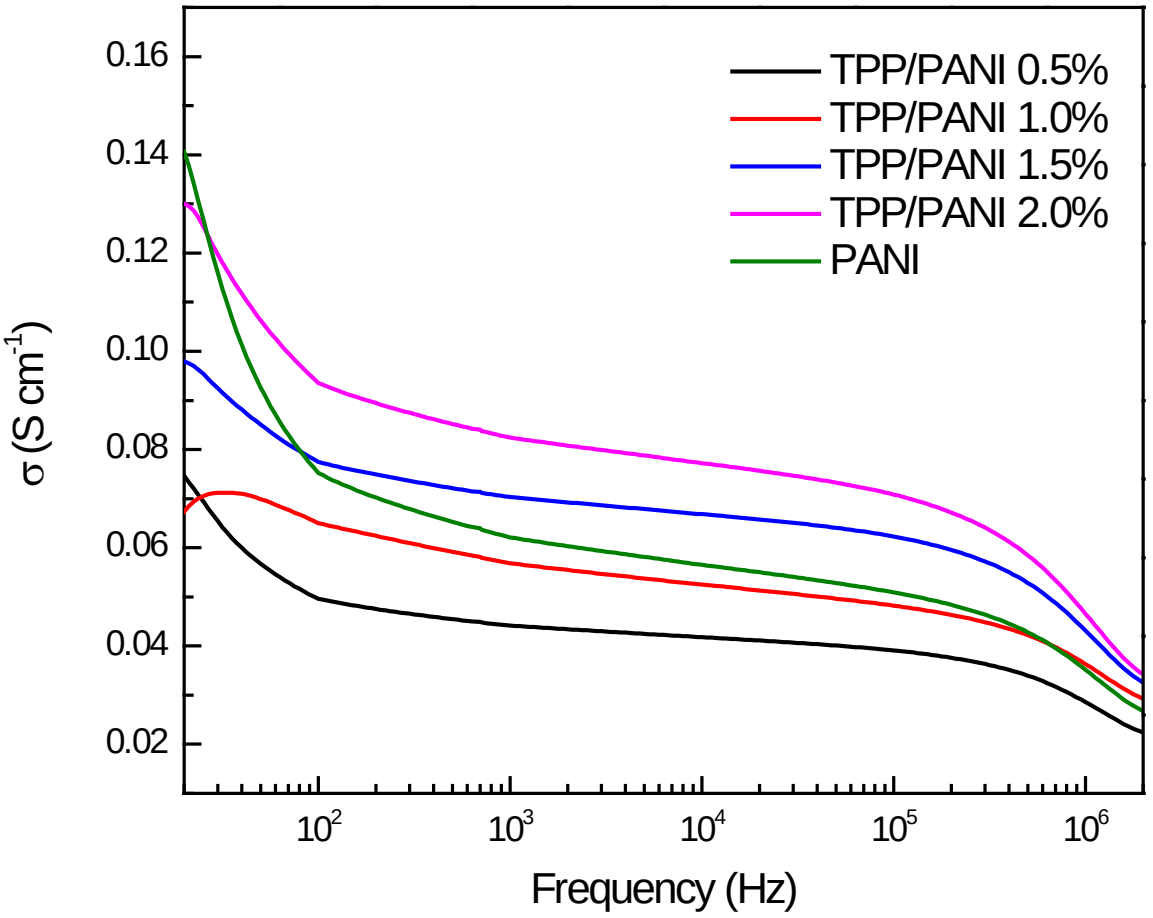
Surface workfunction



UV-Vis reflectance spectra



Electrical conductivity



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CONCLUSIONS

Conclusions

- Both UPS and UV-Vis reflectance results show that the presence of TPP in TPP/PANI blend adds some electronic states in PANI valence band.
- A certain concentration limit is necessary to alter the properties of the blend significantly with respect to the pure PANI.
- Interesting doping feature was also observed in the electrical conductivity as a function of frequency of TPP/PANI blend, where the presence of TPP improved the high frequency part of electrical conductivity significantly.

Future Plans

- Ab initio study on the interaction between TPP and PANI in TPP/PANI blend and its electronic properties.
- Photoluminescence measurements of TPP/PANI blends in their resonance wavelengths.
- Raman/FTIR measurements to reveal the interaction between TPP and PANI in TPP/PANI blend
- Applying TPP/PANI blends as a simple PV device.

Thank you