UNIVERSITY OF CAMBRIDGE
800 YEARS 1209 ~ 2009

Phototech: COST Action TD1102

Towards Photoelectrochemical Cells based on Photosystem II Integrated in Nanostructured Electrodes

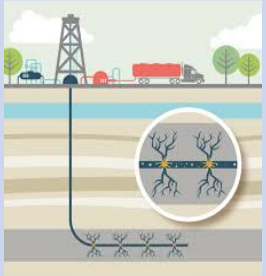
Supervisor: Dr. Erwin Reisner
Co-supervisor: Prof. Sir Richard Friend

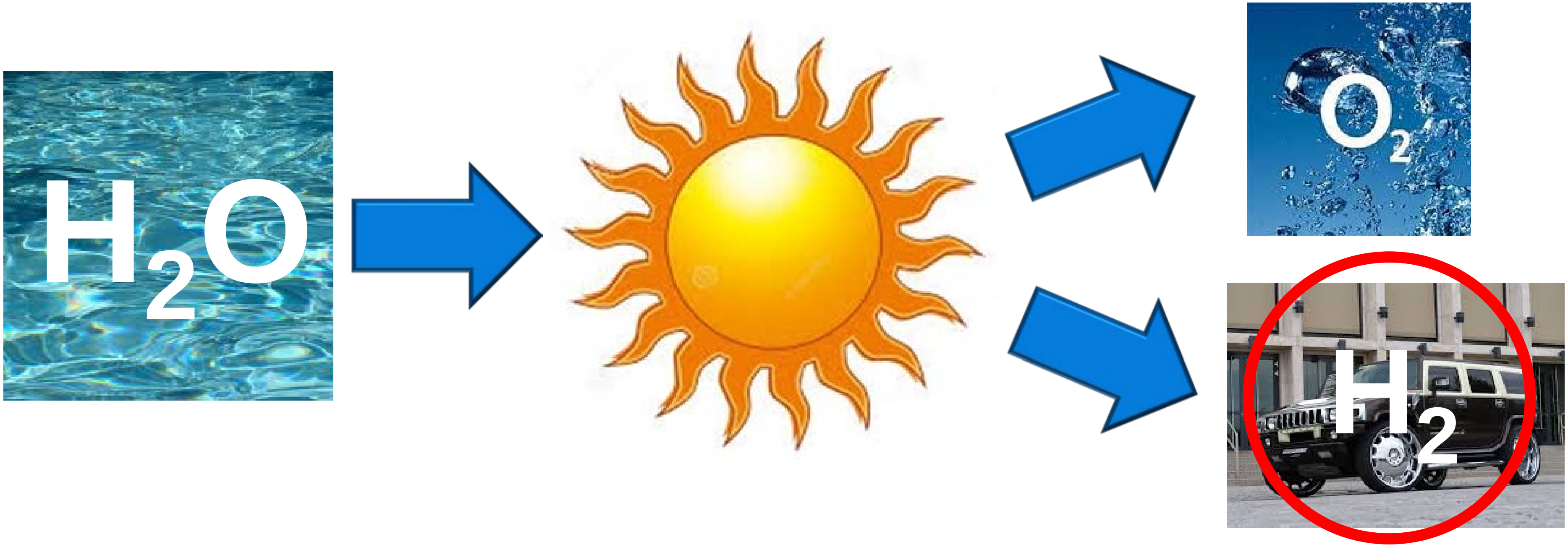
09/04/14

Dirk Mersch

Problem and solution

Most common energy sources:

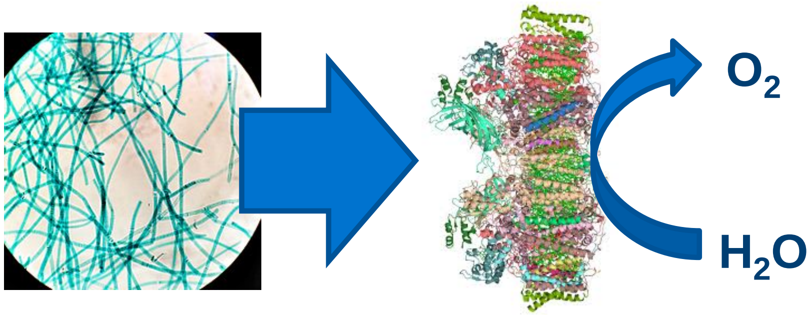




Concept

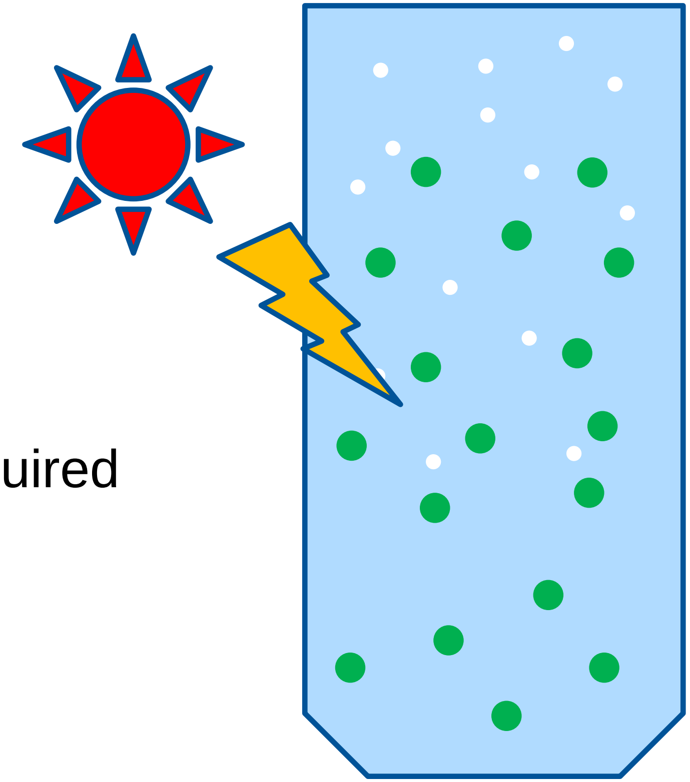
Solar energy today:

Cheap, scalable



PSII: Dispersion

Dispersion based water splitting

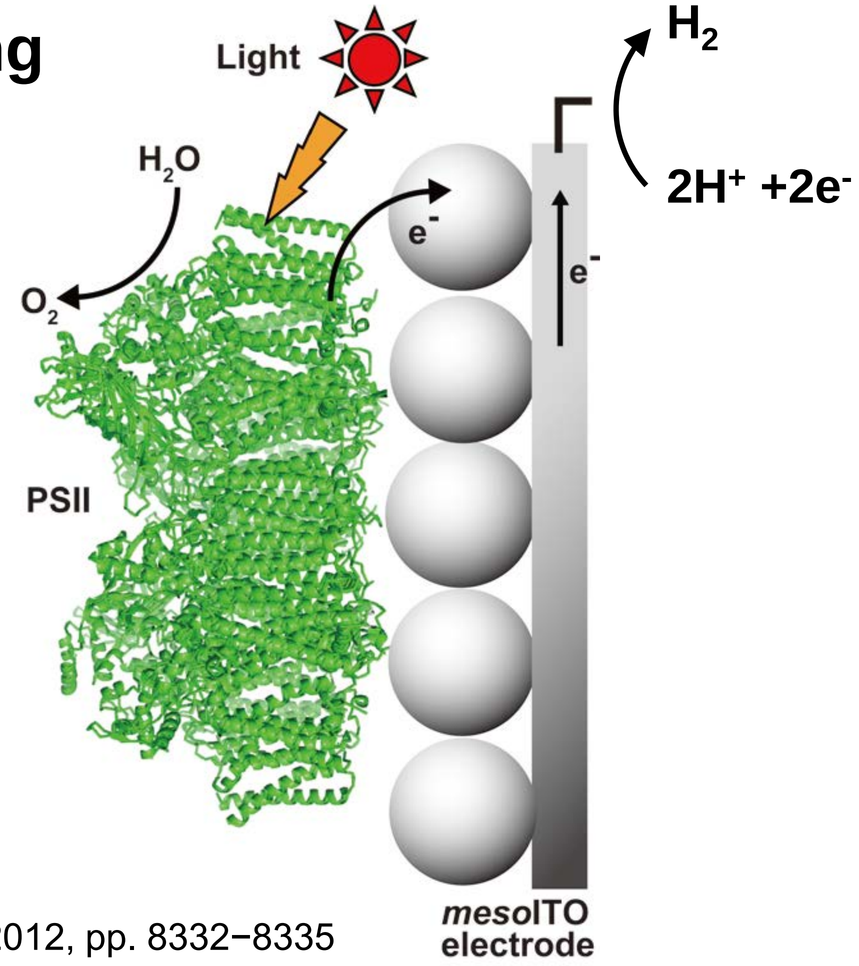


- High turnover frequencies
- Sacrificial electron acceptors are required

PSII: Electrode

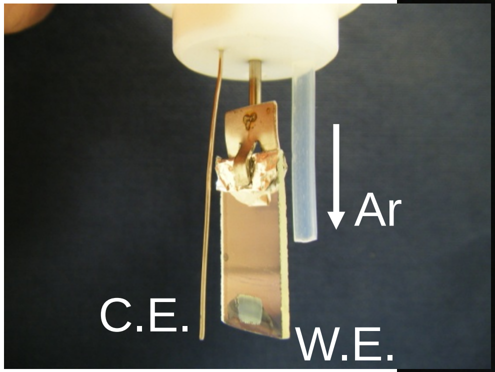
Dispersion based water splitting

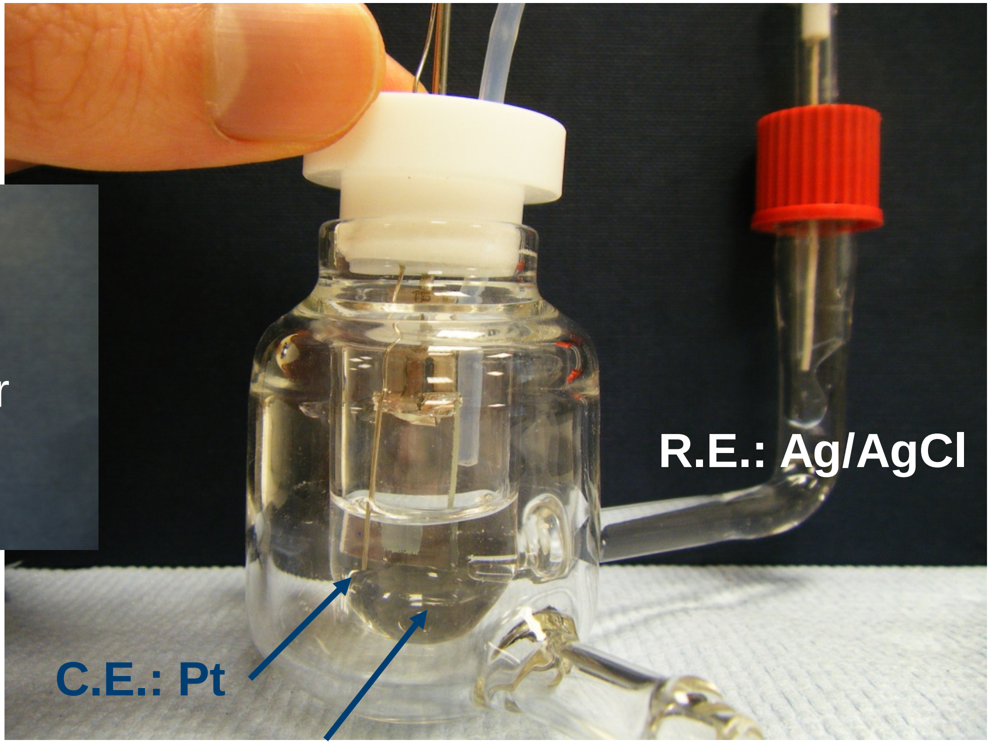
- Orientation problems
- Charge injection problems
- Loading problems
- No sacrificial acceptors are required

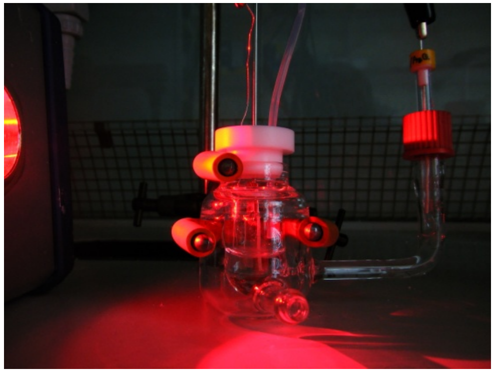


M. Kato, J. Am. Chem. Soc. 134, 2012, pp. 8332−8335

PSII: Setup

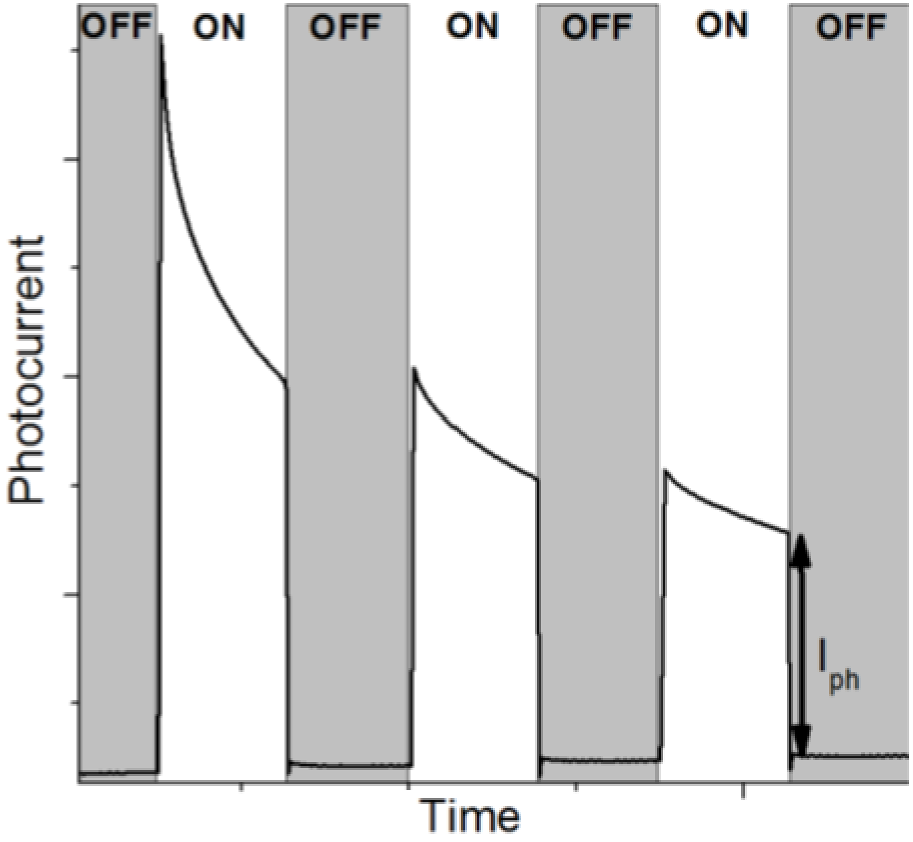






Dirk Mersch

PSII: Photo Electrochemistry

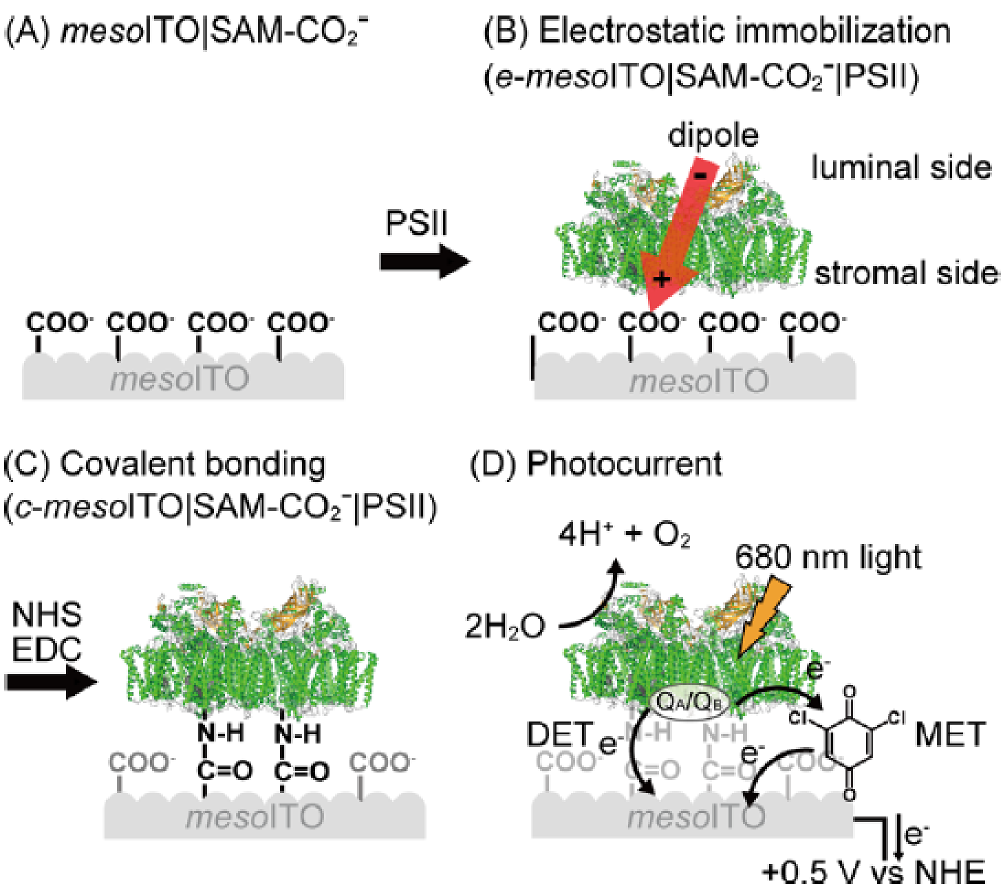


- Constant potential of 0.3 V vs Ag/AgCl
- 30 sec on/off cycles
- Height of the 3rd peak recorded

PSII: Challenges

- Orientation and coupling
- Good conductivity of the substrate
- Amount of PSII adsorbed

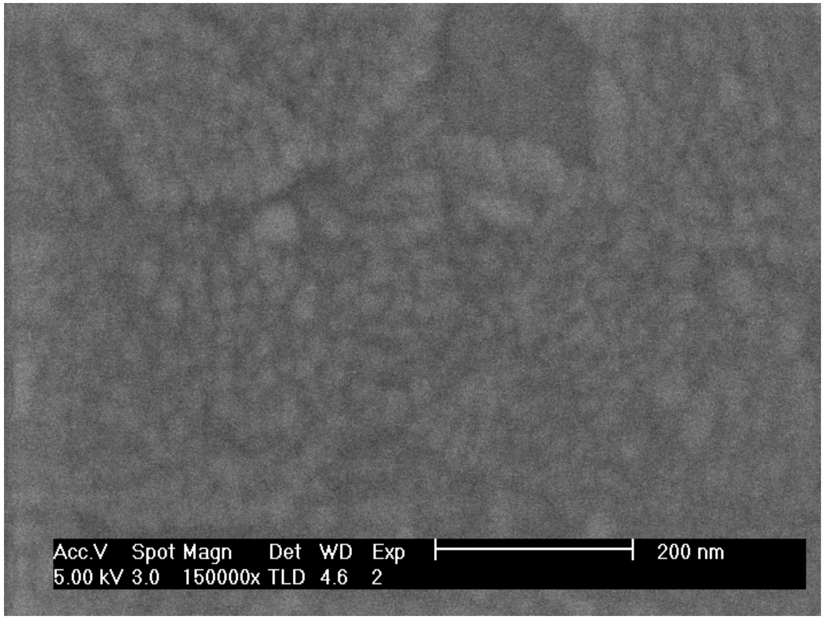
Orientation and coupling



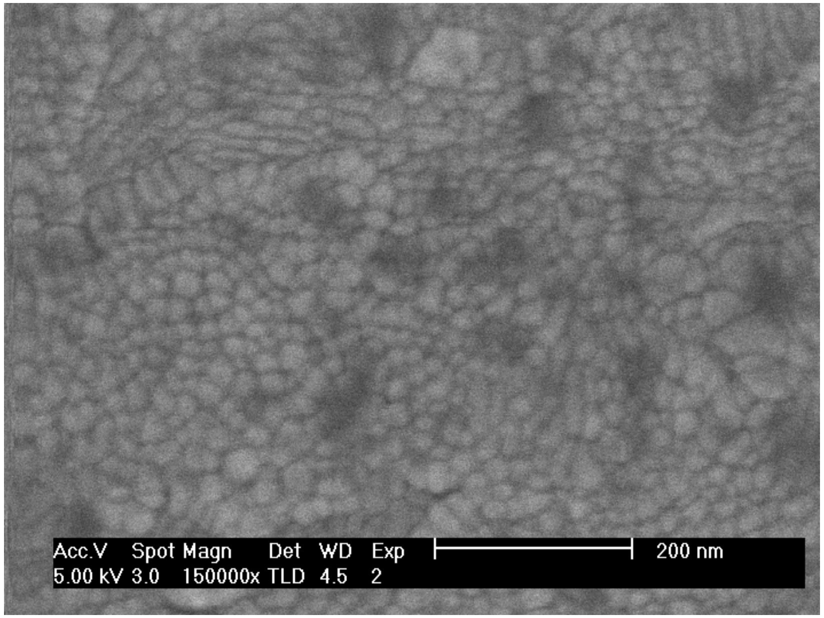
M. Kato, J. Am. Chem. Soc. 2013, 135, 10610−10613

Orientation and coupling

Scanning Electron Microscopy

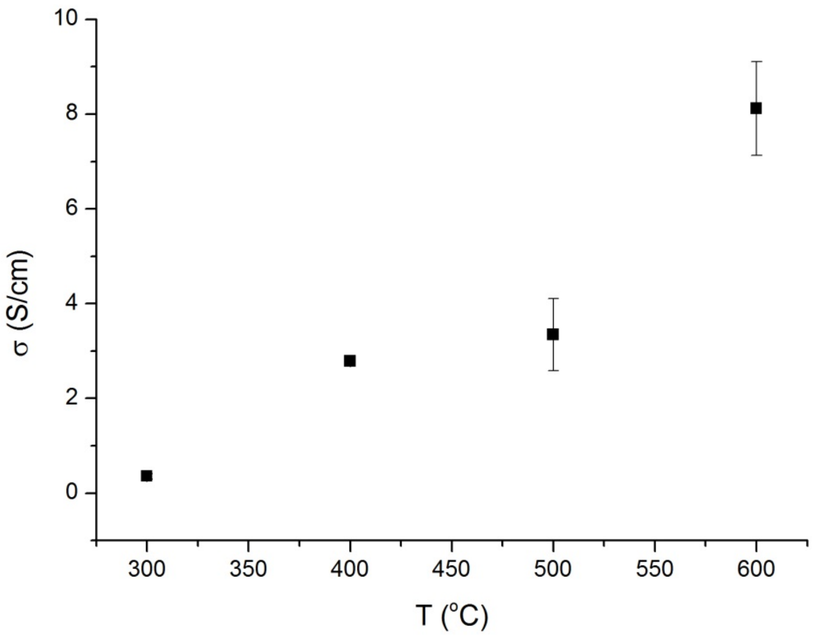


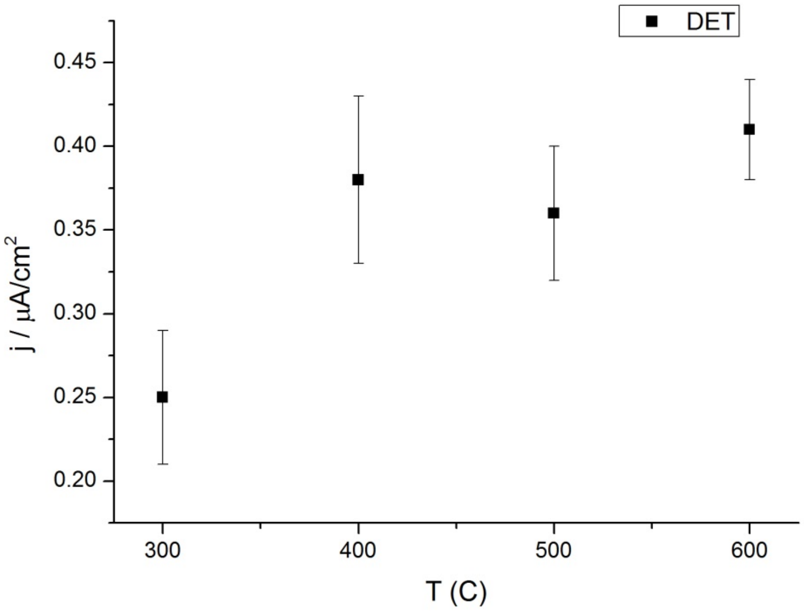
Bare ITO



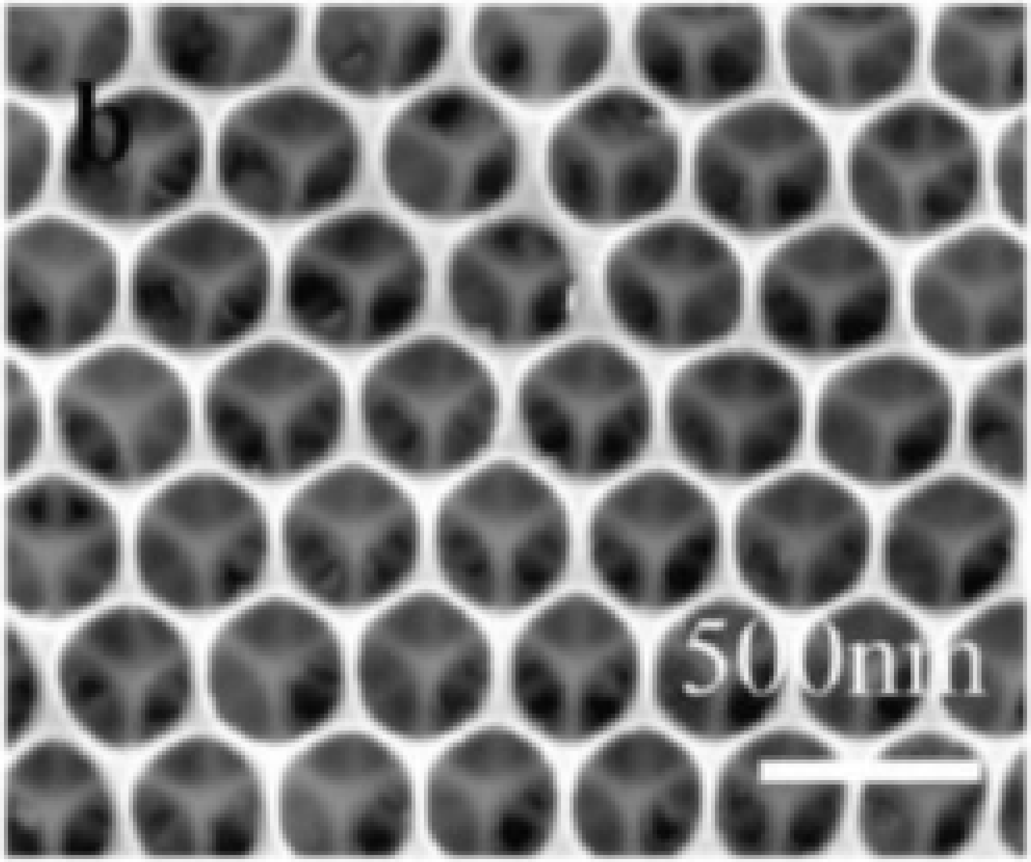
ITO with linked PSII

Conductivity of the substrate



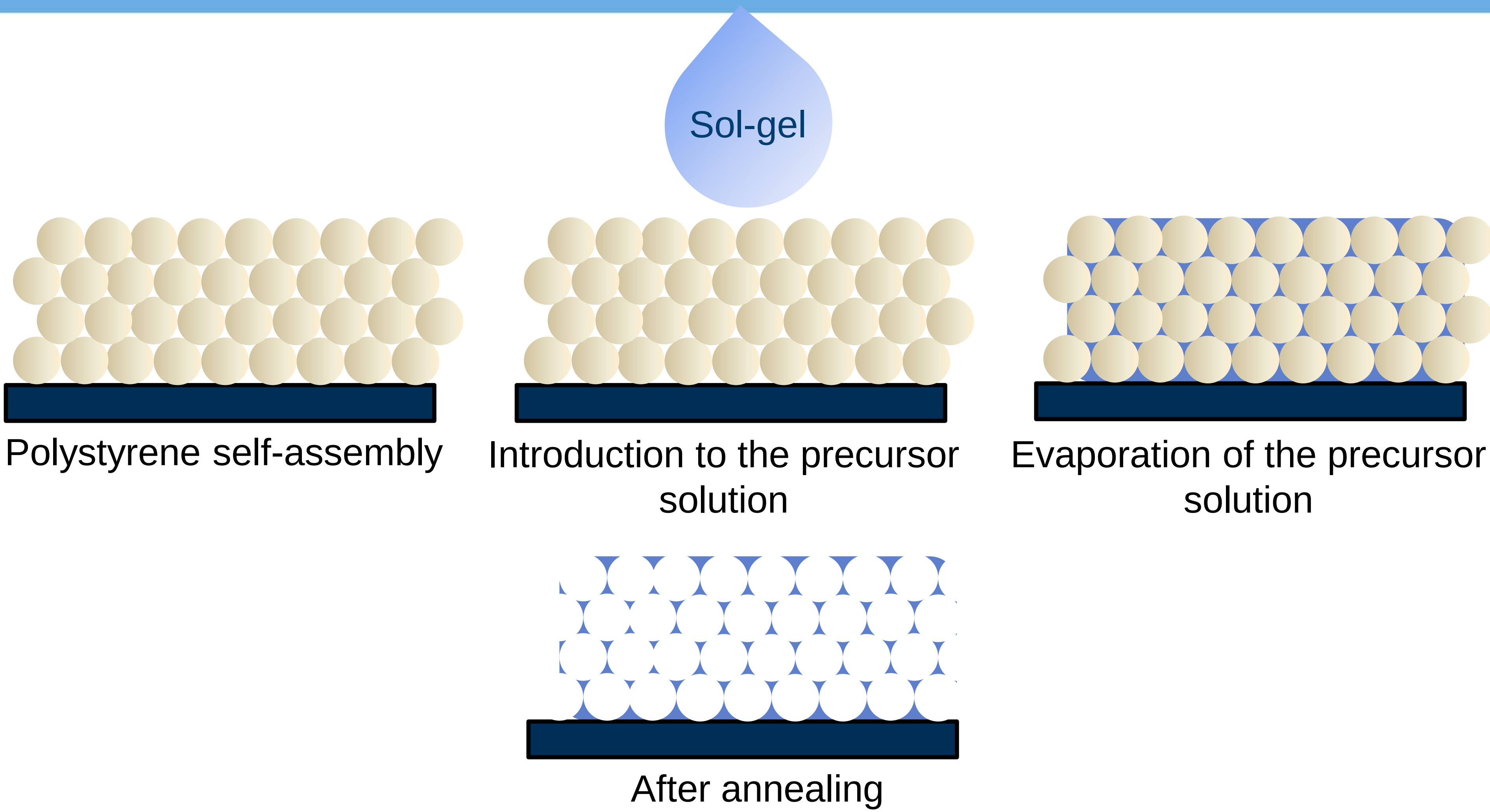


Amount of PSII adsorbed

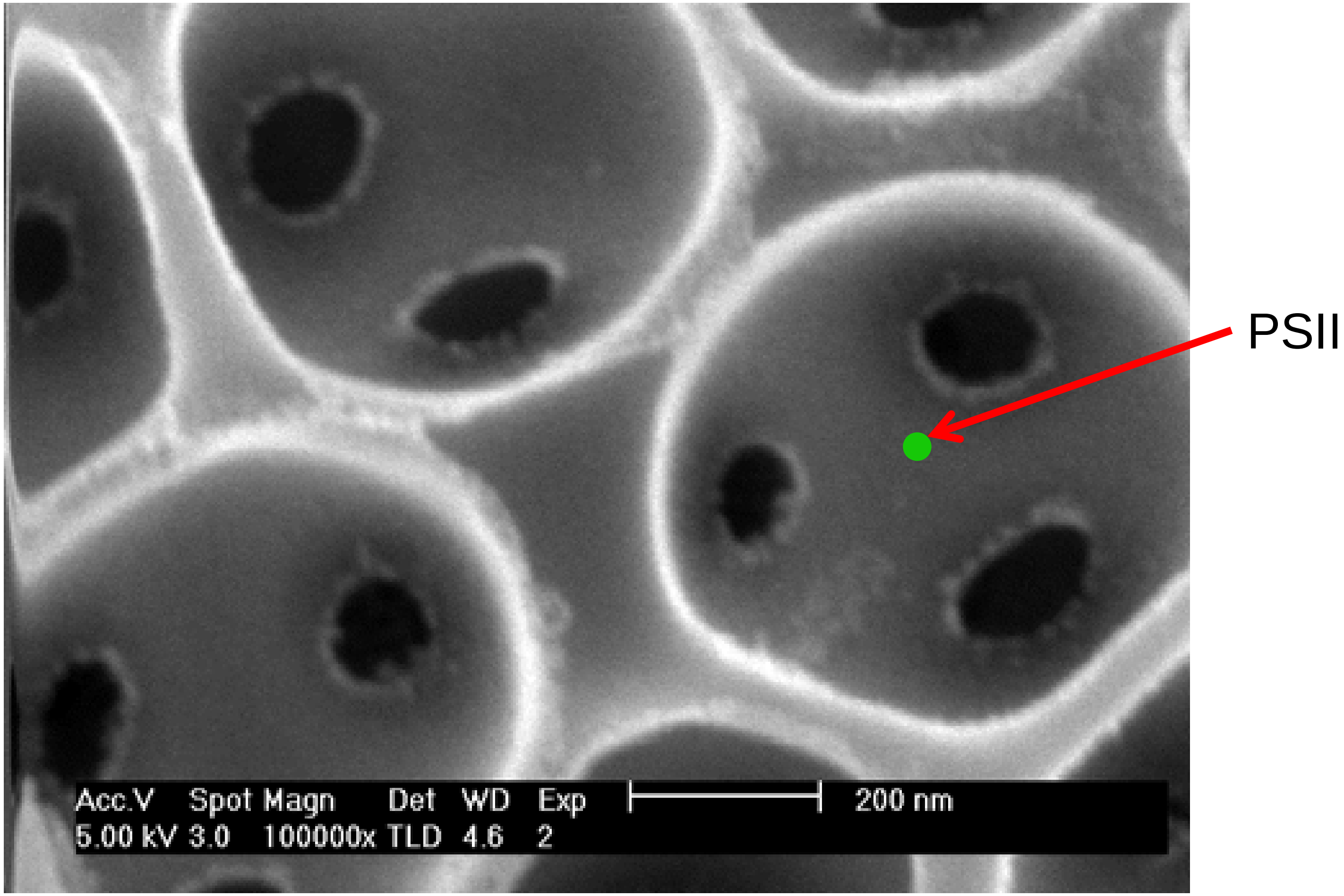


Zhenzhen Yang and Shanmin Gao, 2011

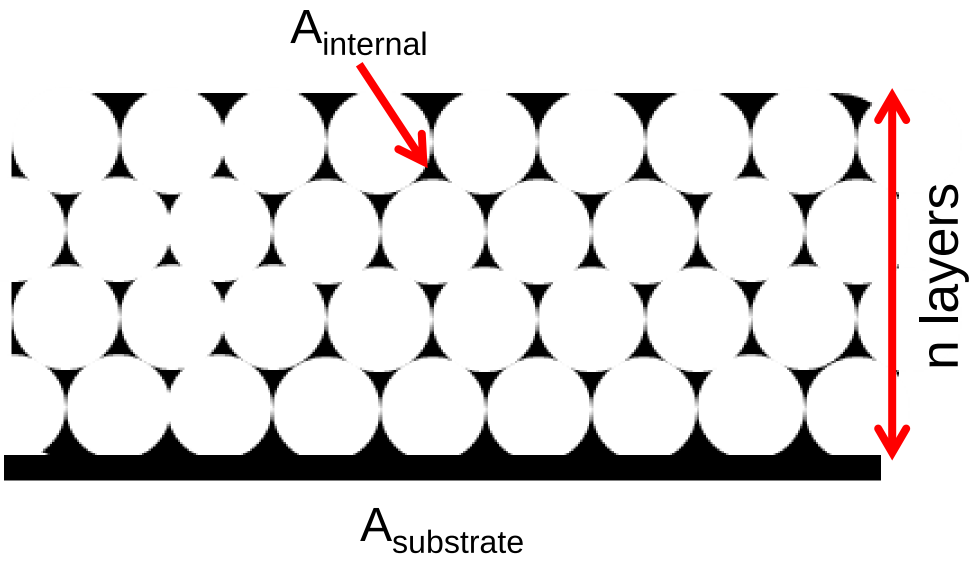
Amount of PSII adsorbed



Amount of PSII adsorbed



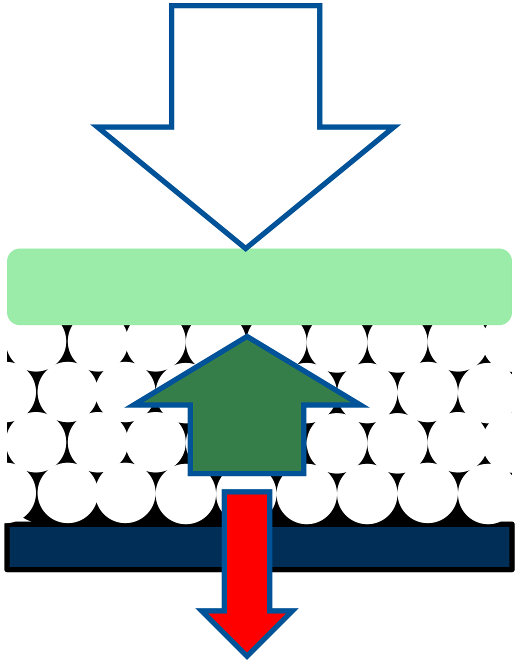
Amount of PSII adsorbed

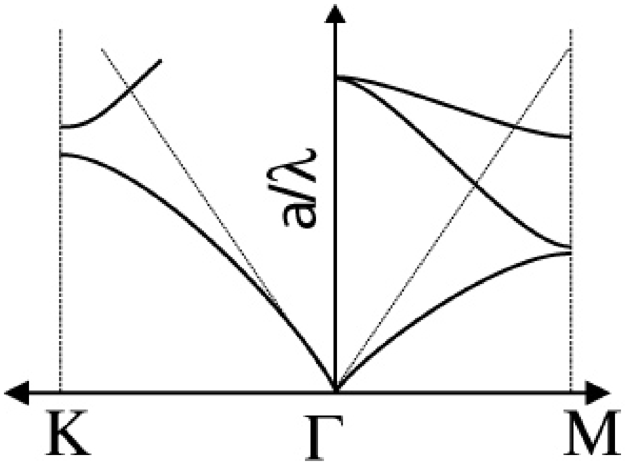


…boring math…

$A_{internal}/A_{substrate} \approx 3.5 \times n$

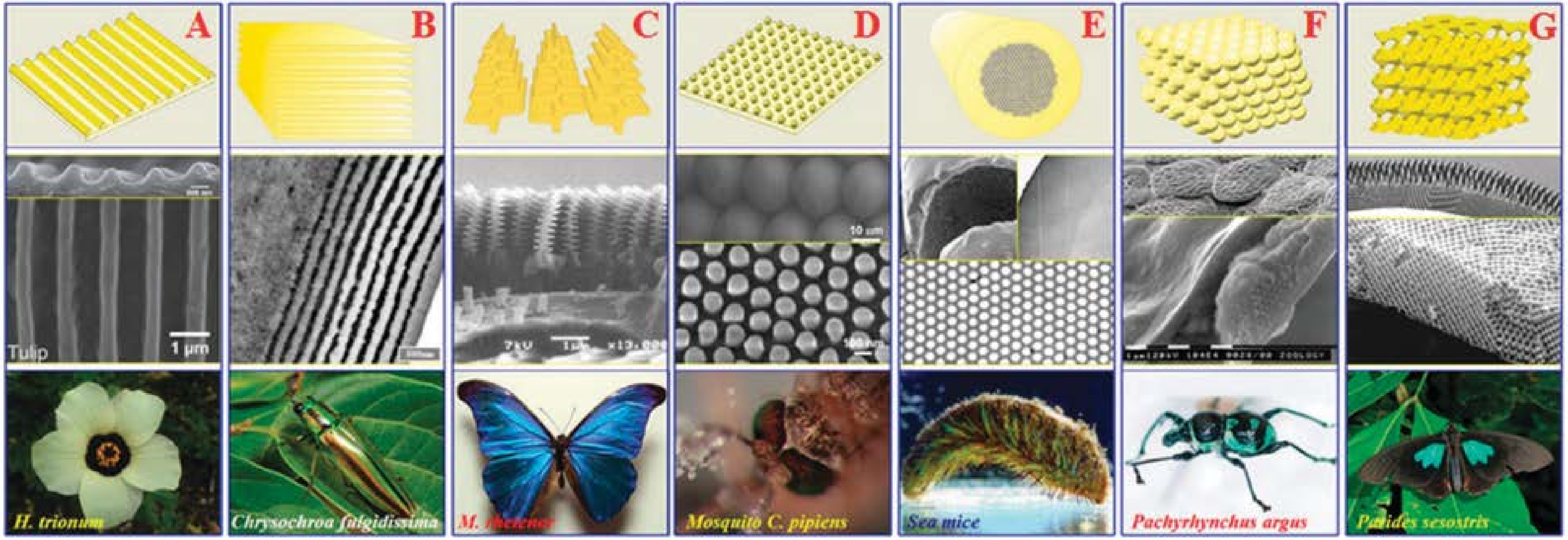
Photonic effect





Photonic effect

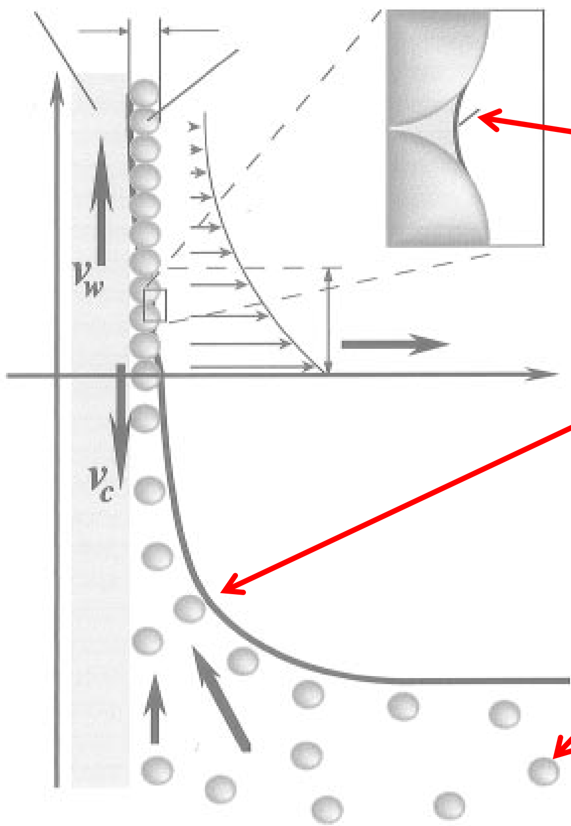
Nature



Yuanjin Zhao et. al. 2012

Polystyrene beads self-assembly

Method I: Vertical deposition



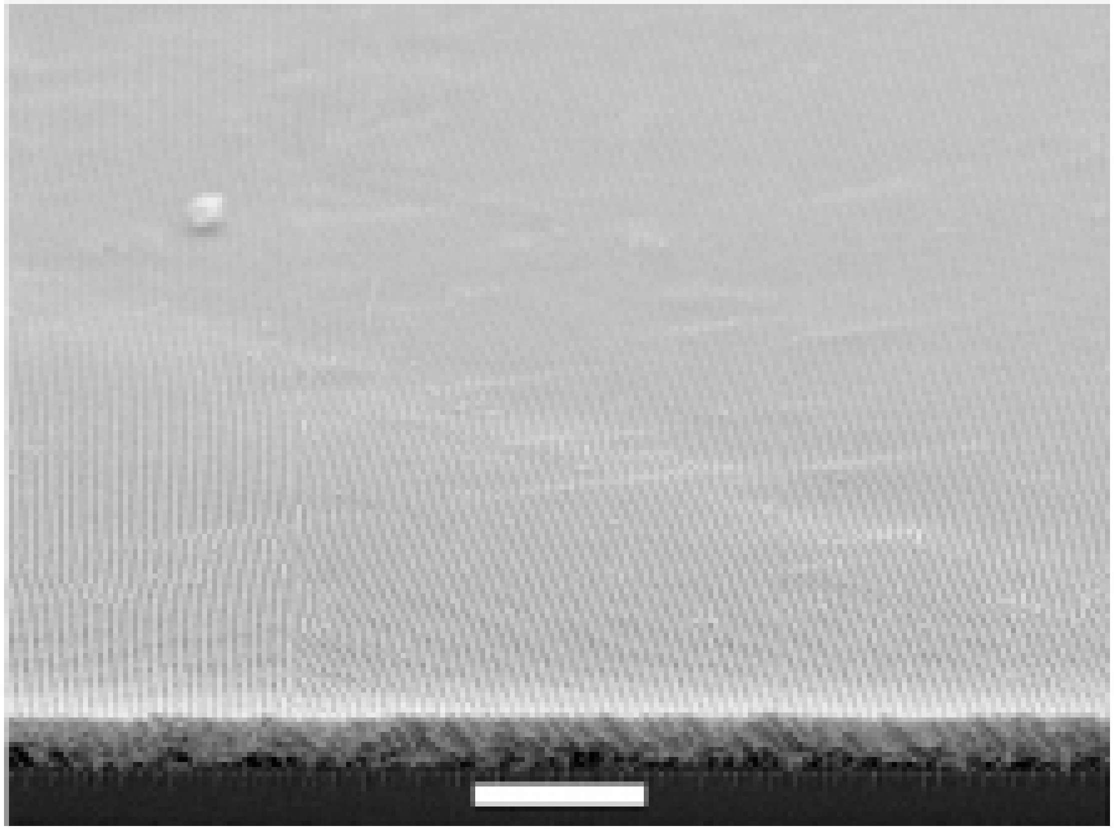
Dimitrov *Langmuir* **1996,** *12,* 1303-1311

<u>Three main forces:</u>

- Capillary force
- Convection force
- Flotation force

Polystyrene beads self-assembly

Method I: Vertical deposition

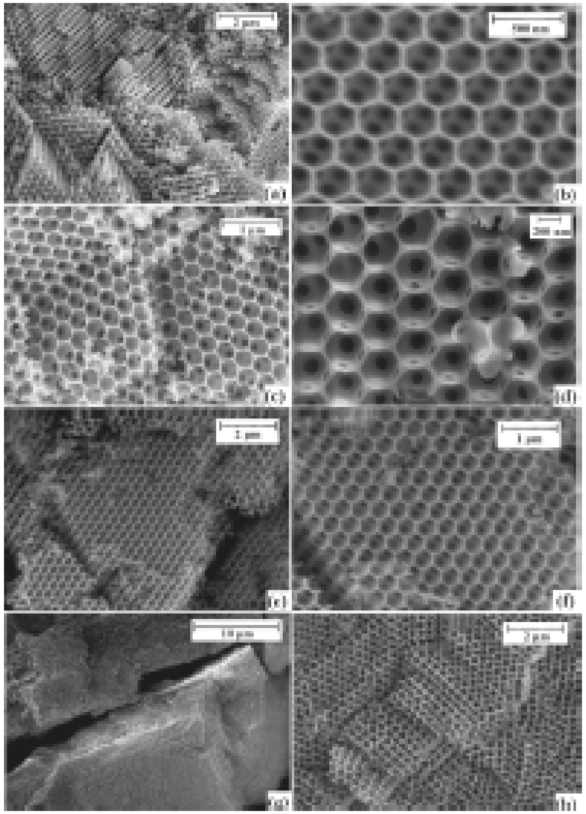


Hatton et al. 2010

Polystyrene beads self-assembly

Method II: Impregnation

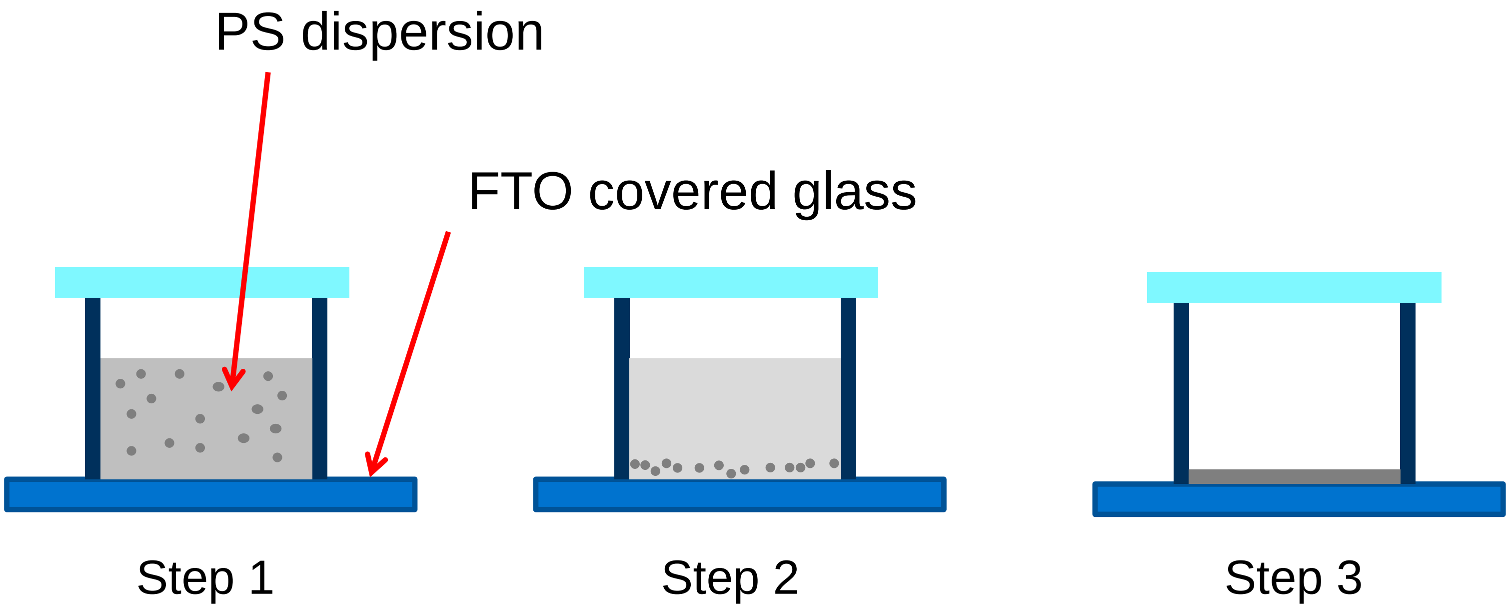
- High speed centrifugation
- Centrifugal forces drives the self-assembly
- Not ordered on the large scale



Xiaoqing Chen et al. 2010

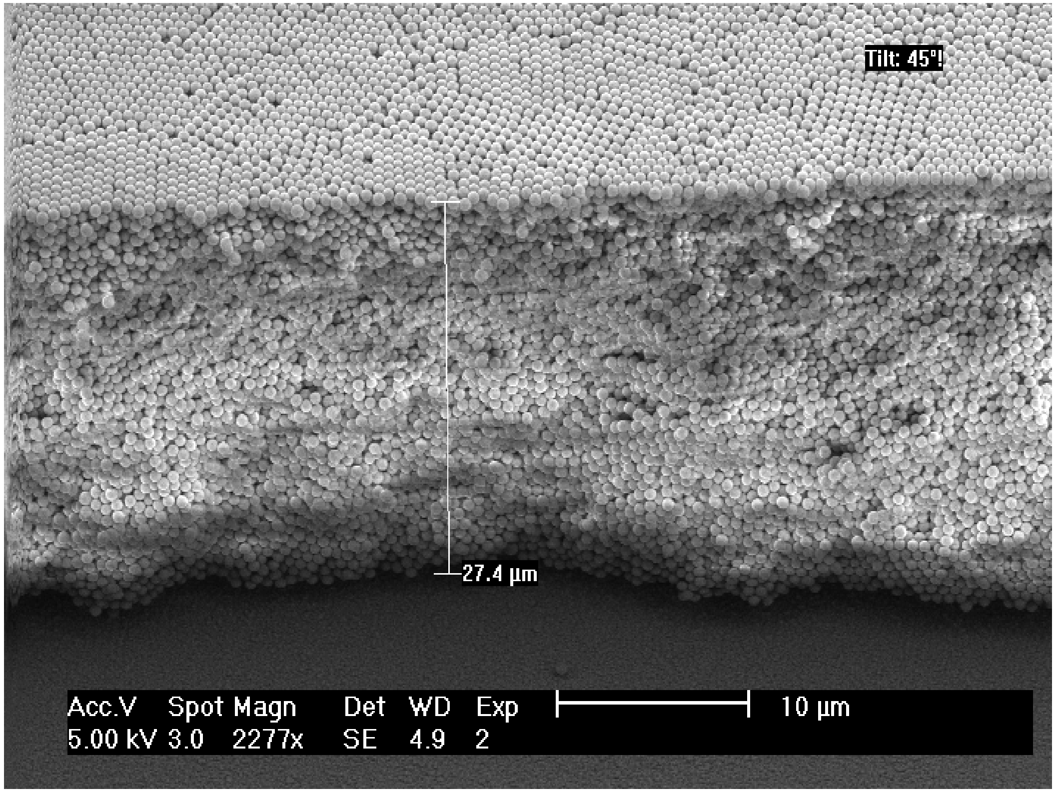
Polystyrene beads self-assembly

Method III: Sedimentation



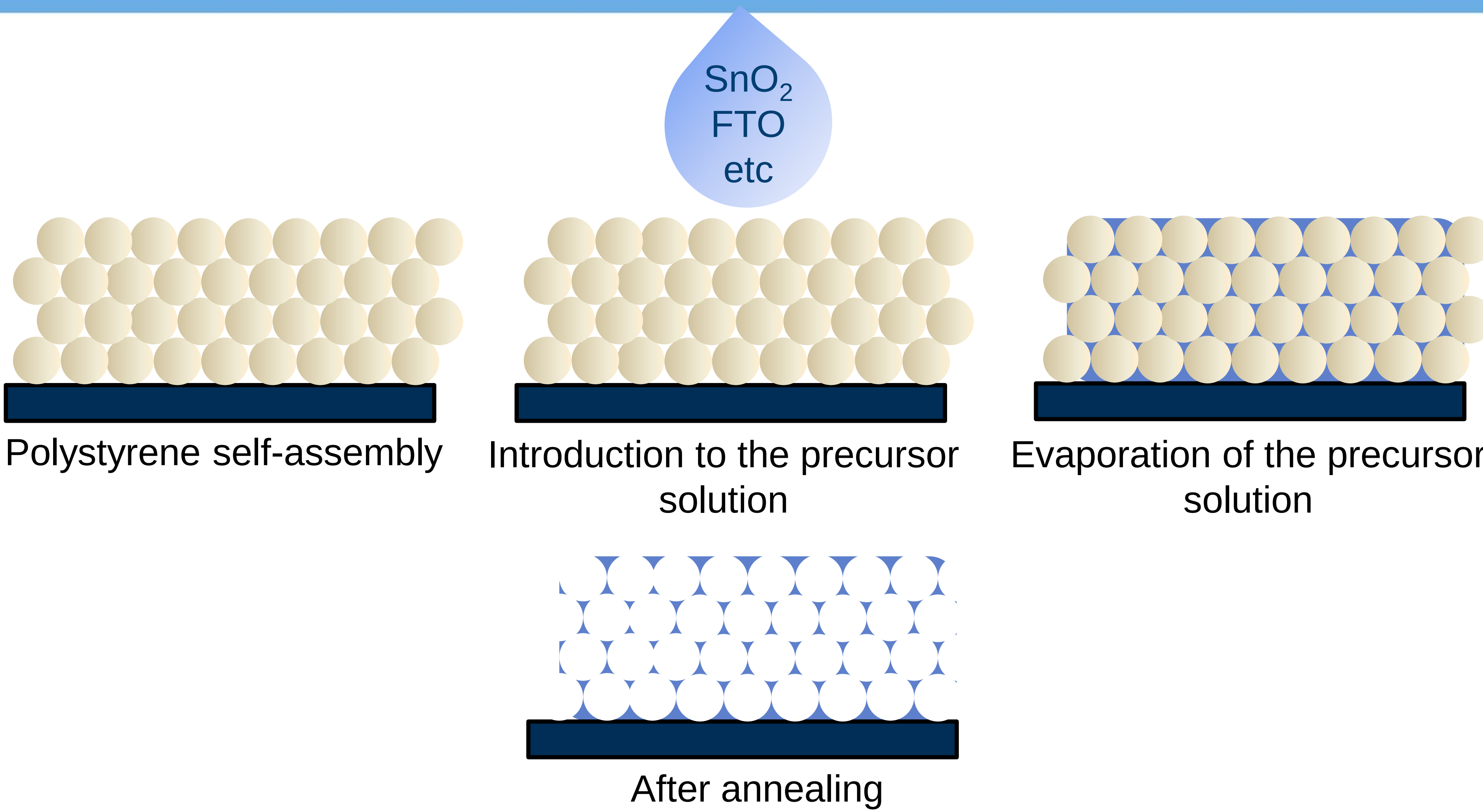
Polystyrene beads self-assembly

Method III: Sedimentation



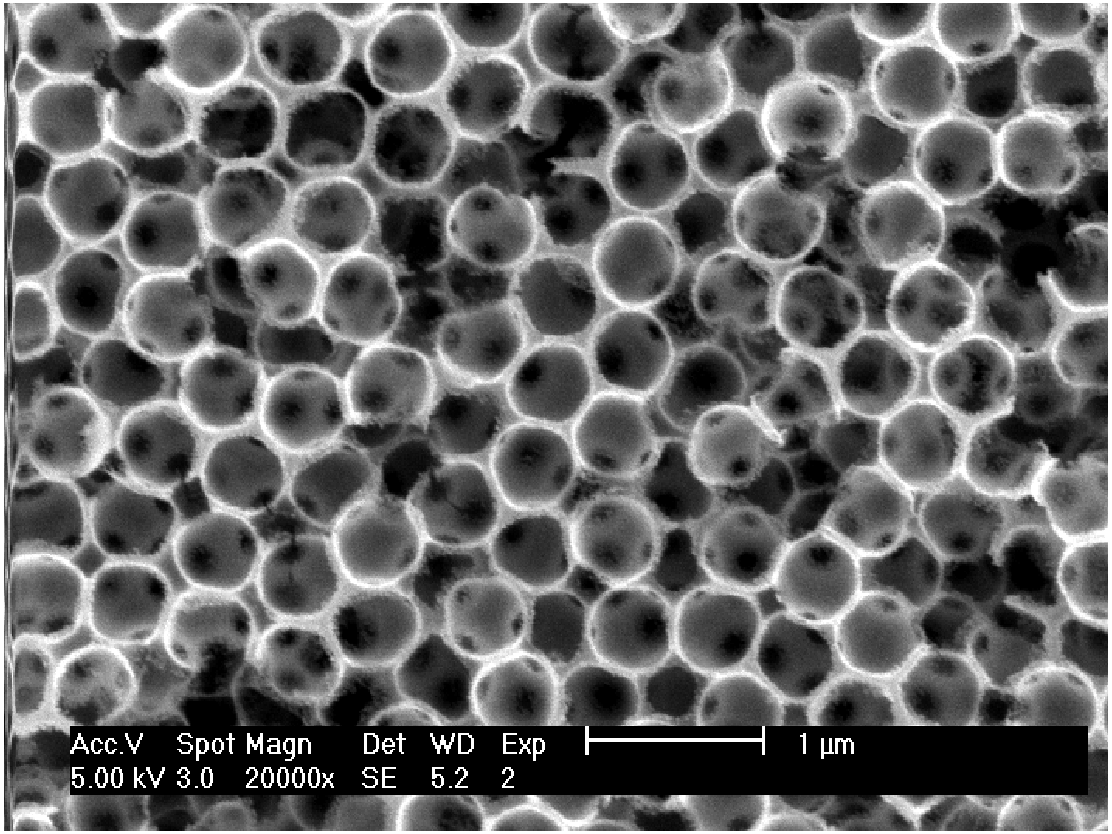
~50 layers

Amount of PSII adsorbed



Amount of PSII adsorbed

- Large loadings
- High currents
- Enhancement of light harvesting potential



Summary

Cheap, scalable

Acknowledgement

Thank You!