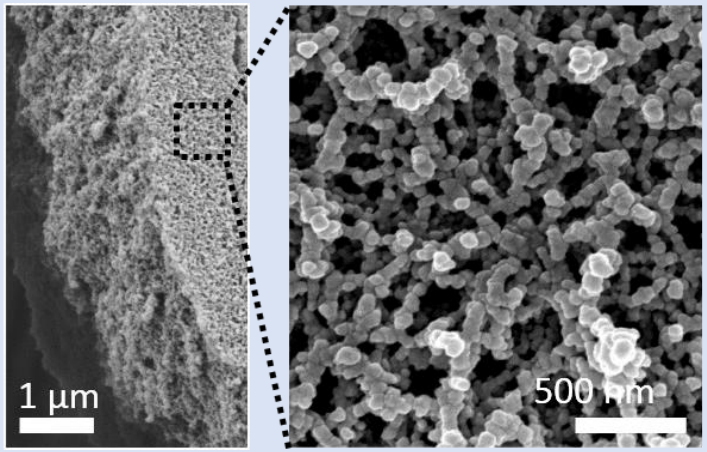
3D metallic networks – A new class of materials



Adi Salomon

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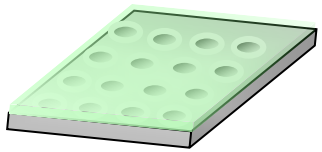
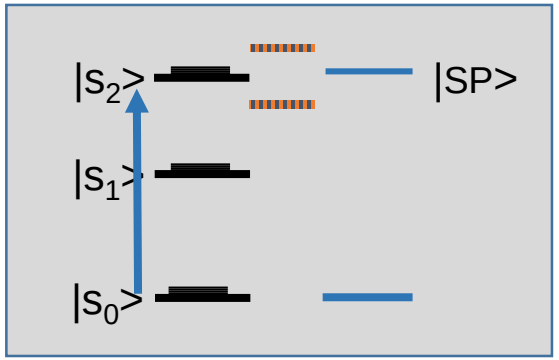
Bilbao 2018

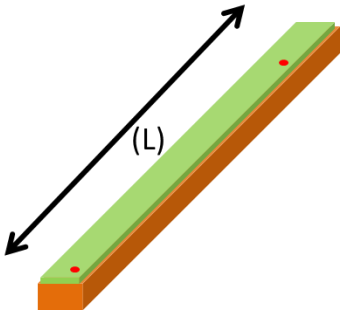
Bar-Ilan University

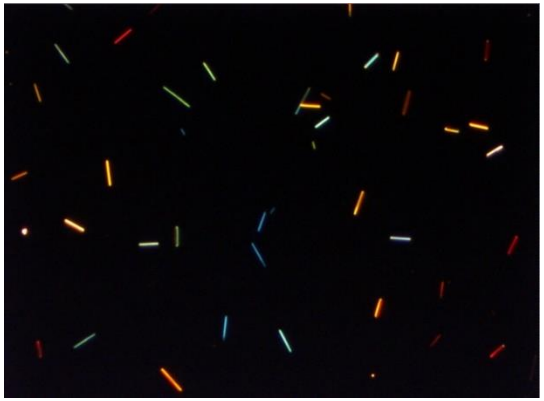
Motivation :
Light Matter Interaction @Nano Scale

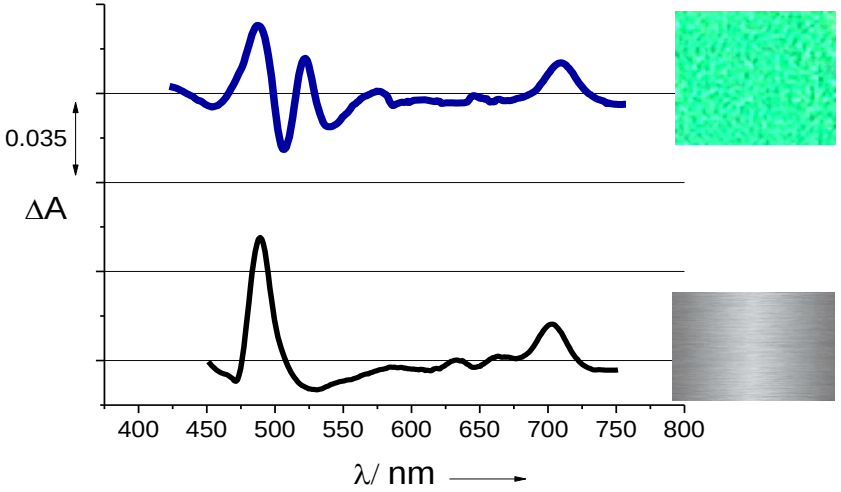


- Hybrid photonic materials
- Photochemistry/ photo-catalysis
- Long Rang Energy transfer
- Strong coupling / C-dots







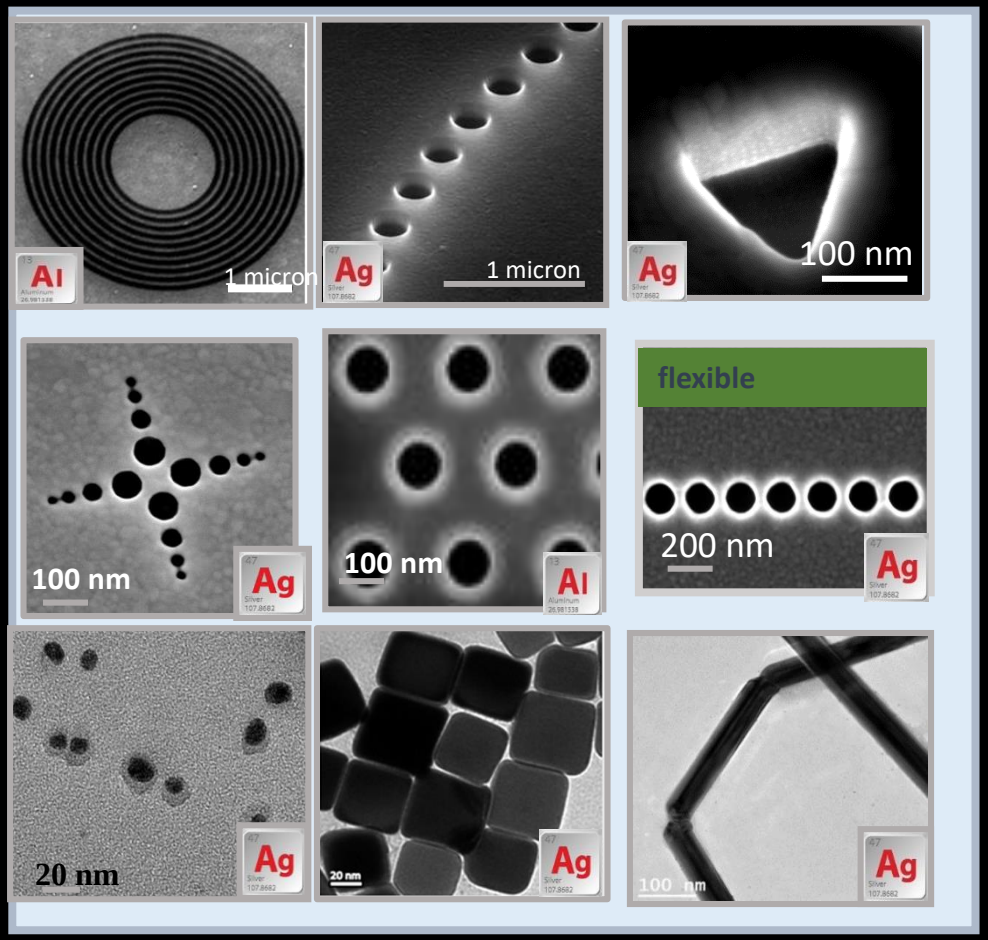


Phys. Rev. Lett. 109, 73002 **2012**.

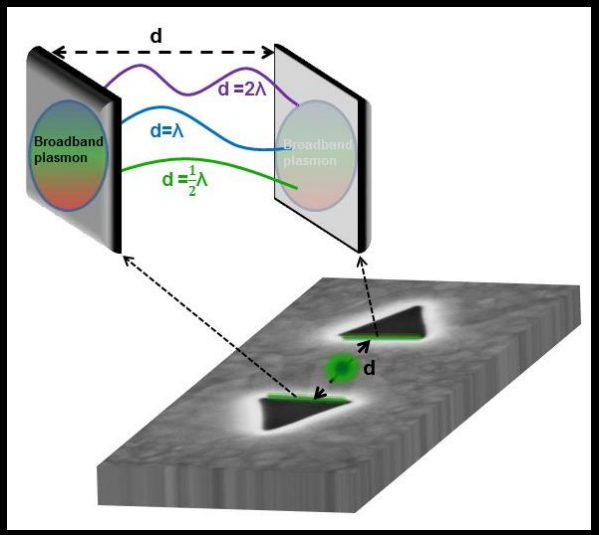
The journal of physical chemistry letters 8 (24), 6080-6085, 2017

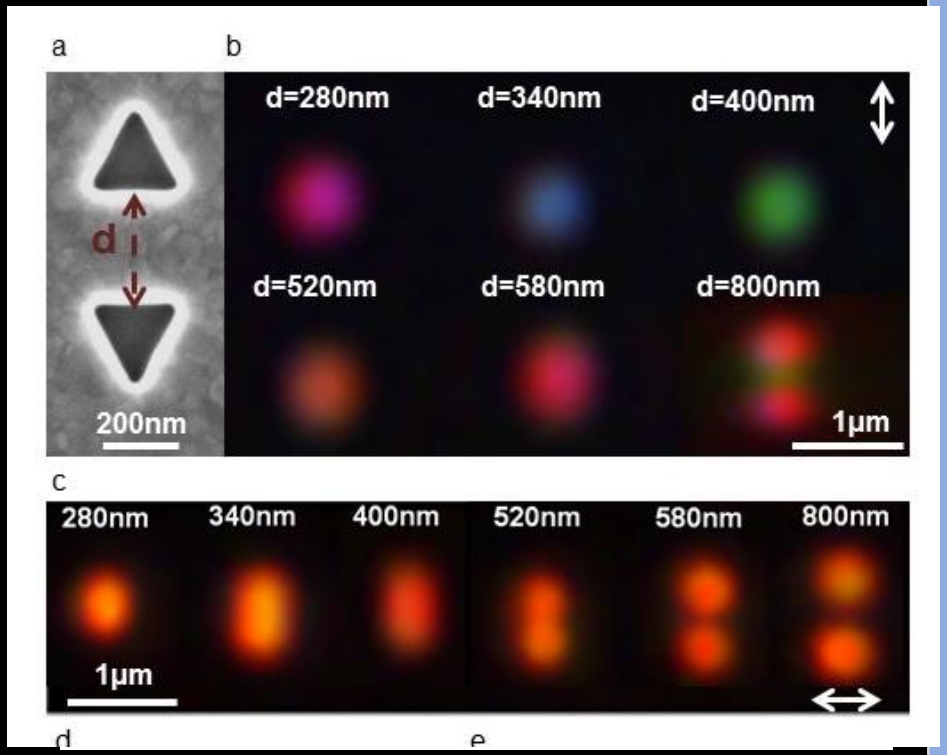
Angew. Chem. Int. Ed. **2009**, 48, 1-5

Well defined Metallic Nano Structures



Confinement of light onto a flat surface/interface



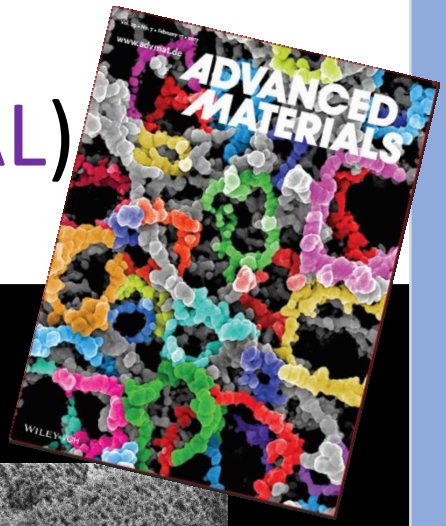


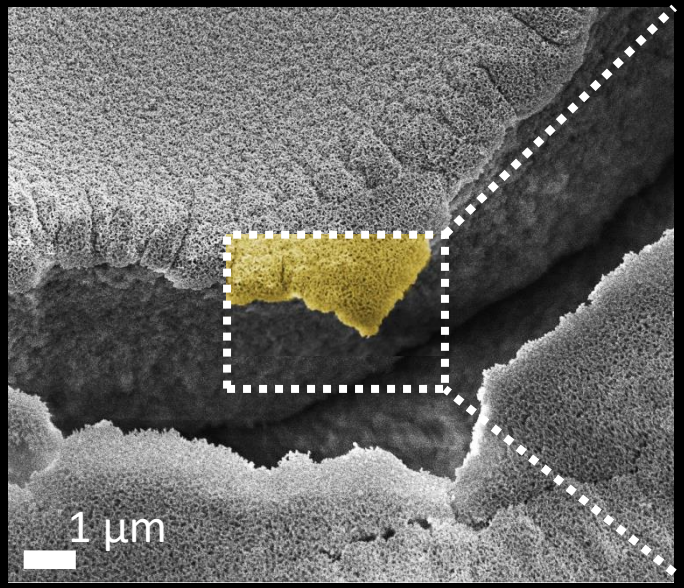
- *A. Weissman, M. Galanty, D. Gachet, E. Segal, O. Shavit and A. Salomon Advanced optical Materials, 2017*

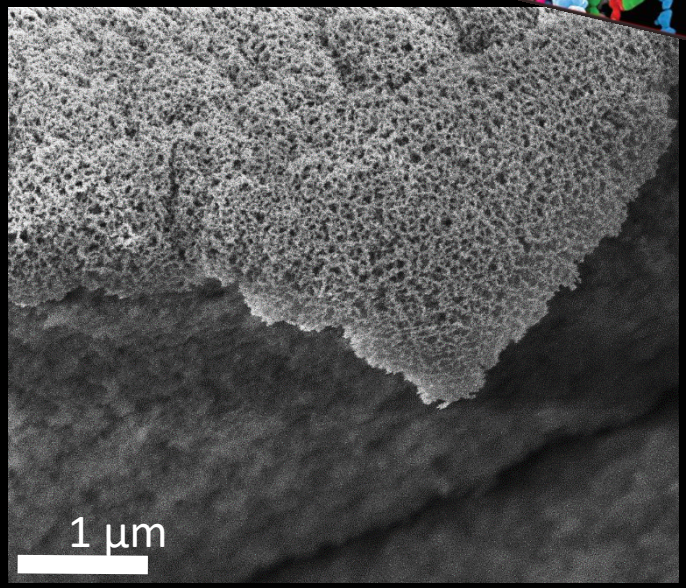
But…

* In corals light is diffusively scattered enabling symbiotic algae to capture a large fraction of photons and optimize subaquatic photosynthetic energy production.

3D Metallic Network (NetAL)





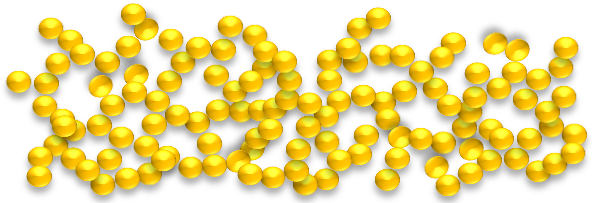


large scale 3D Metallic electrode / huge surface area

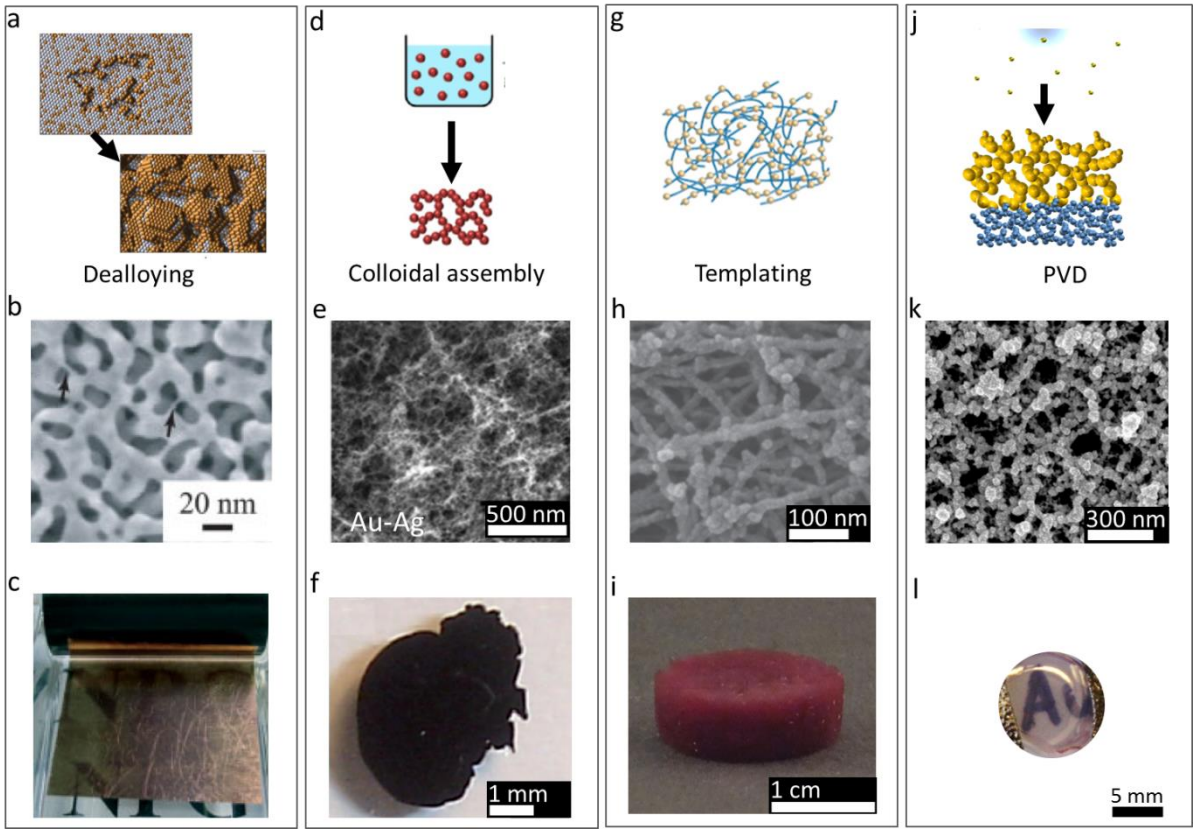
Ron, R. et al. Advanced Materials 2017

Why?

- Very high surface area – **Catalysis/ photo-catalysis**
- Light transparent metal
- Metamaterials
- Electrodes for batteries
- Both localized and propagating surface Plasmons
- optical sensing, photovoltaics, LEDs, nonlinear optics, thermo-electrics, field-emission.
- **Scalable**

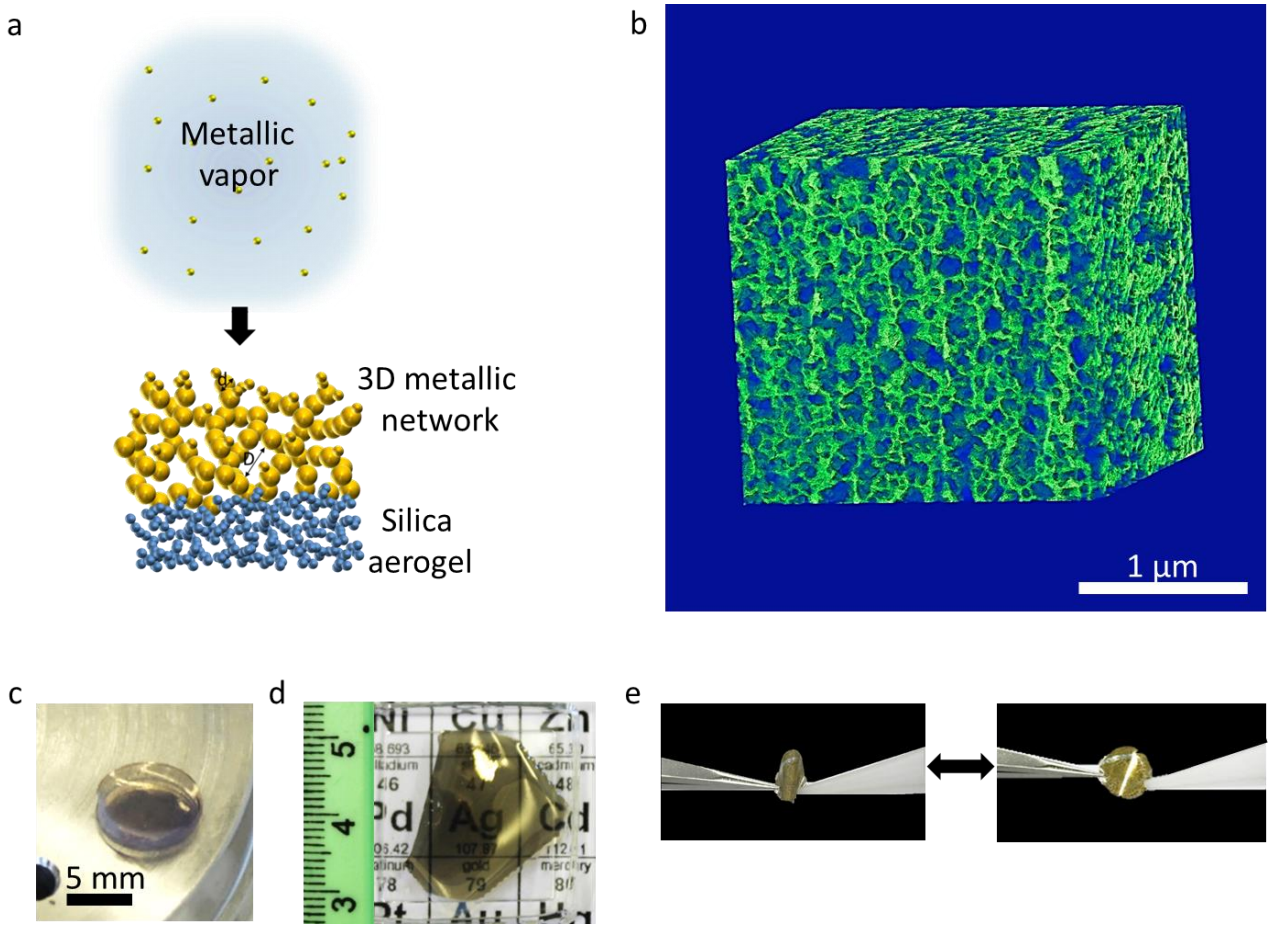


Strategies for preparation of large-scale disordered nanoporous metals



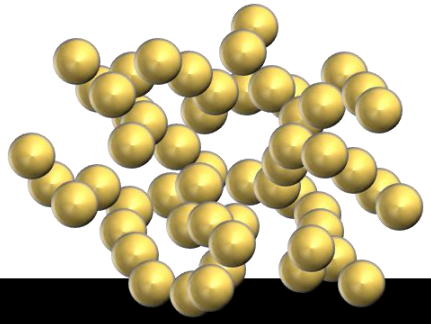
Ron, R. Haleva, E. and Salomon A. Advanced Materials 2018 (progress Review, accepted)

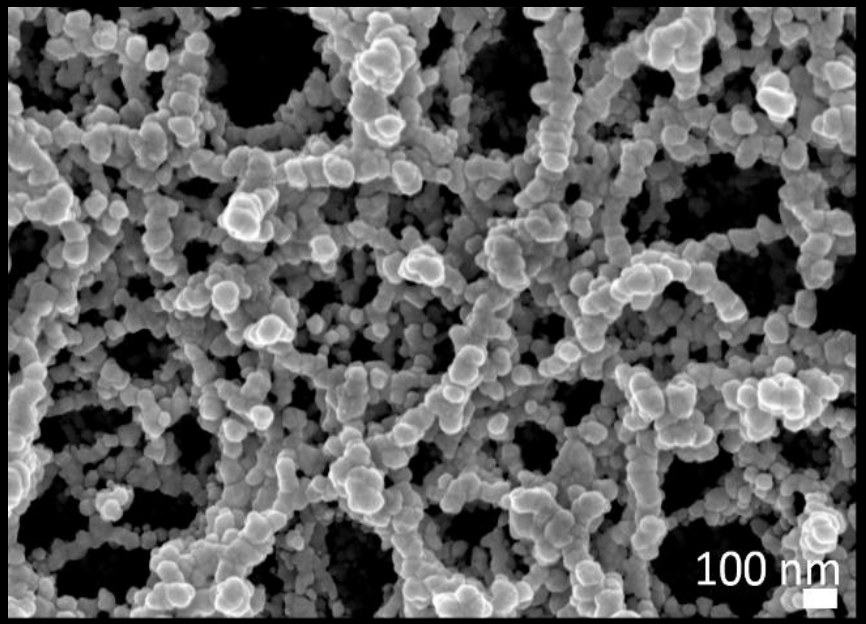
Our new developed strategy -PVD

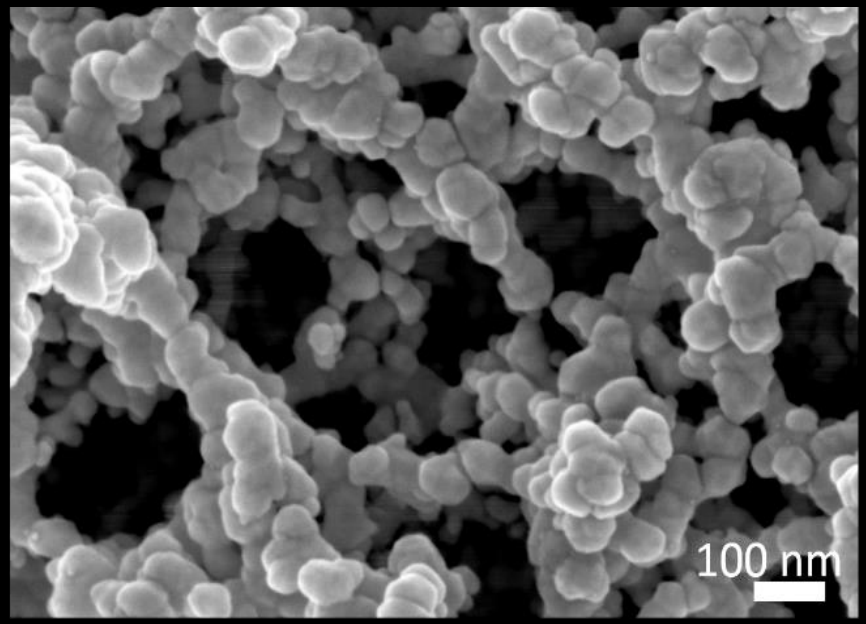


Ron, R. Gachet, D. Racav K. and Salomon A. *Advanced Materials* 2017, *29,* 1604018

3D Metallic network



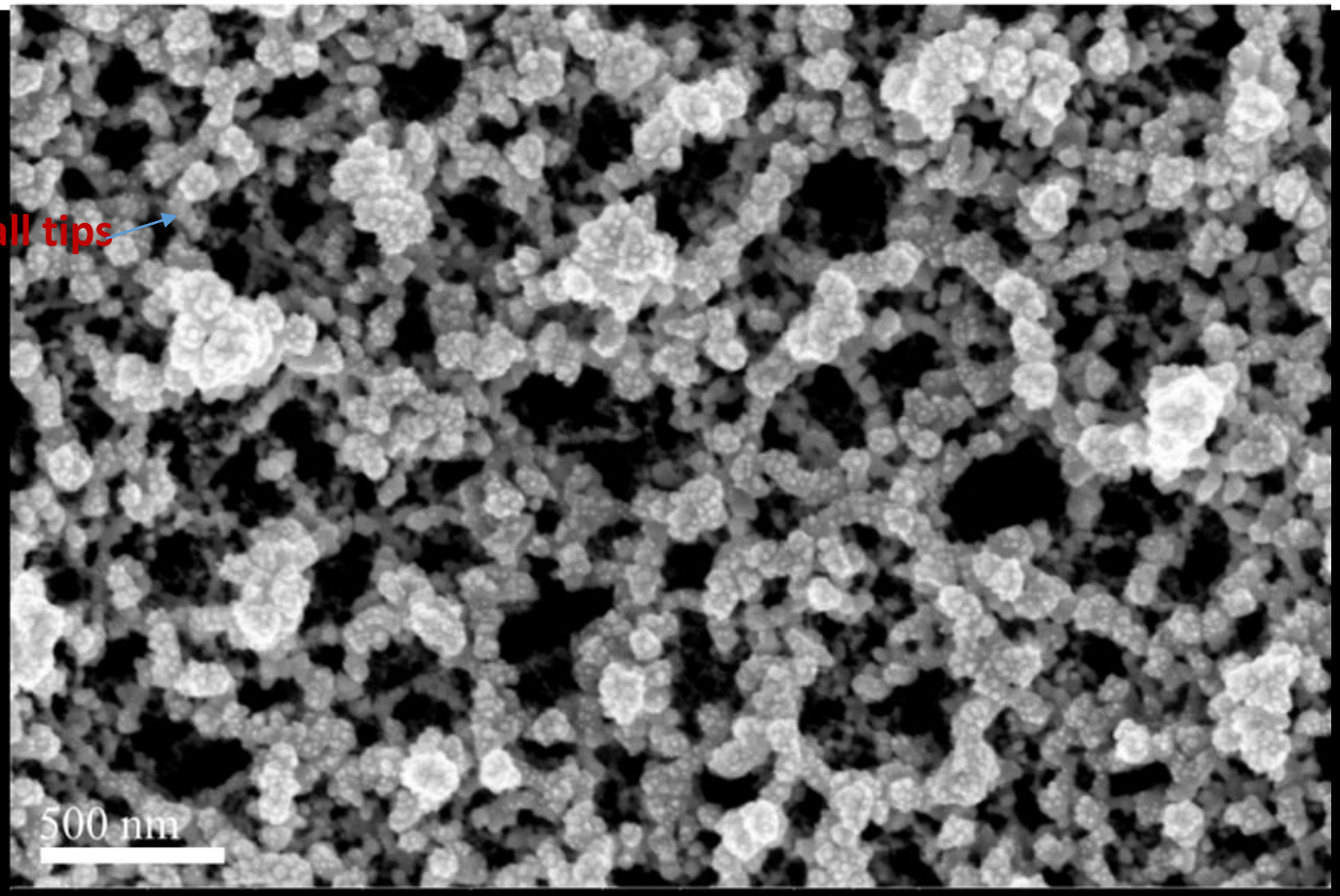




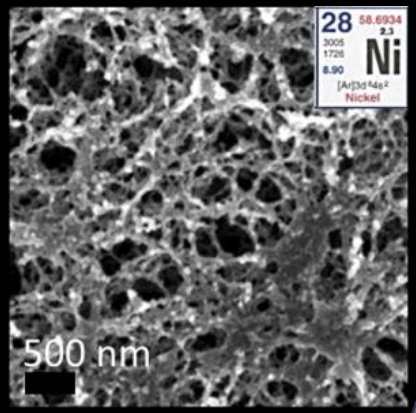
Multisizes of holes and particles – large pores for molecular transport

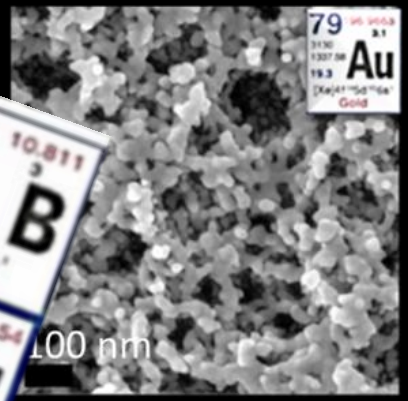
Ron, R. Gachet, D. Racav K. and Salomon A. *Advanced Materials* 2017, *29,* 1604018

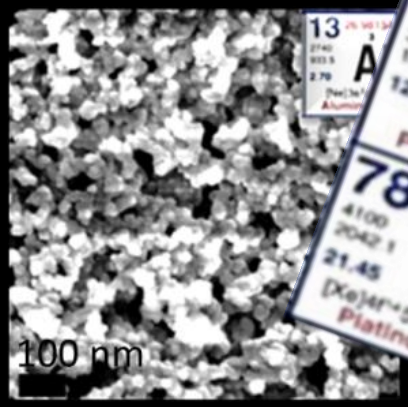
3D Metallic Network

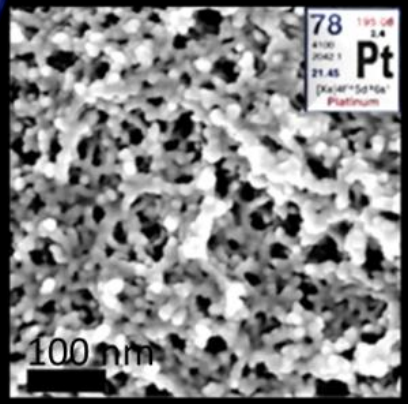


Gallery of porous metals





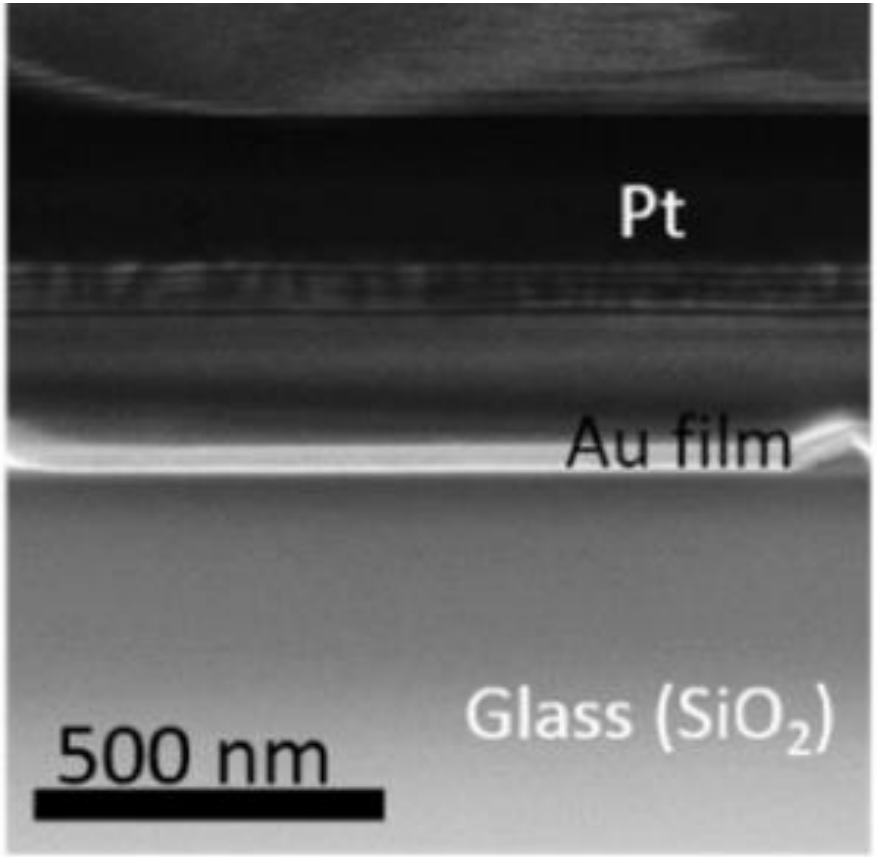


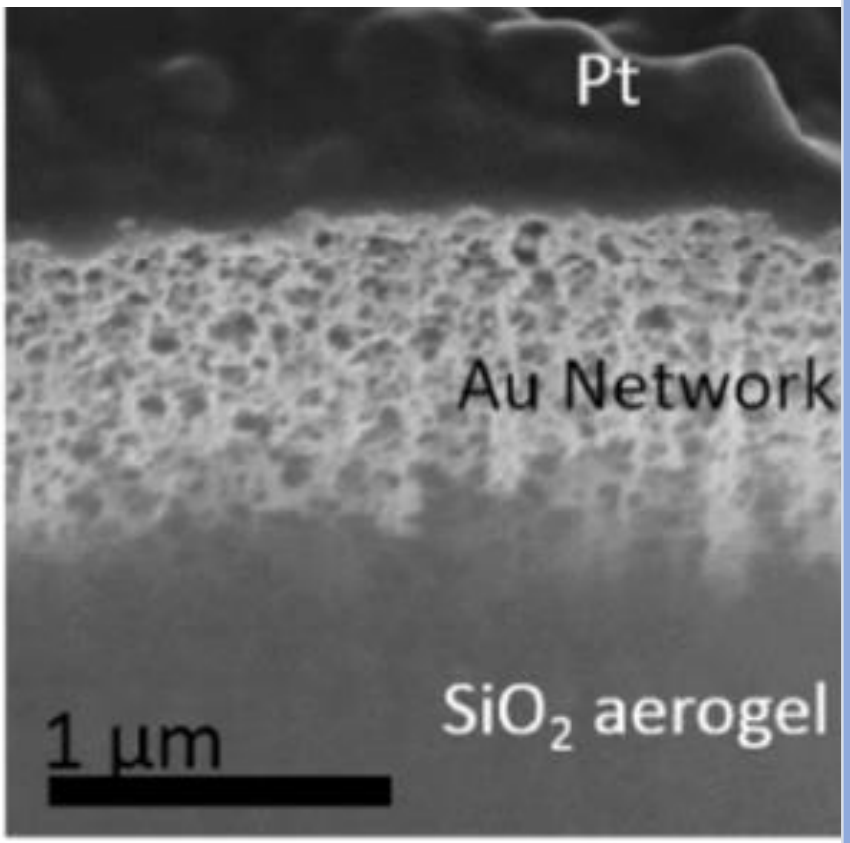


How does it work ?

R. Ron, D. Gachet, K. Rechav, A. Salomon, *Adv. Mater.* **2017**, *29*, 1604018.

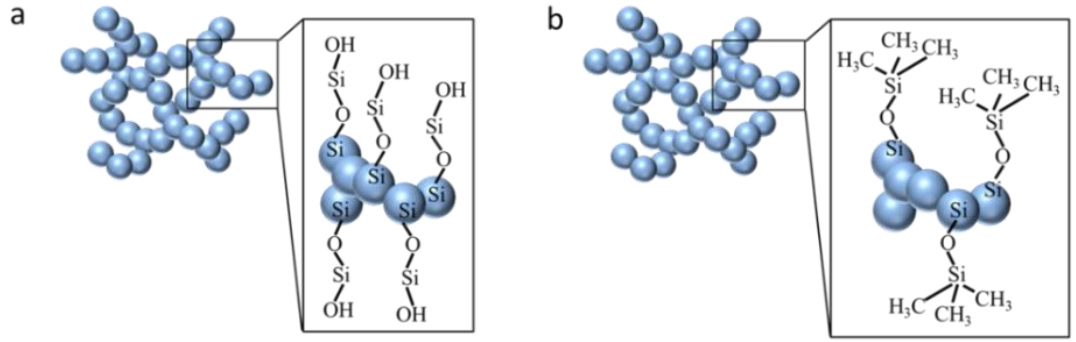
PVD On Different substrates

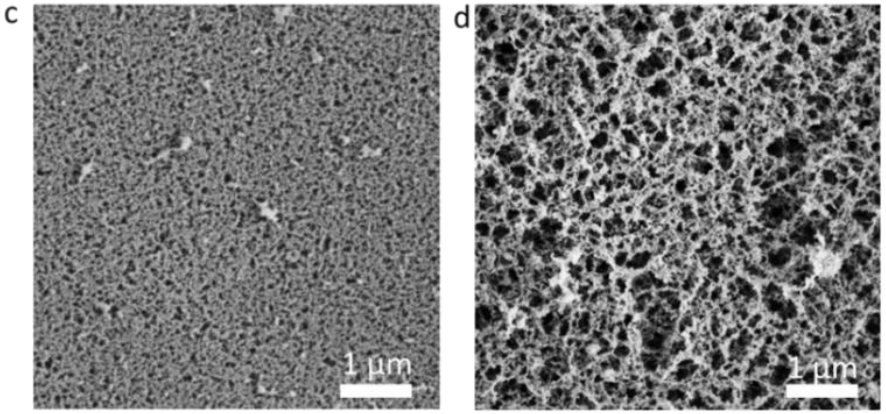




R. Ron, D. Gachet, K. Rechav, A. Salomon, *Adv. Mater.* **2017**, *29*, 1604018.

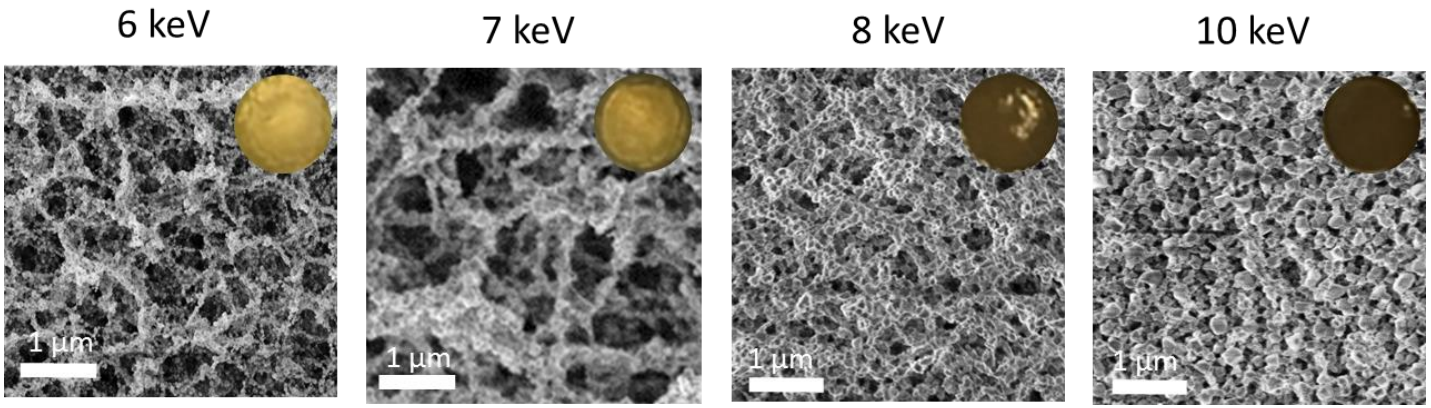
Controlling the building blocks size





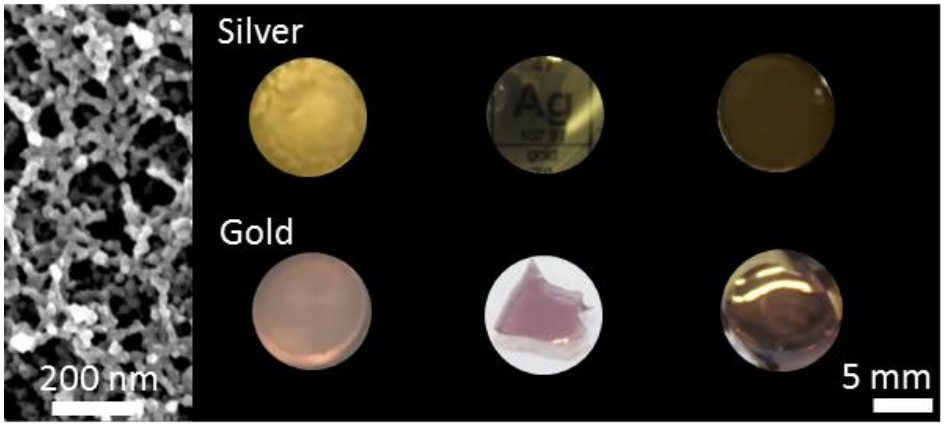
Effect of surface chemistry on the network growth

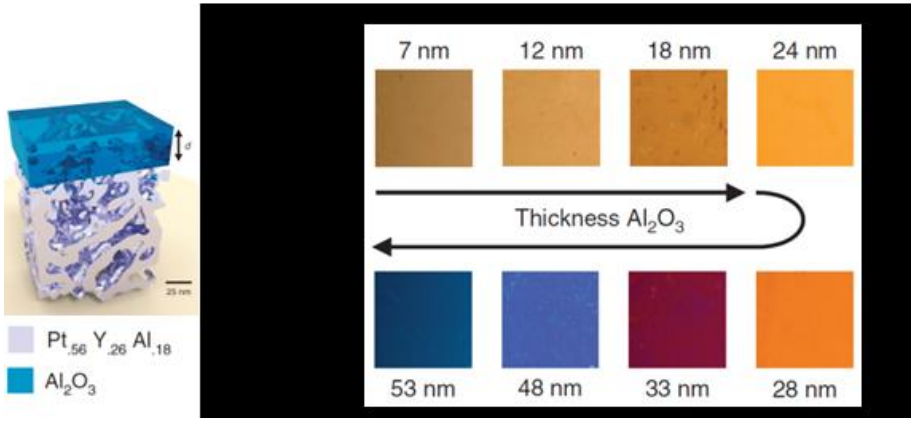
Controlling the building blocks size



Ron, R. Haleva E. and Salomon, A. *Growth mechanism of 3D metallic network using PVD (under preparation)*

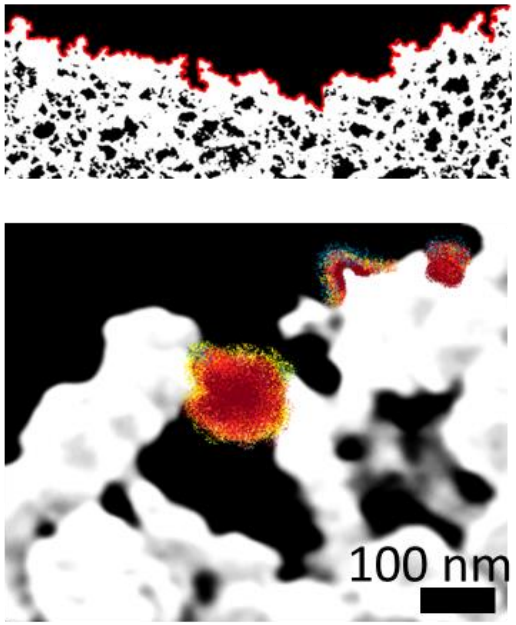
Metallic networks as Color Generators

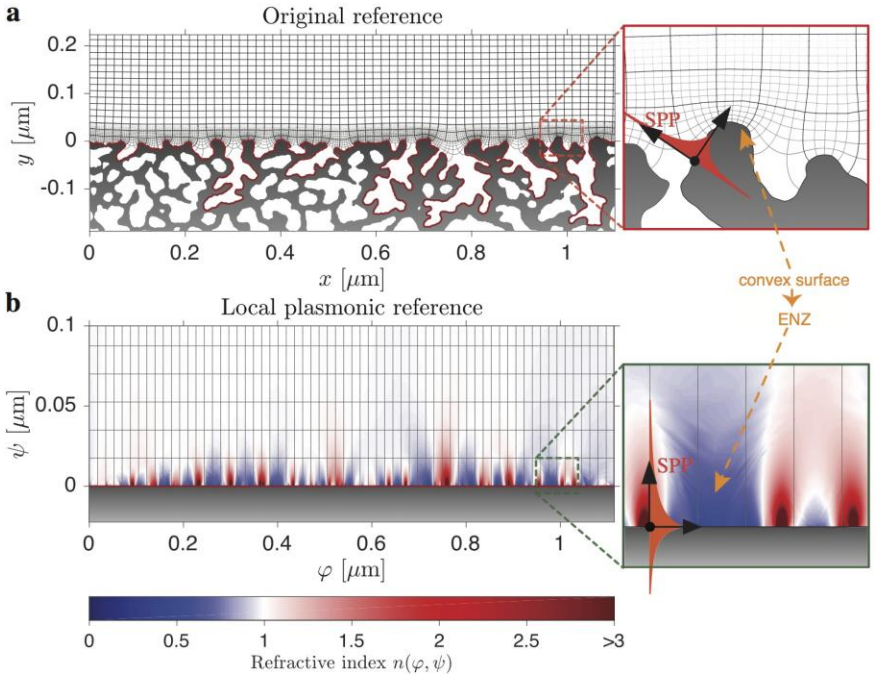




Light: Science & Applications (2017) 6, e16233; doi:10.1038/lsa.2016.233

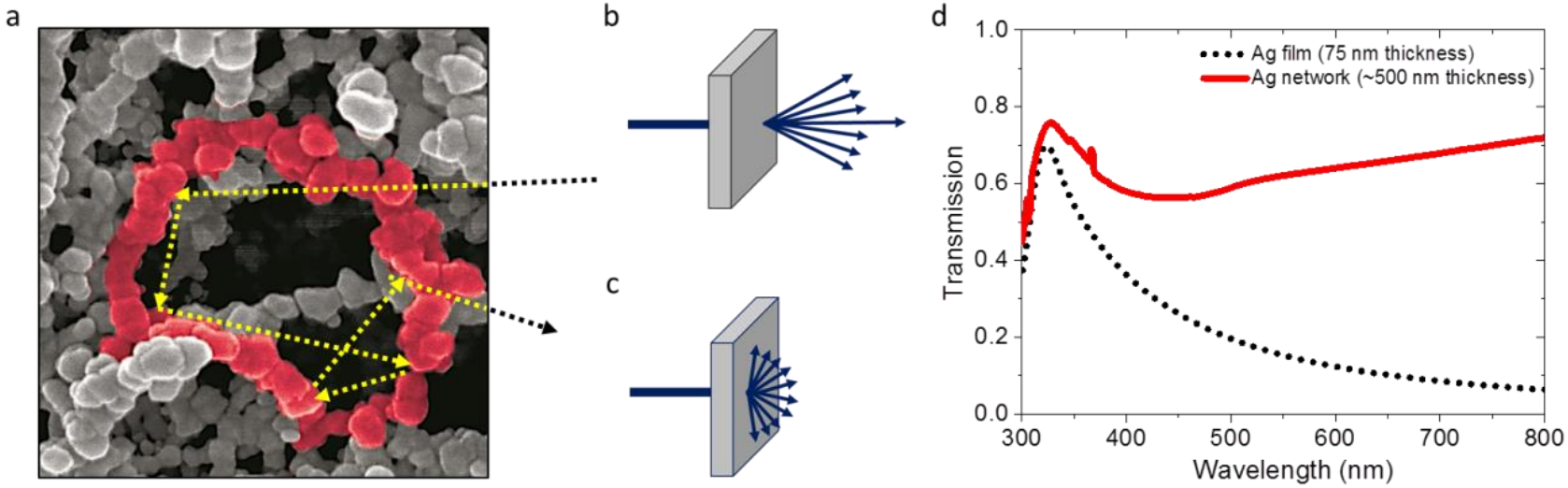
Modulation of the Refractive Index at the submicron scale





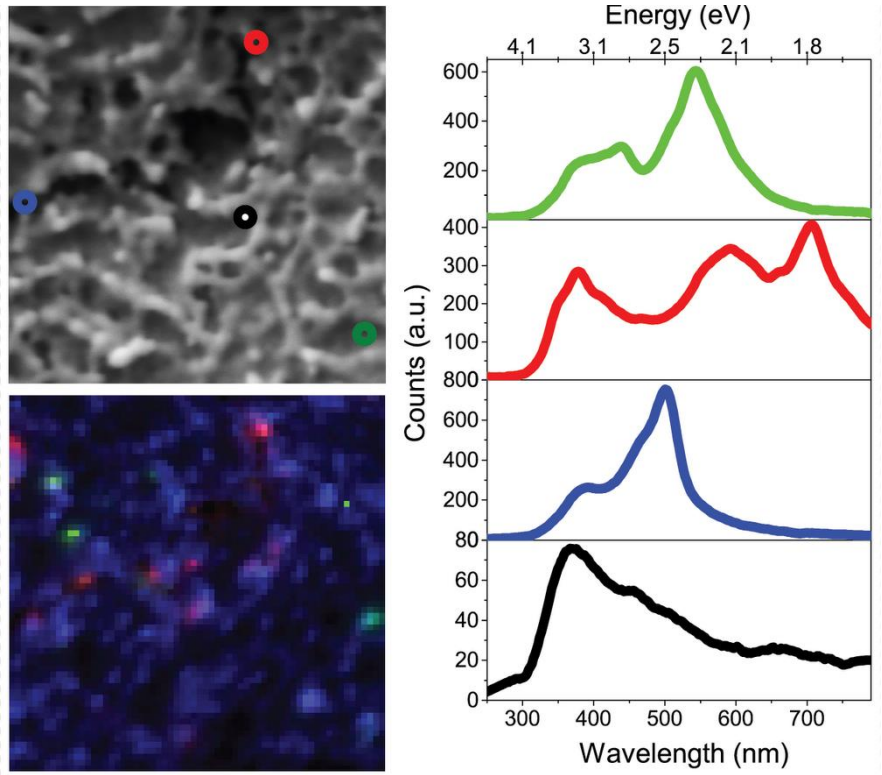
Henning Galinski, Gael Favraud, Hao Dong, Juan S Totero Gongora, Grégory Favaro, Max Döbeli, Ralph Spolenak, Andrea Fratalocchi, and Federico Capasso *Light: Science & Applications* **2017**

Extraordinary Transmission : excitation of surface plasmons and directed scattering



Ron, R. Haleva, E. and Salomon A. Advanced Materials 2018 (progress Review, accepted)

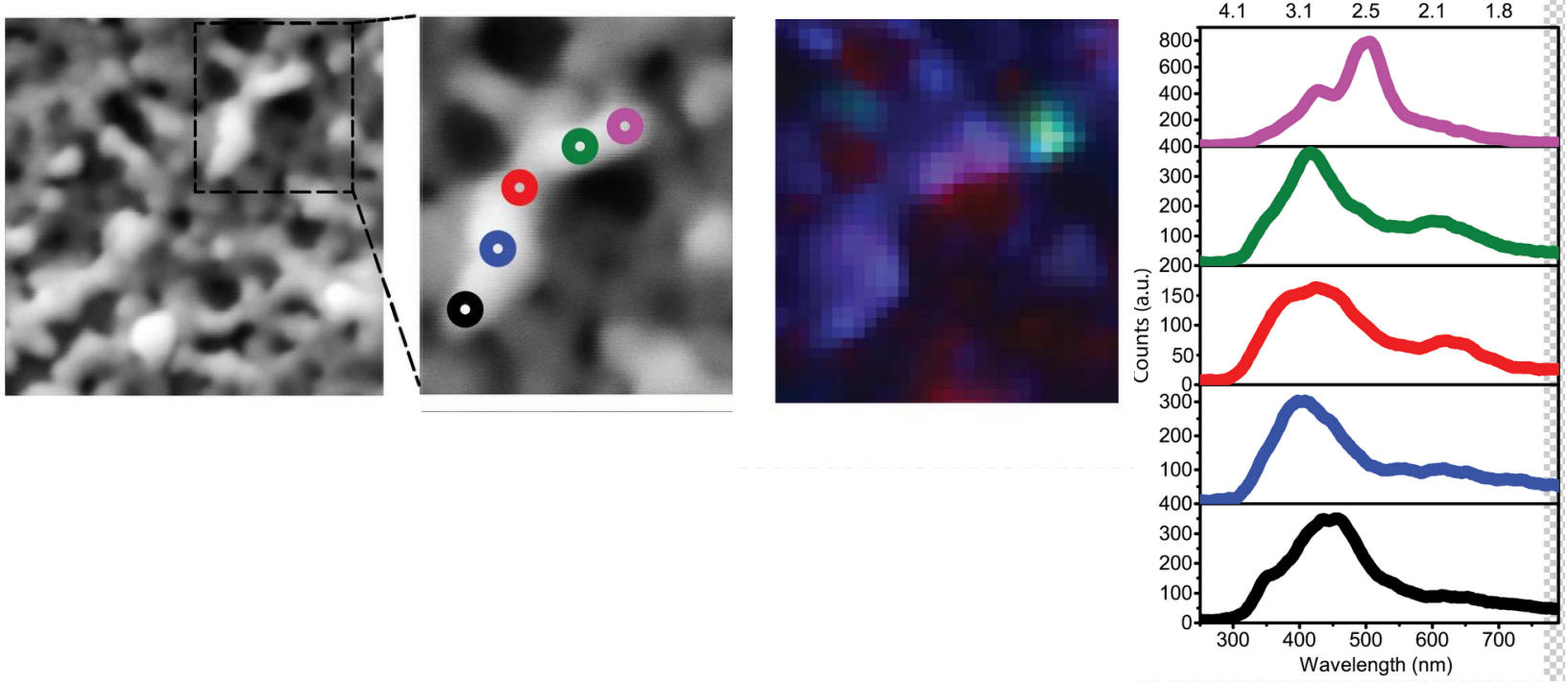
Cathodoluminescence Imaging and spectroscopic measurements



* Multipole plasmonic modes

* Ron, R. et al. under preparation

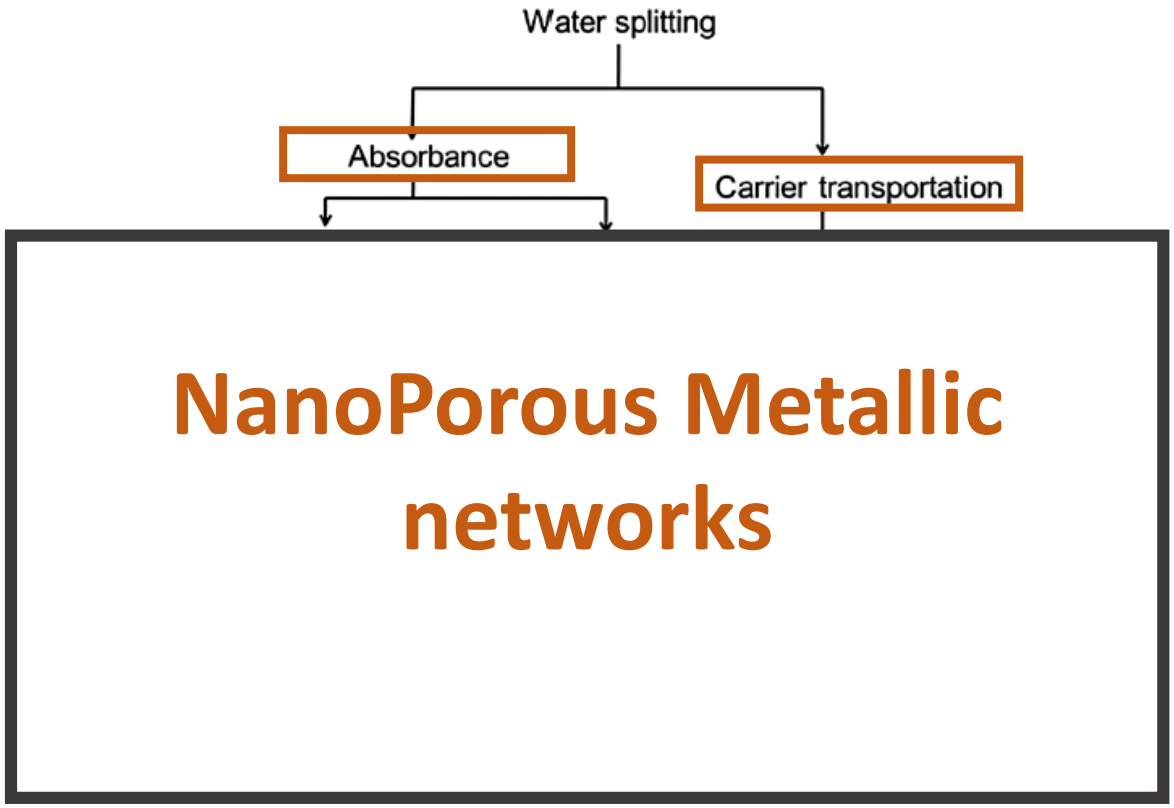
Cathodoluminescence Imaging and spectroscopic measurements



* Ron, R. et al. under preparation

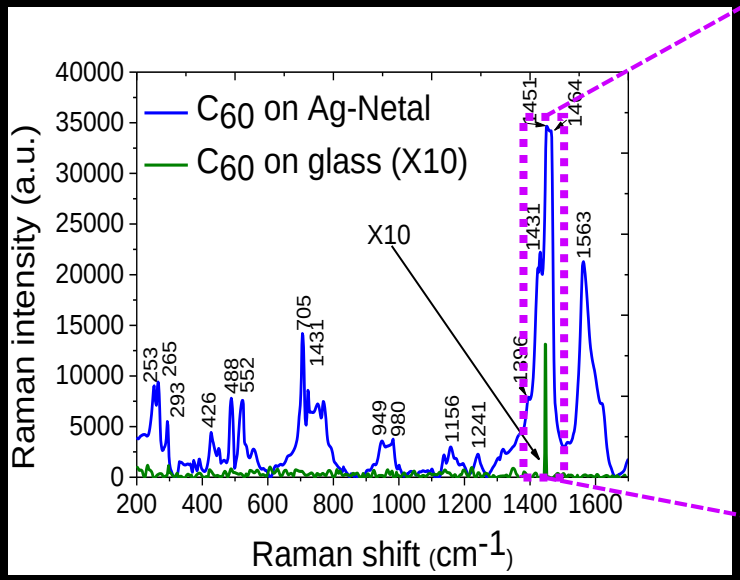
Applications

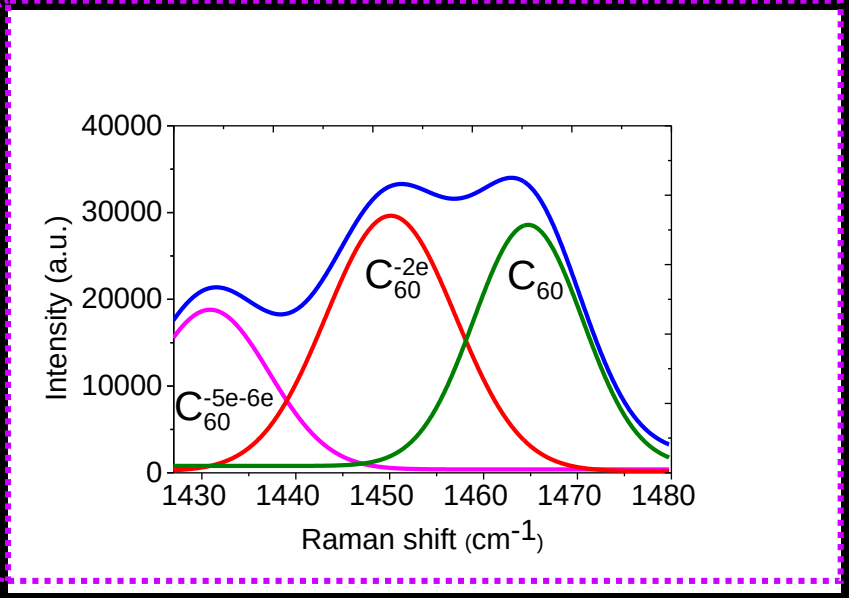
PEC today – challenges



Surface enhance Raman scattering as a probe for photo-catalysis

Reduction of C_{60} fullerenes on an Ag NETAL (metallic network)



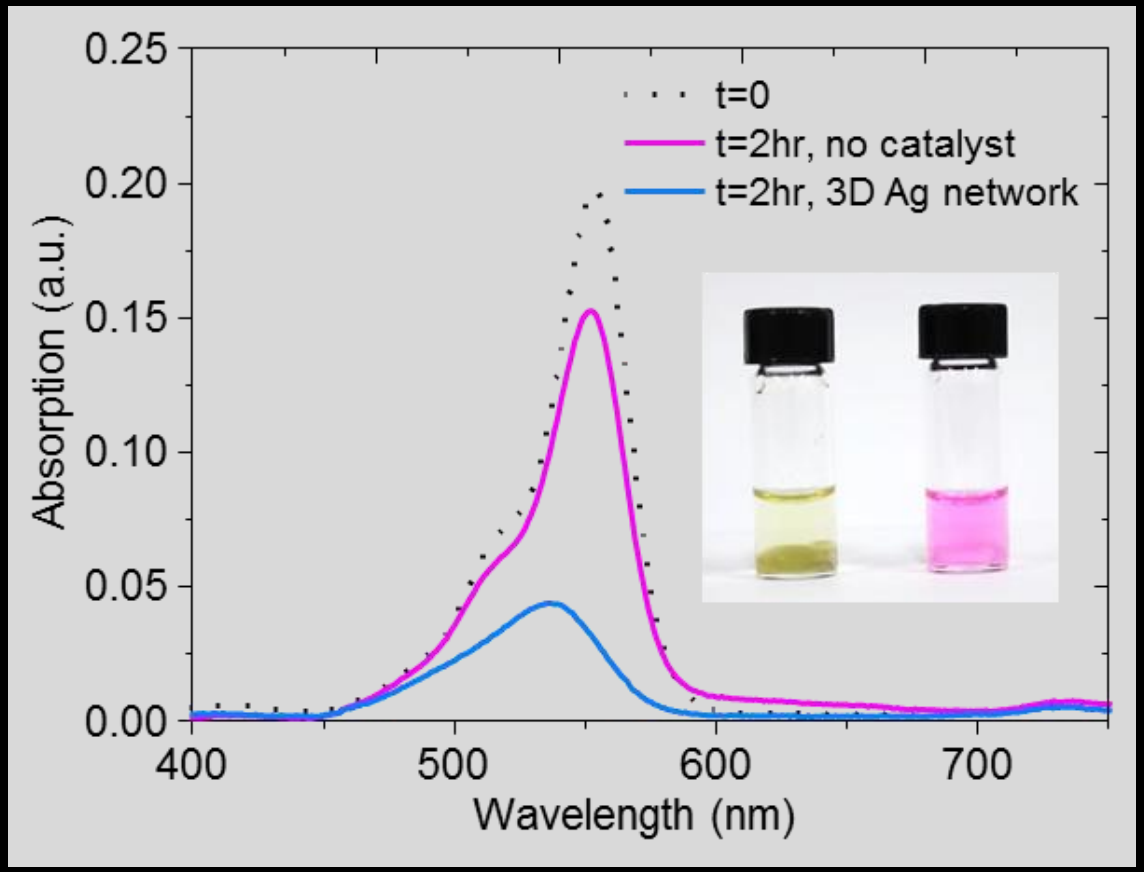


Electron transfer from the metallic electrode into C_{60} molecules

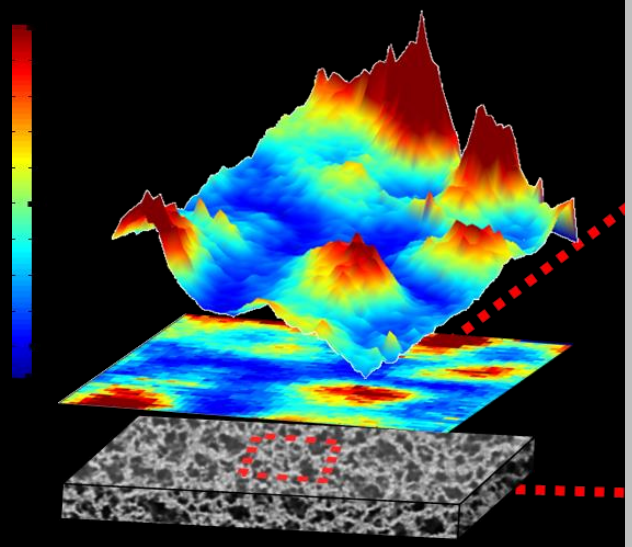
R. Ron, D. Gachet, K. Rechav, A. Salomon, *Adv. Mater.* **2017**, *29*, 1604018.

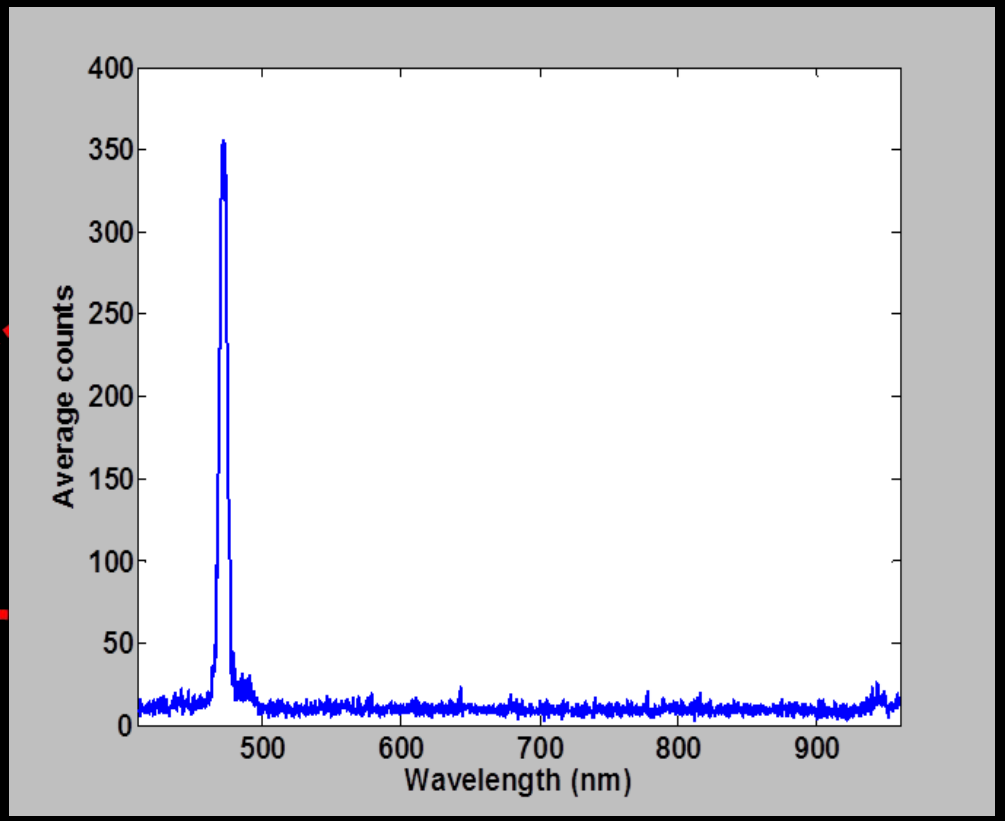
adi.salomon@biu.ac.il

Photo-Catalysis
By formation of energetic carriers



Second Harmonic Generation measurements

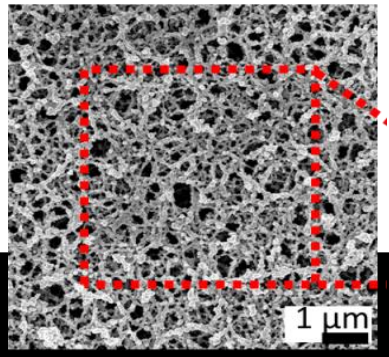


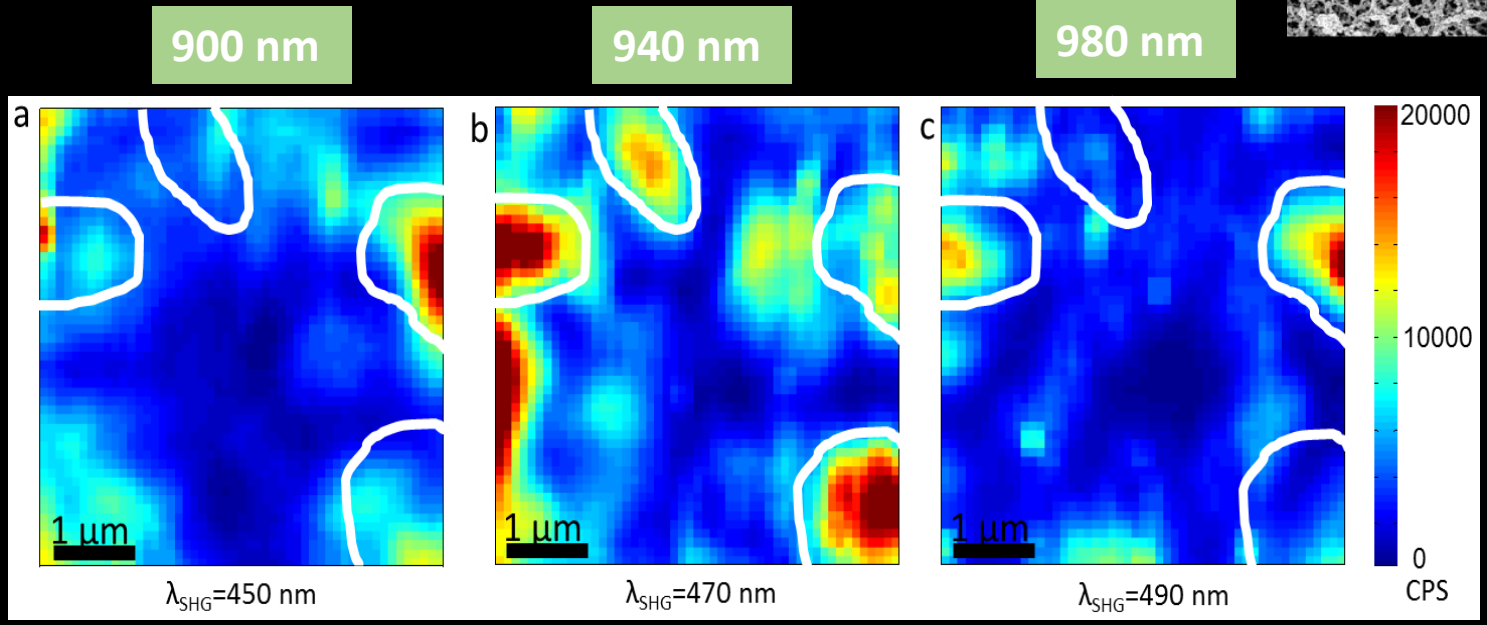


Huge Non Linear responses (particles and holes)

Non Linear Responses

Frequency dependency

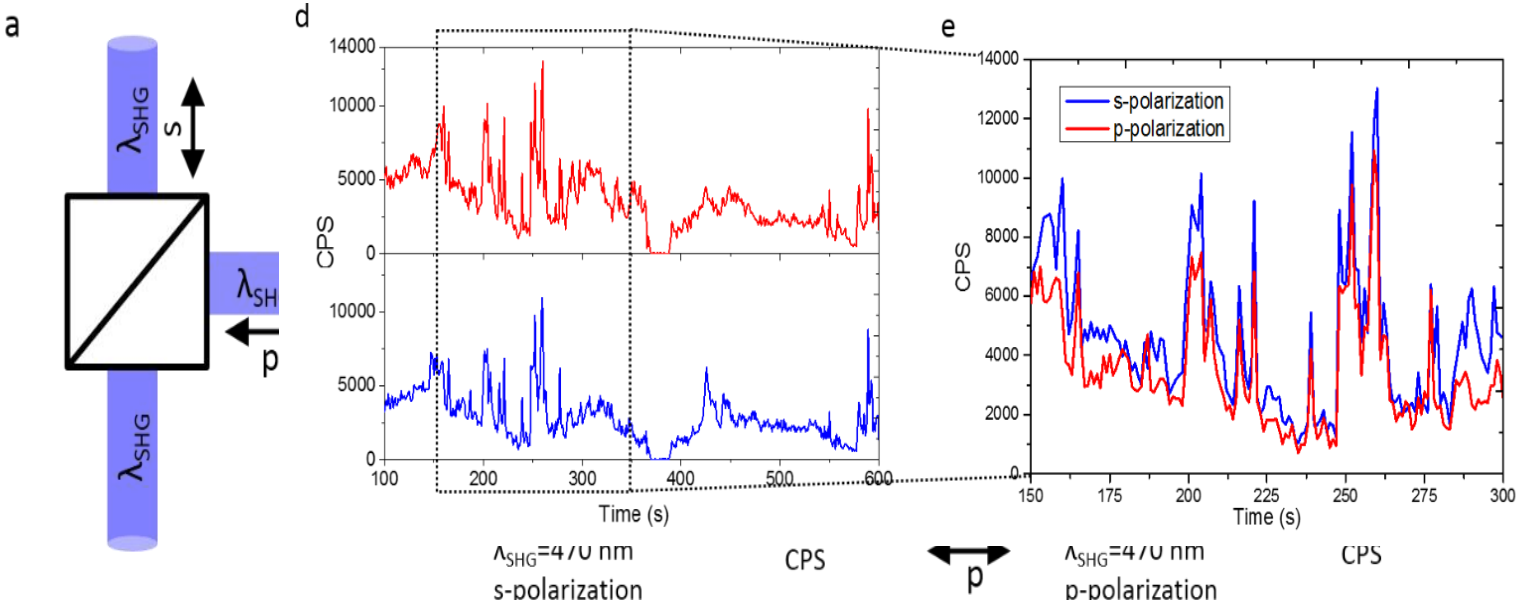


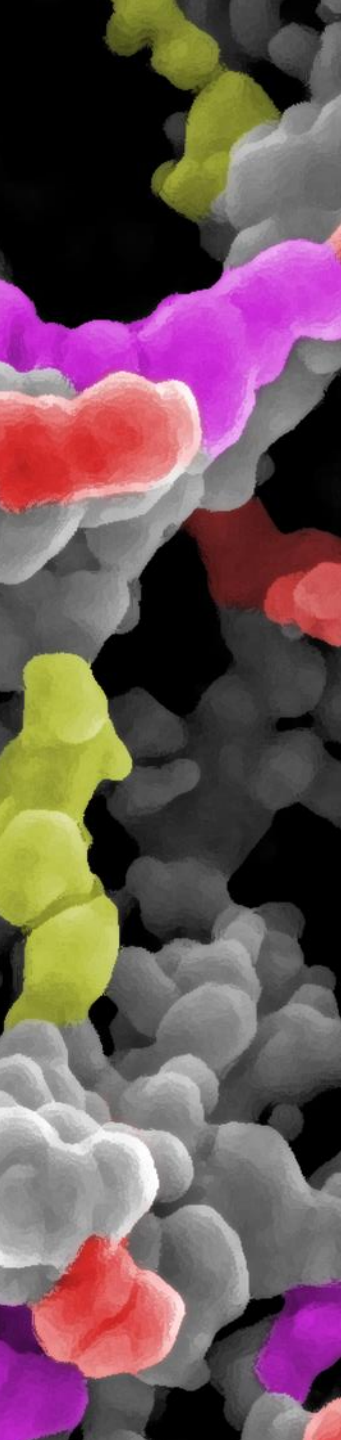


- **Each wavelength results as different area of 'hot spots'**

Ron, R. Nature: Light, Science & Applications, 2018, under second revision

Non Linear Responses

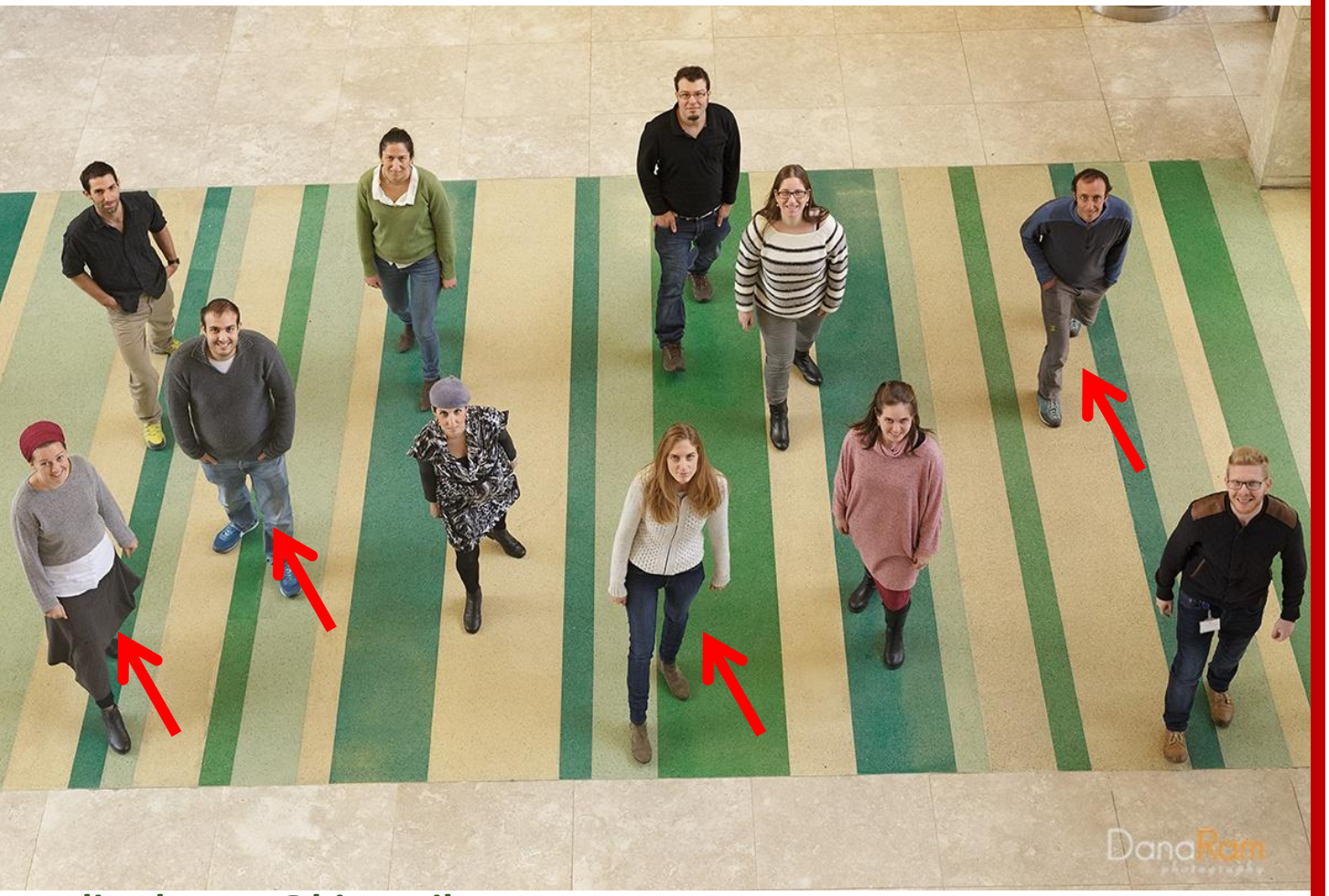




Summary

- Scalable and robust nanoporous metallic network
- Colors generator
- Nonlinear optical properties
- Catalysis/Photo-catalysis

Salomon Group



adi.salomon@biu.ac.il

Money:

Bar-Ilan University

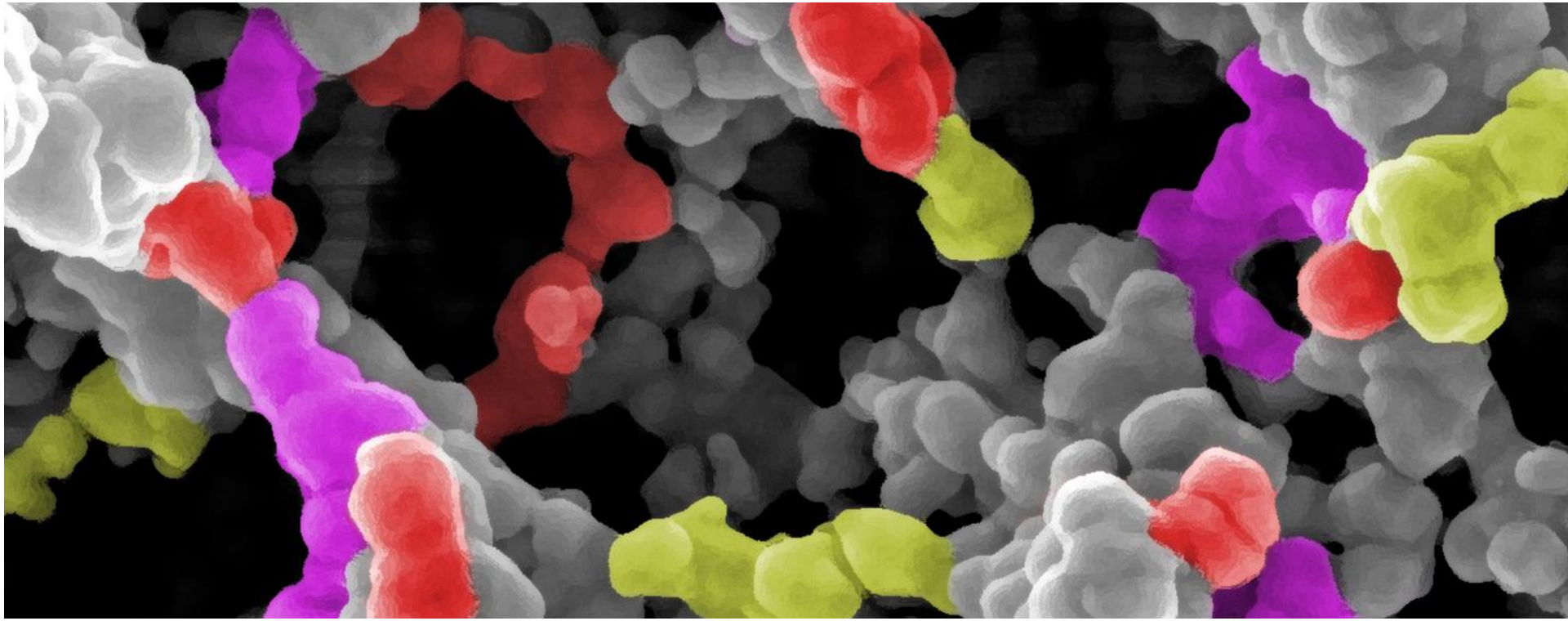
GIF German-Israeli Foundation for Scientific Research and Development

ISRAEL SCIENCE FOUNDATION

Ministry of National Infrastructures, Energy and Water Resources

Thank You!

Bar-Ilan University



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Salomon Group

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Thank You!

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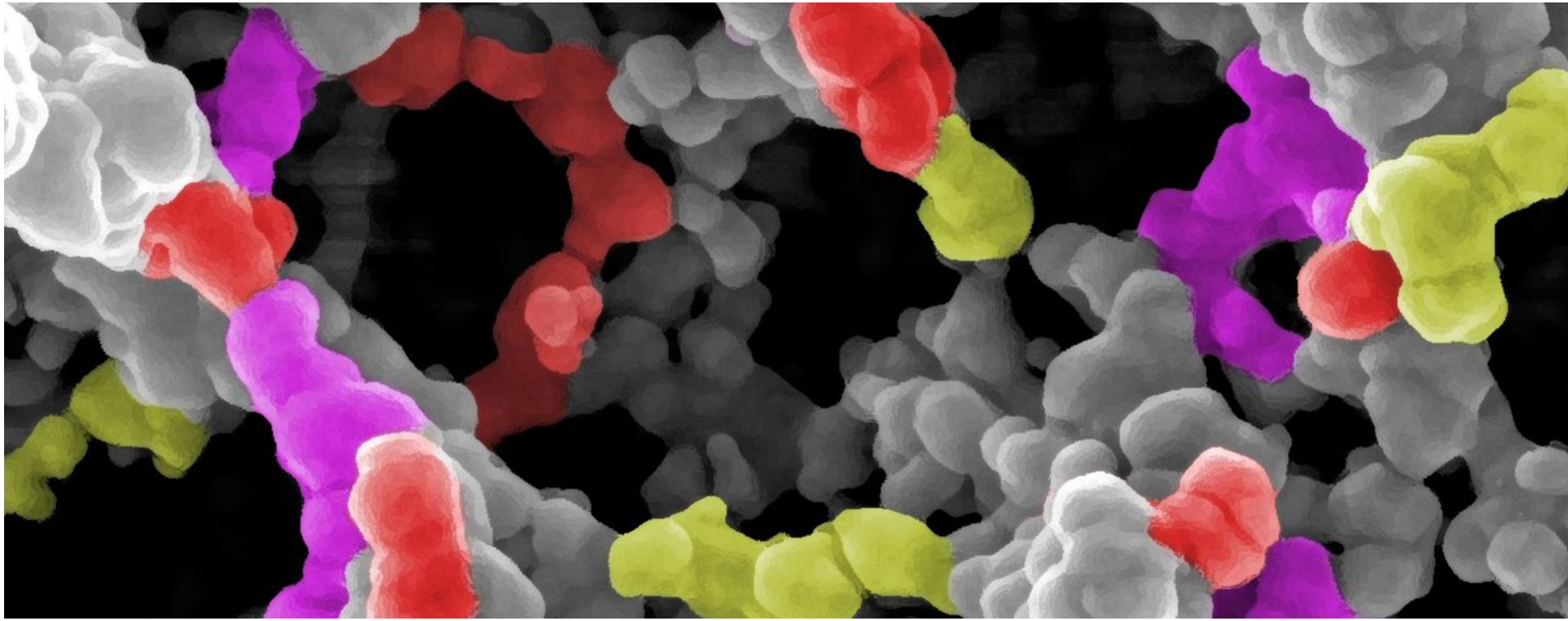

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