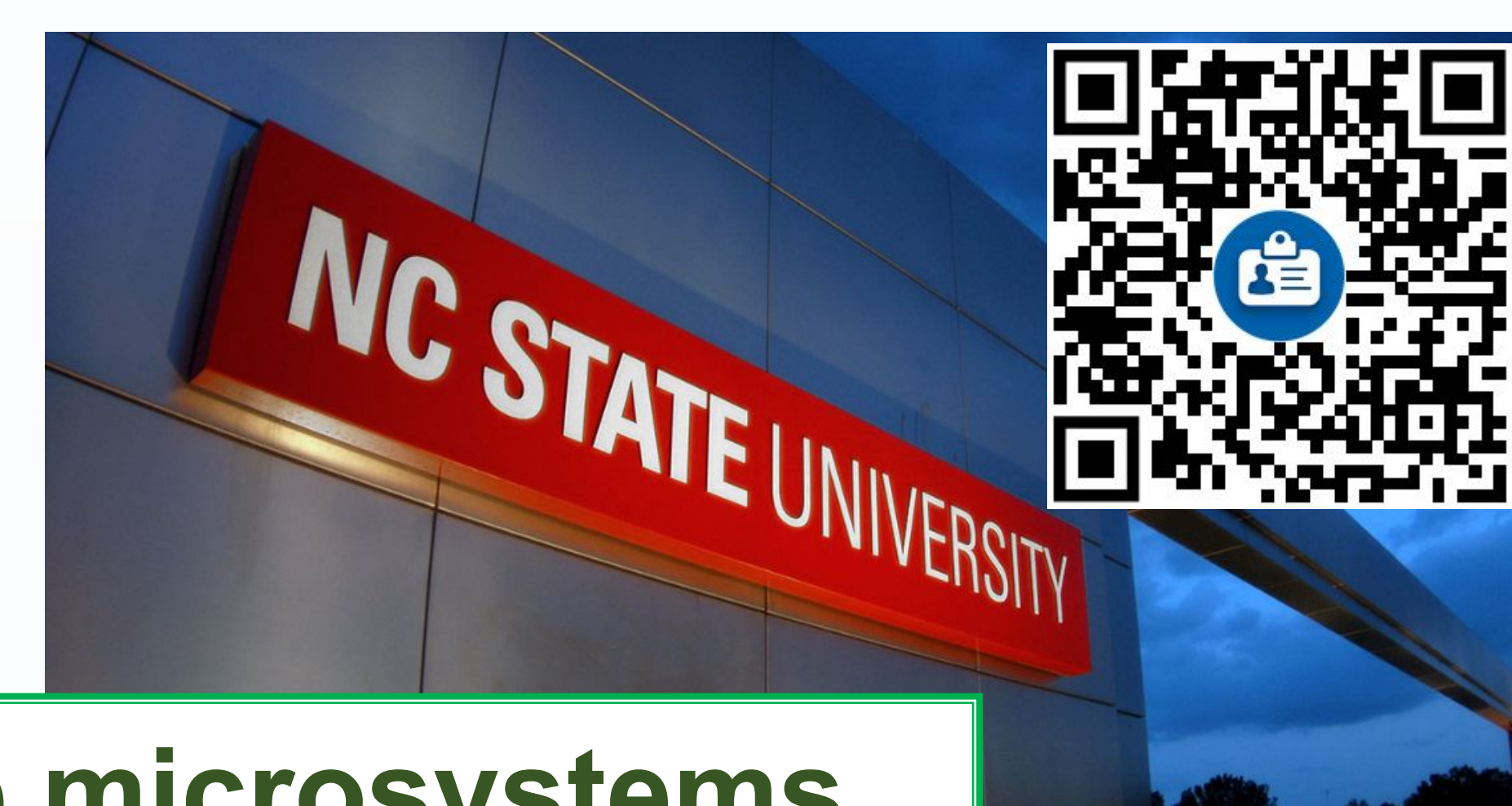




Velev Research Group

Department of Chemical & Biomolecular Engineering

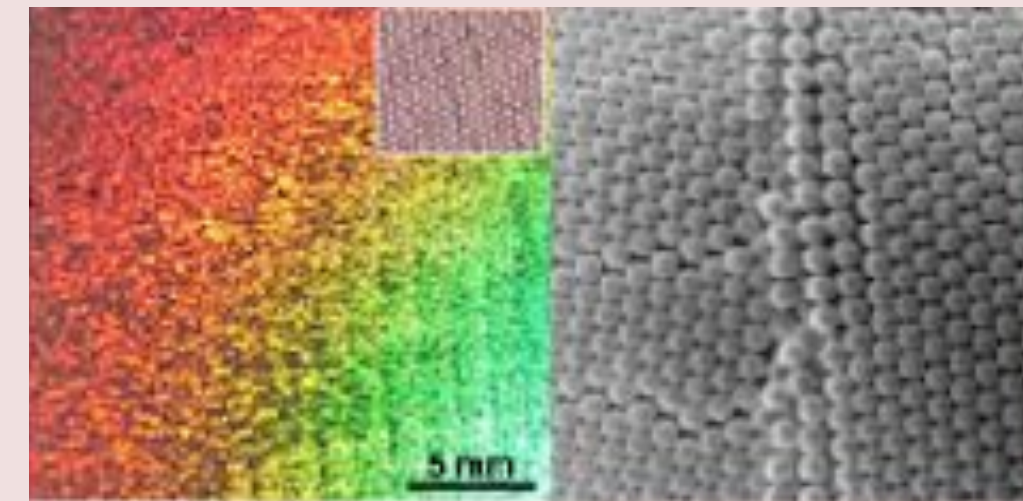
<https://www.cbe.ncsu.edu/velevgroup/>



Novel nanocolloidal materials

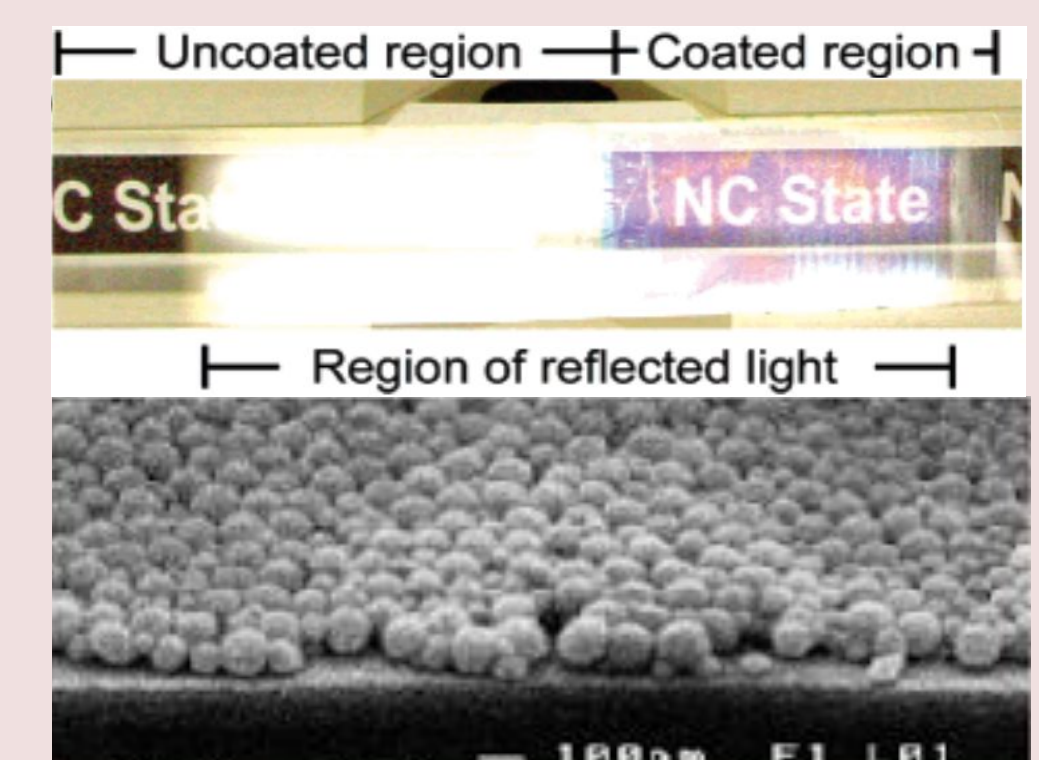
Engineered deposition of functional nanocoatings

Latex colloidal crystals deposited in an engineered film



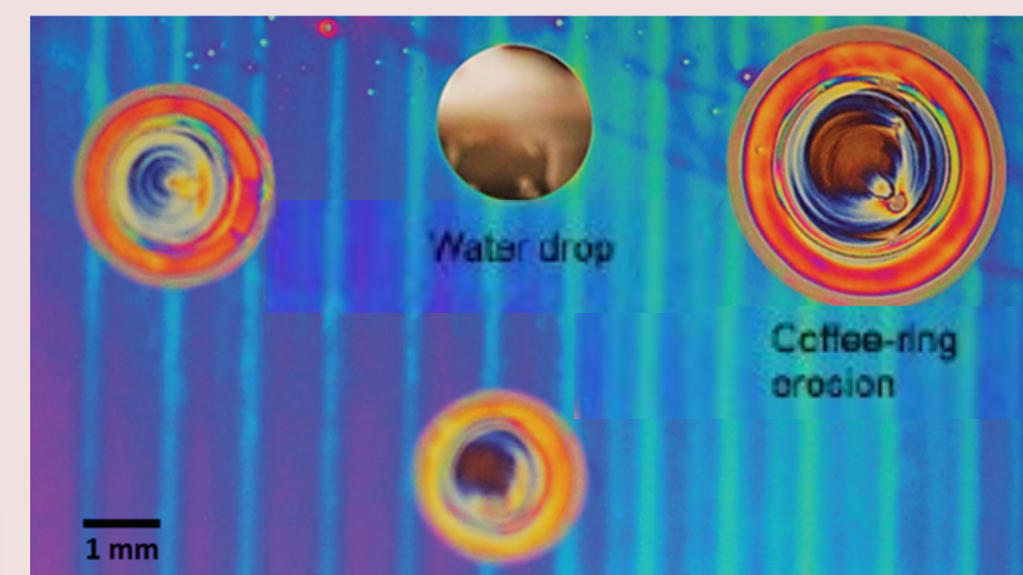
Prevo et al. *Langmuir* (2004)

Antireflective coatings of colloidal silica



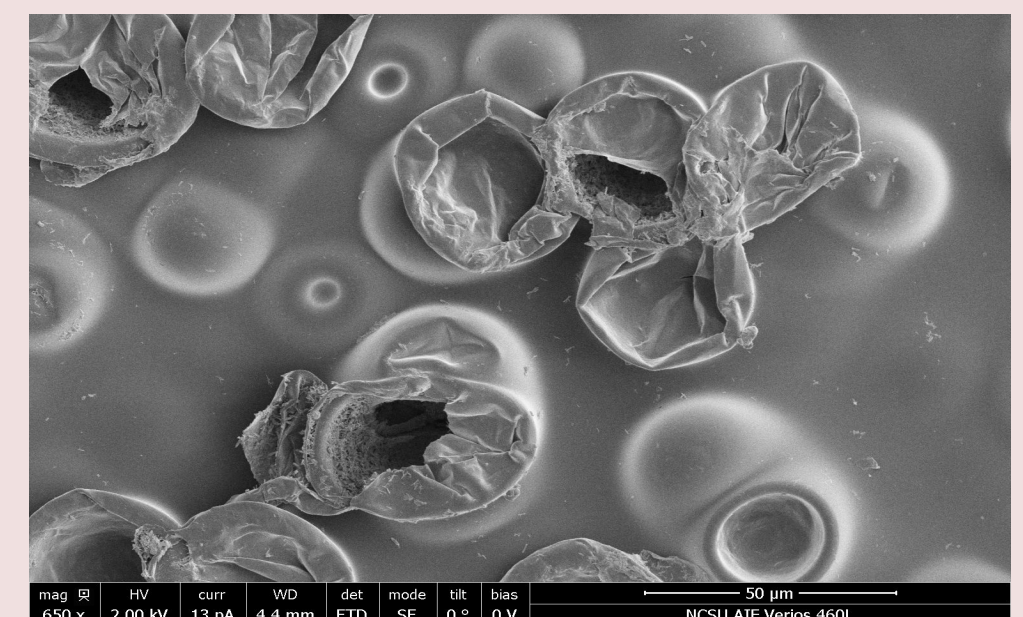
Prevo et al. *J. Mater. Chem.* (2007)
Prevo et al. *Chem. Mater.* (2005)

Coffee-ring evolution as a tool to understand water-resistance of polymer nanofilms

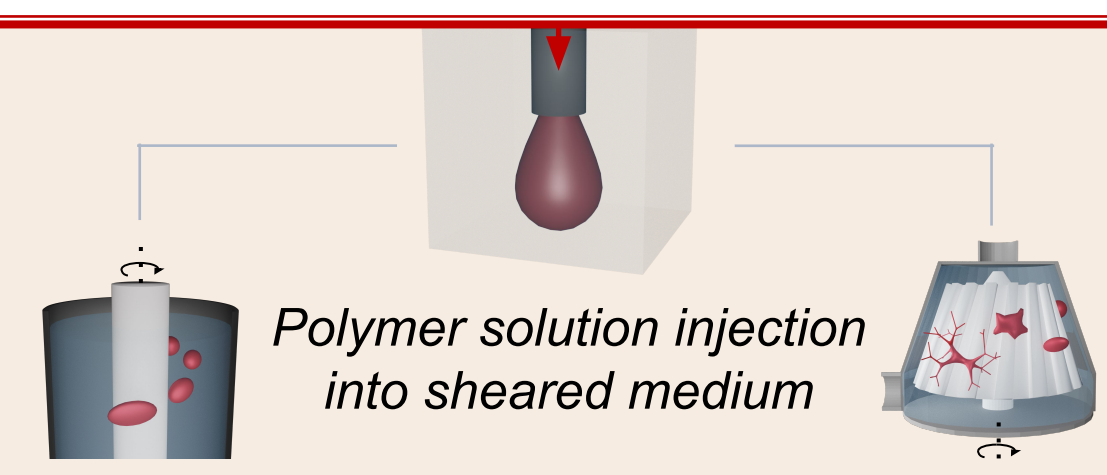


Islam et al. *Soft Matter* (2018)

Degradation of epoxy coatings on tin free steel substrate under acidic corrosion



Kotb et al. *J. Colloid Interface Sci.* (2022)

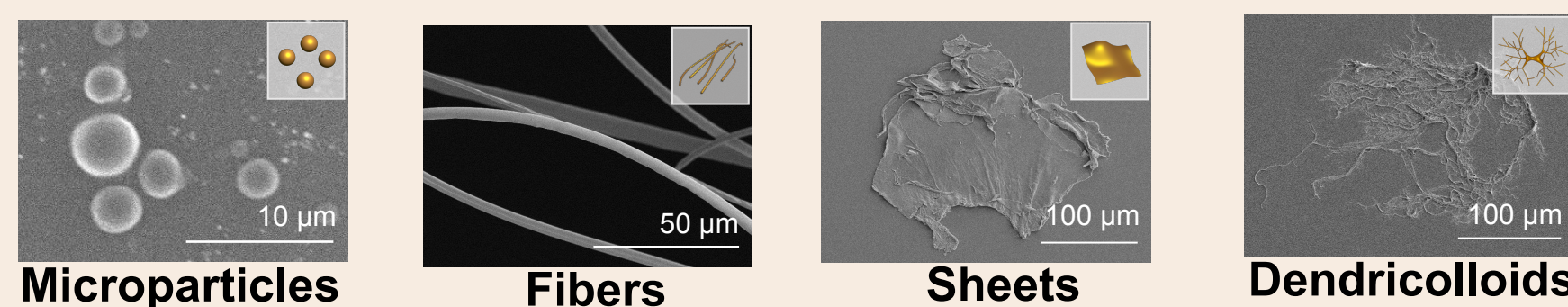


Three main operational stages



Liquid shear-based nanofabrication

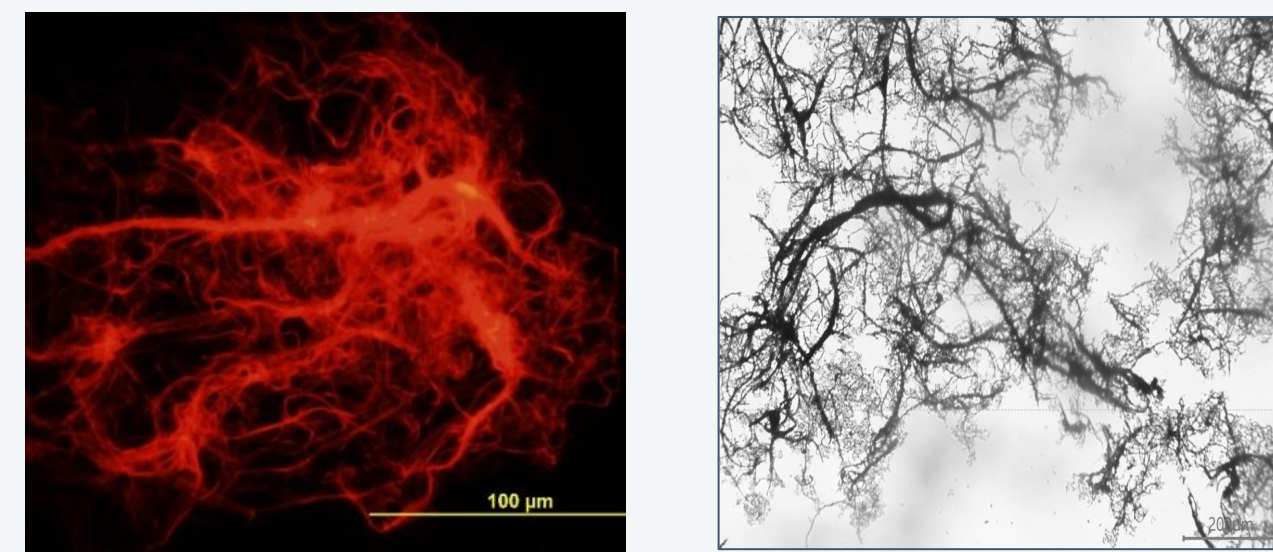
Processing conditions leads to formation of twelve unique colloidal morphologies including:



Smoukov et al. *Adv. Mater.* 2015
Velev and Roh, US patents
Bang et al. *Adv. Mater.* 2023



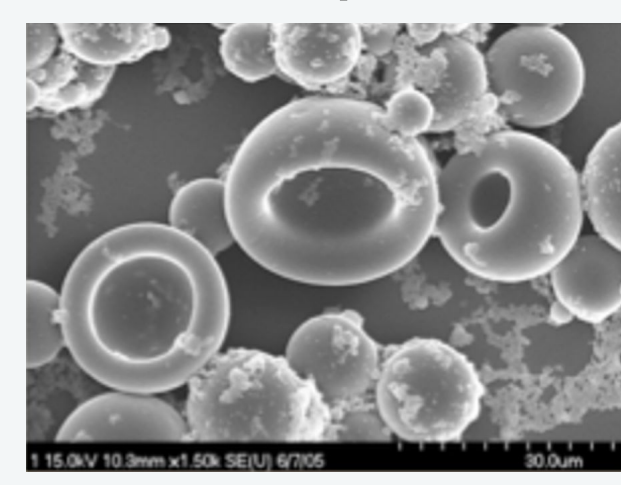
Soft Dendritic Colloids



Roh et al. *Nature Mater.* (2019)

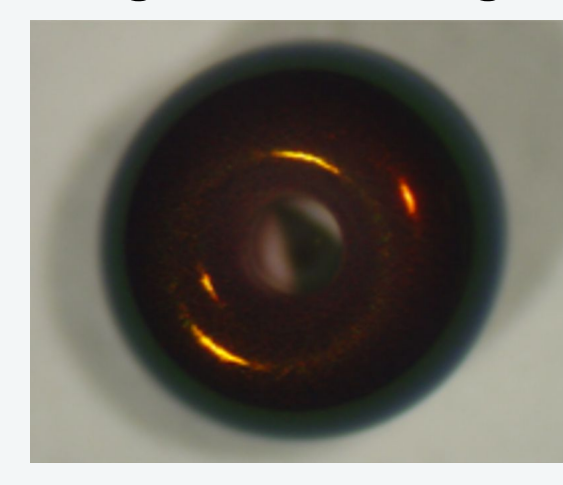
Advanced microparticles and microcapsules

Microcapsules



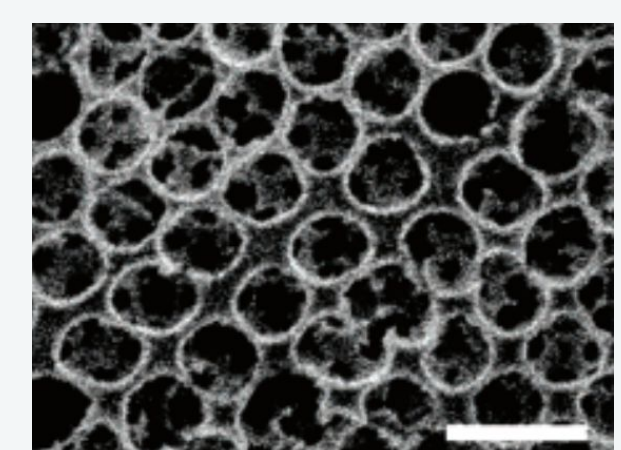
Koo et al. *Chem. Mater.* (2006)

Silica/gold NPs Doughnut



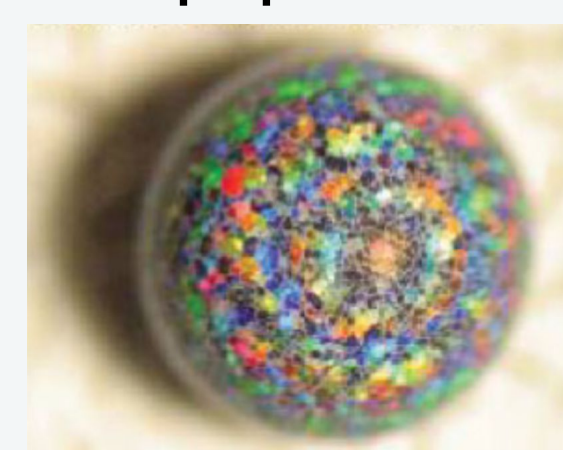
Rastogi et al. *MRC* (2010)

SERS bio- and chemical sensors



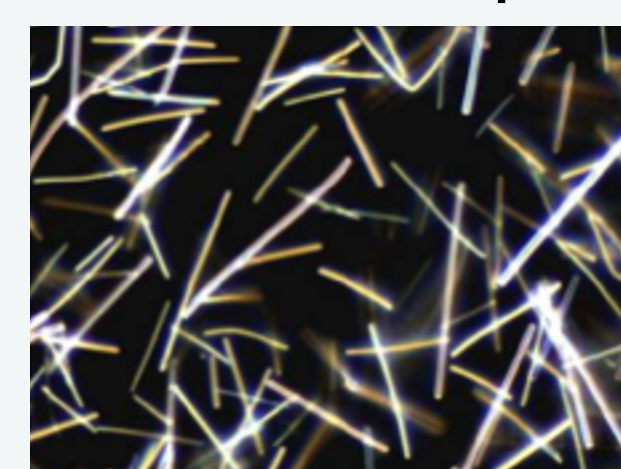
Kuncicky et al. *J. Mater. Chem.* (2006)

Light-diffracting supraparticles

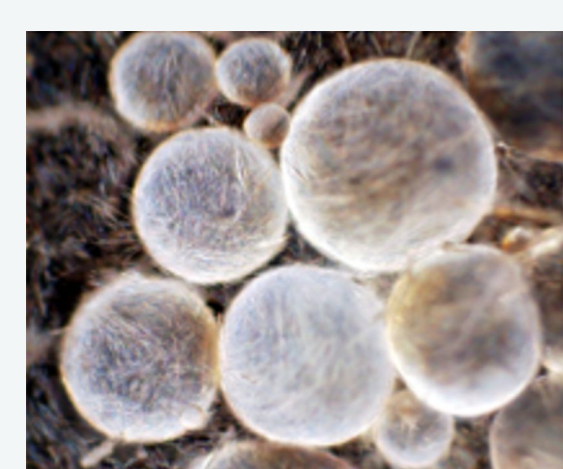


Rastogi et al. *Adv. Mater.* (2008)

Polymer microrods, foam and emulsion superstabilization

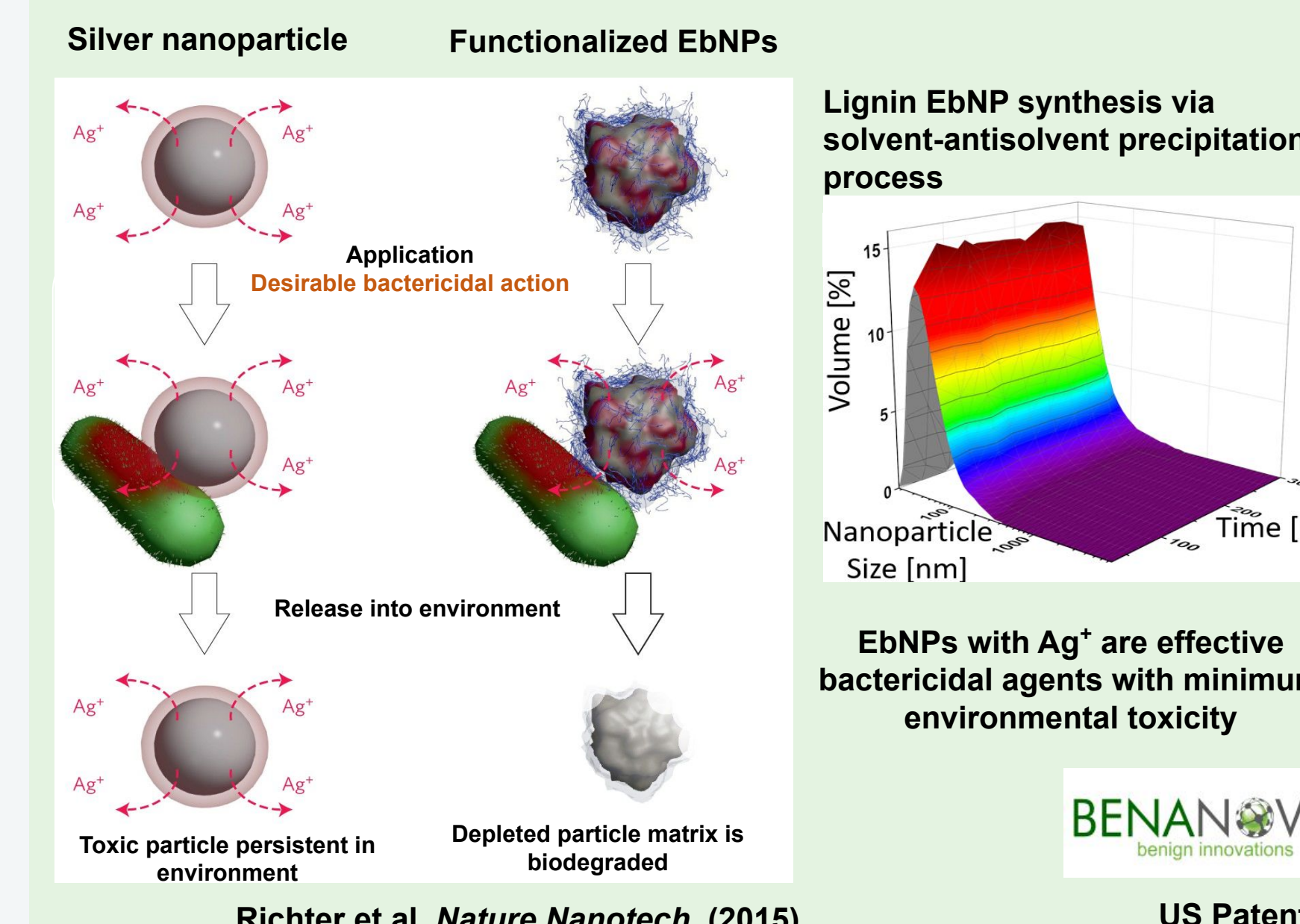


Alargova et al. *Adv. Mater.* (2004)



Alargova et al. *Langmuir* (2004)

Environmentally-benign nanoparticles



Richter et al. *Nature Nanotech.* (2015)

Lignin EbNP synthesis via solvent-antisolvent precipitation process

EbNPs with Ag⁺ are effective bactericidal agents with minimum environmental toxicity



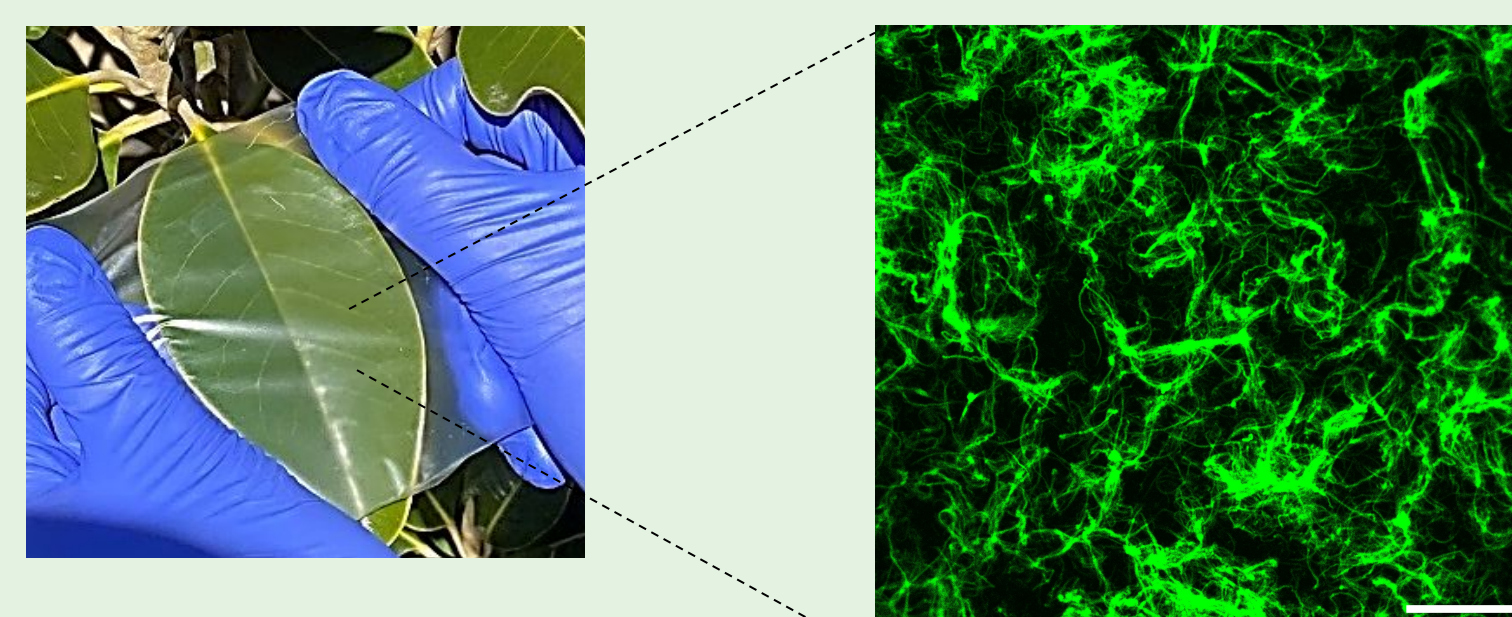
US Patents

Biodegradable substrates for soft electronics



Ahmad et al., *AEM* (2024)

Sustainable packaging films

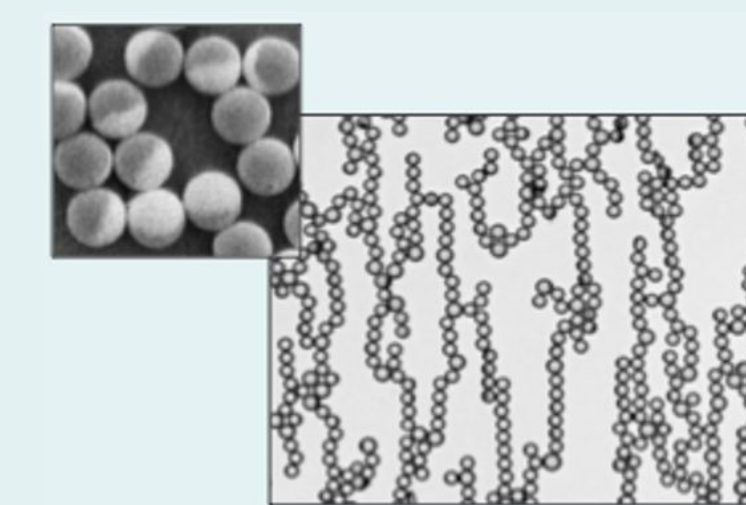


SDC-reinforced biopolymer plastic alternatives

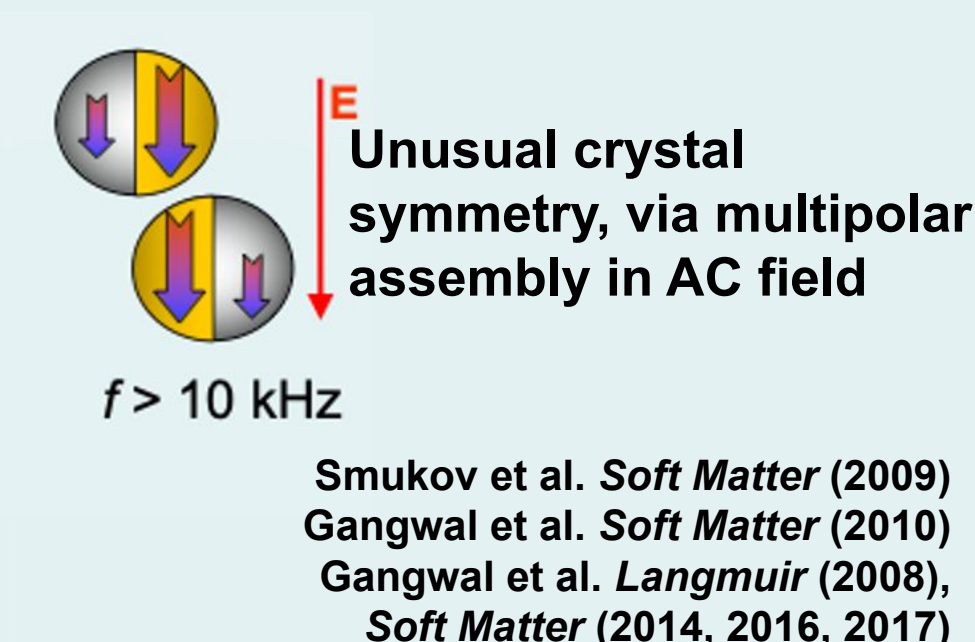
Kotb and Velev, *Cell Rep. PS* (2023)

Functional active microsystems

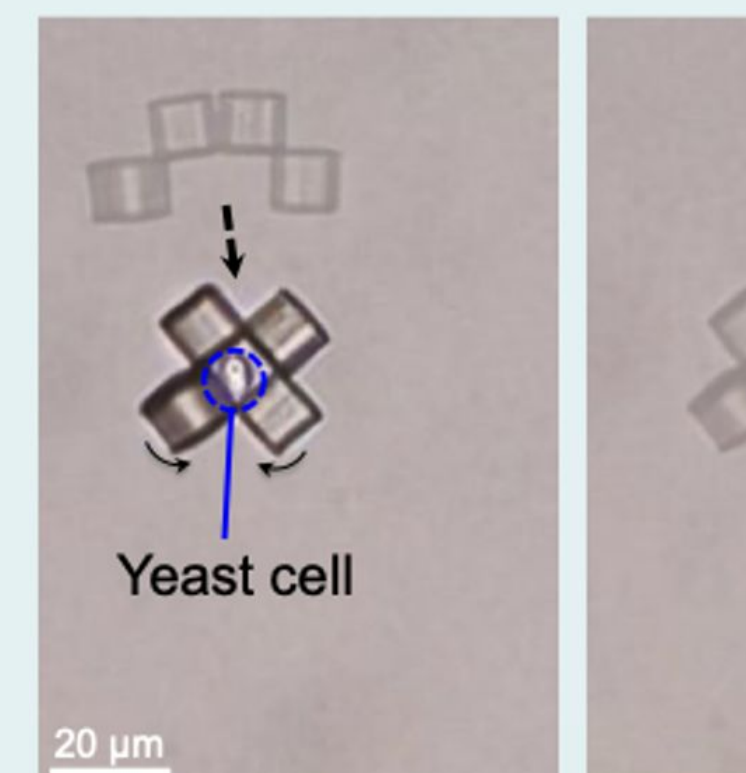
Anisotropic particles in external fields



Janus particles in high frequency AC electric field



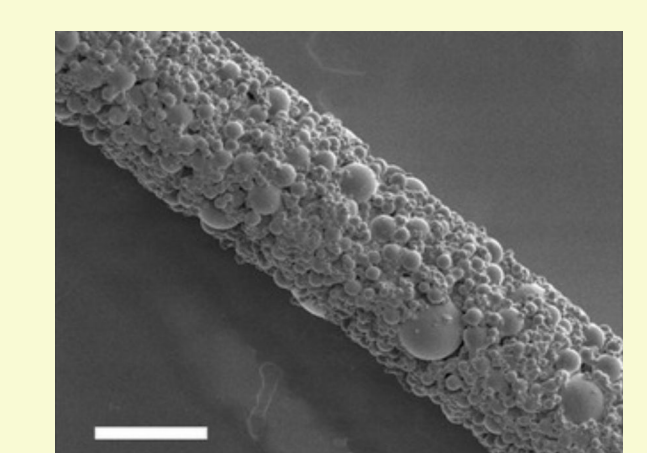
Smukov et al. *Soft Matter* (2009)
Gangwal et al. *Soft Matter* (2010)
Gangwal et al. *Langmuir* (2008),
Soft Matter (2014, 2016, 2017)



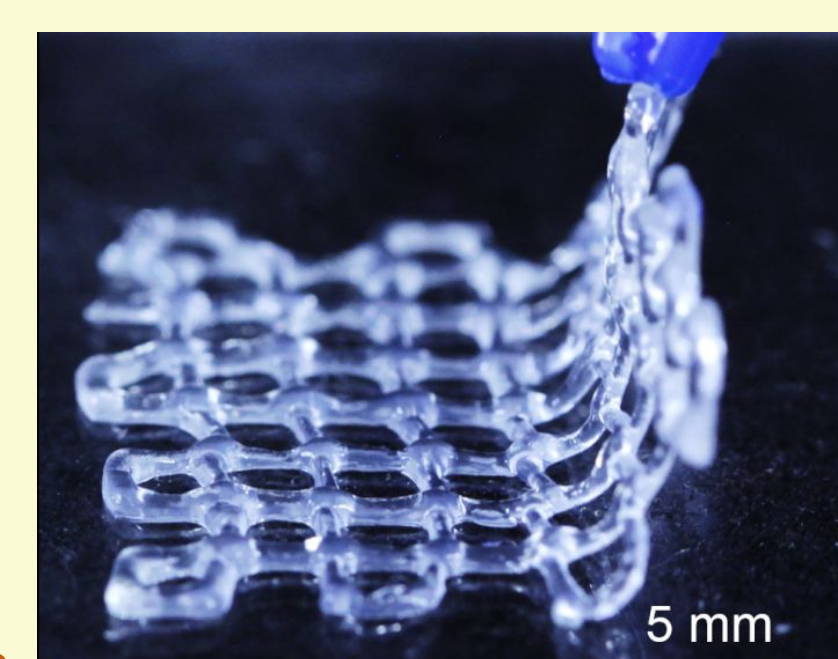
Patchy microcube as a building block for magnetic microbot

Han et al. *Adv. Funct. Mater.* (2018)

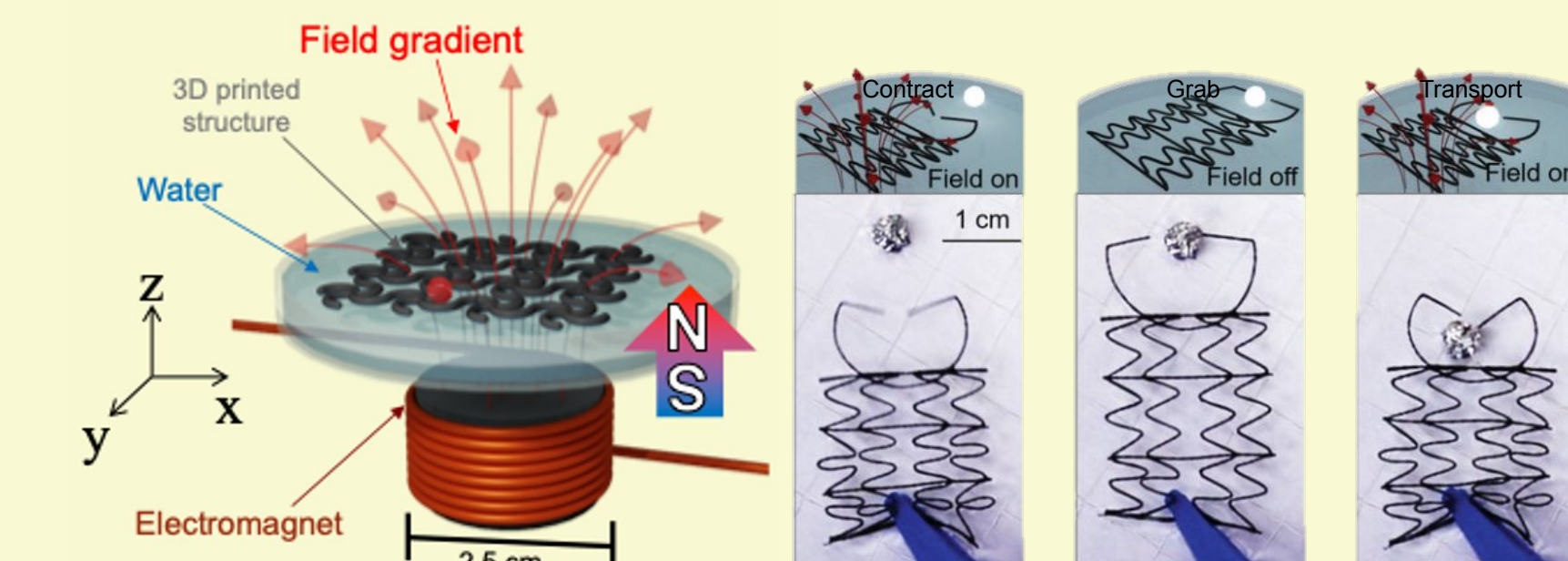
3D printing for soft robotics



Magnetically actuable meshes 3D printed from **Homocomposite Thixotropic Paste** (HTP-3DP)



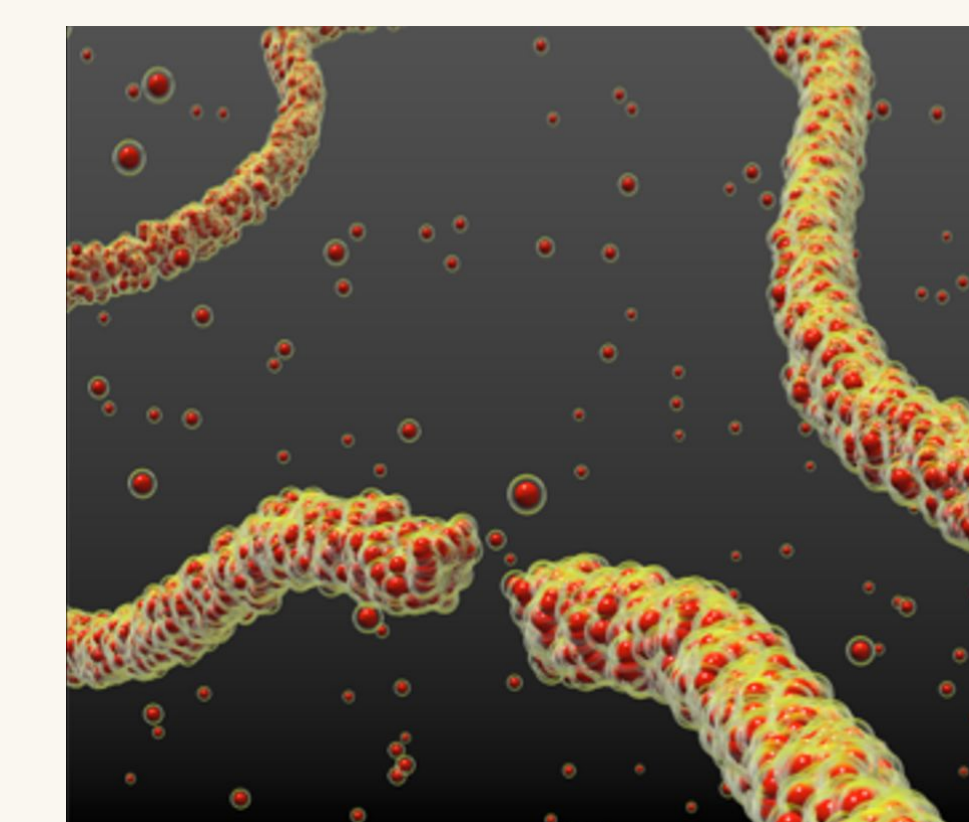
Roh et al. *Adv. Mater.* (2017)



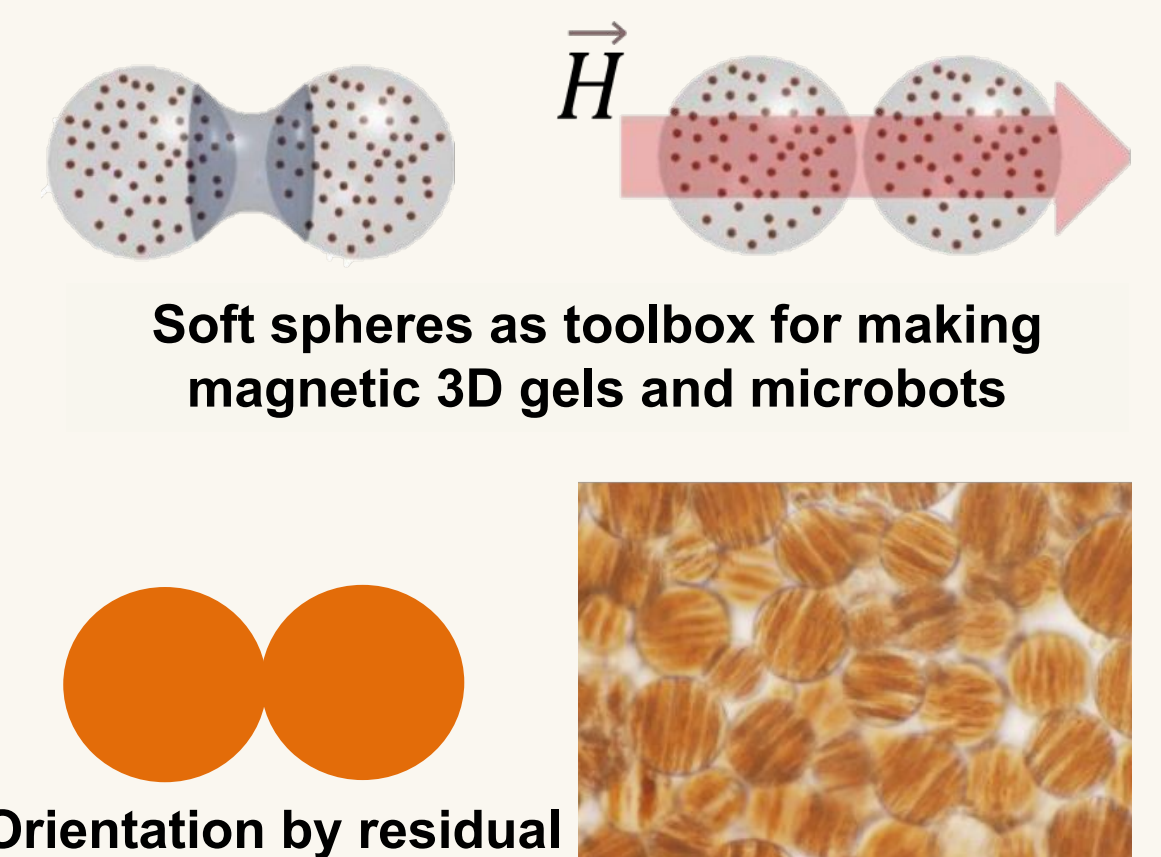
An extendable soft robotic gripper, operated by magnetic field

Roh et al. *Adv. Mater. Technol.* (2019)

Nanocapillary binding of magnetic particles



Nanocapillary-mediated assembly of nanoparticles into magnetic filaments and reconfigurable micro-networks



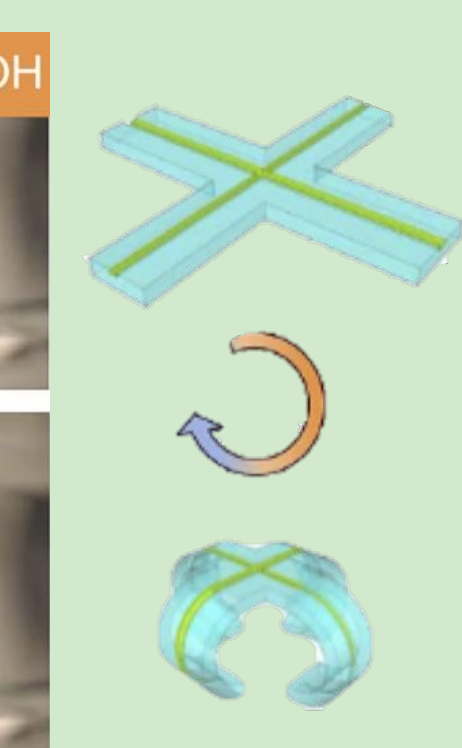
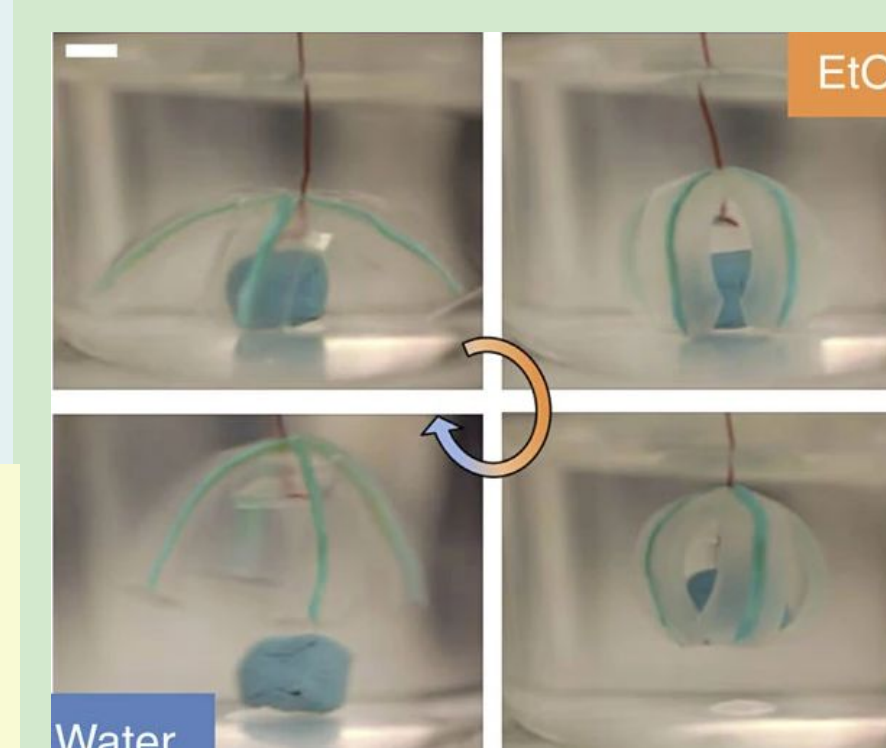
Soft spheres as toolbox for making magnetic 3D gels and microbots



Orientation by residual magnetization

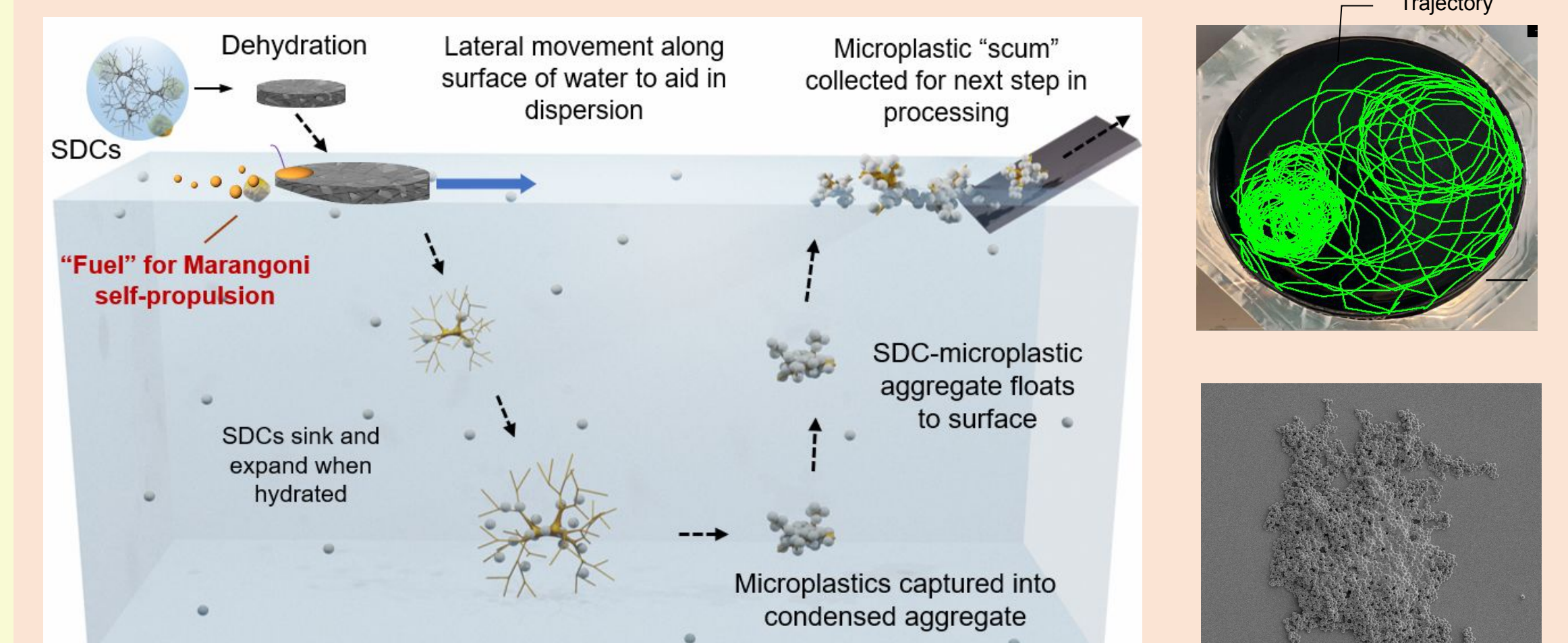
Bharti et al. *Langmuir* (2015)
Roh et al. *AIChE* (2018)
Bharti et al. *Nature Mater.* (2015)
Castellanos et al. *JPCB* (2021)

Hydrogel actuators, grabbers and walkers



Morales et al. *Small* (2016)
Morales et al. *Soft Matter* (2014)
Palleau et al. *Nature Commun.* (2013)

Biodegradable microcleaners for microplastic cleanup



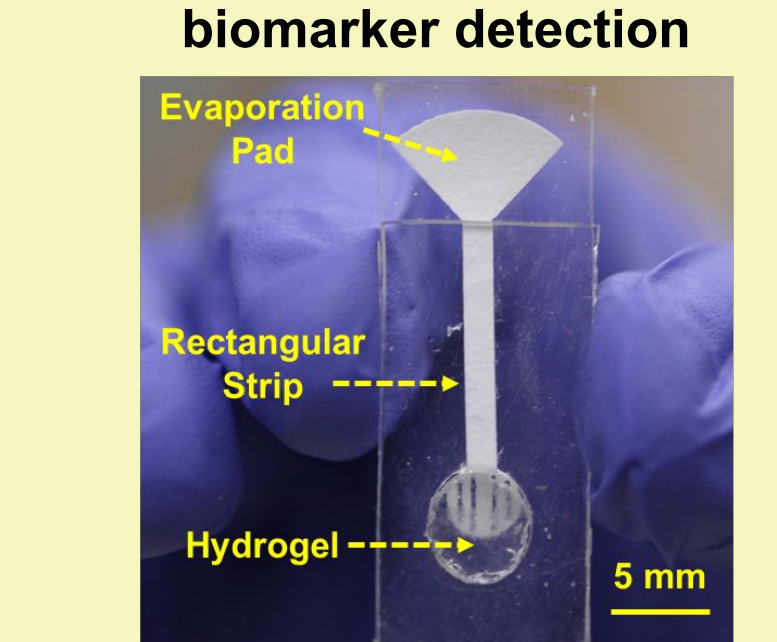
Active soft dendritic colloidal particles (SDCs) move to capture microplastics and float up to be collected

Bang et al. *Langmuir* (2024)

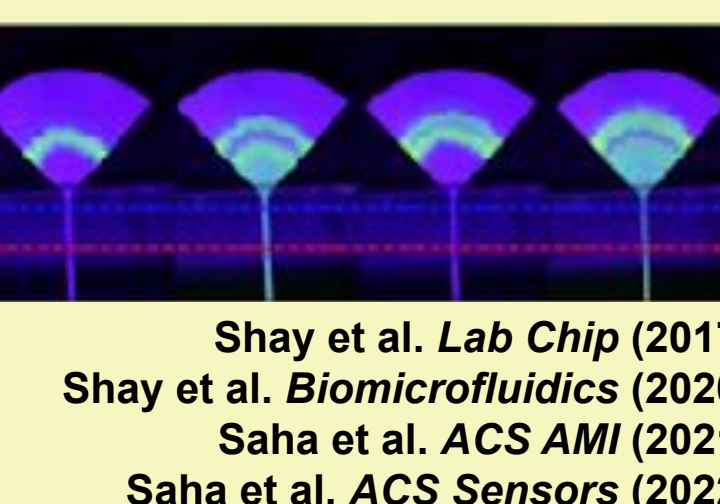
Millifluidics, μ -fluidics & self-propelling particles

Microfluidic soft leaf materials and skin interfaces

Sweat sensing devices and biomarker detection

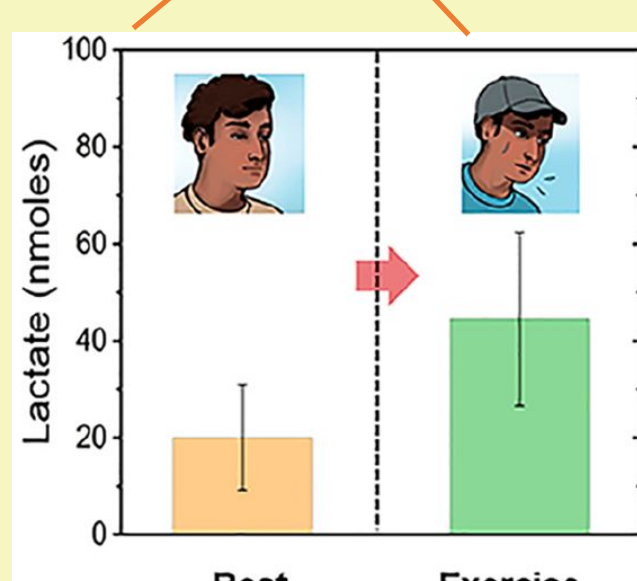
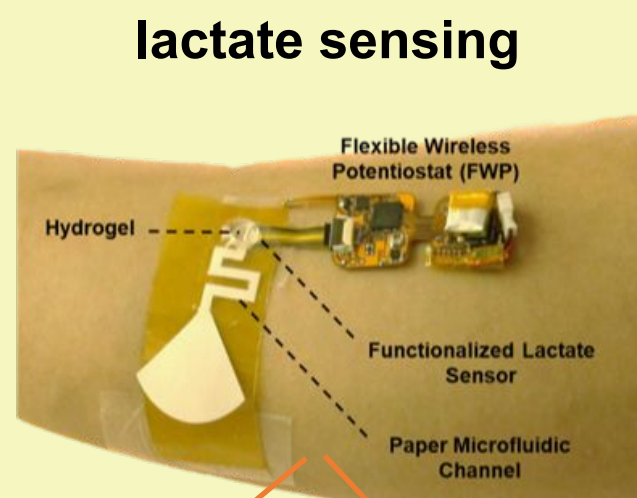


Osmotic Patch

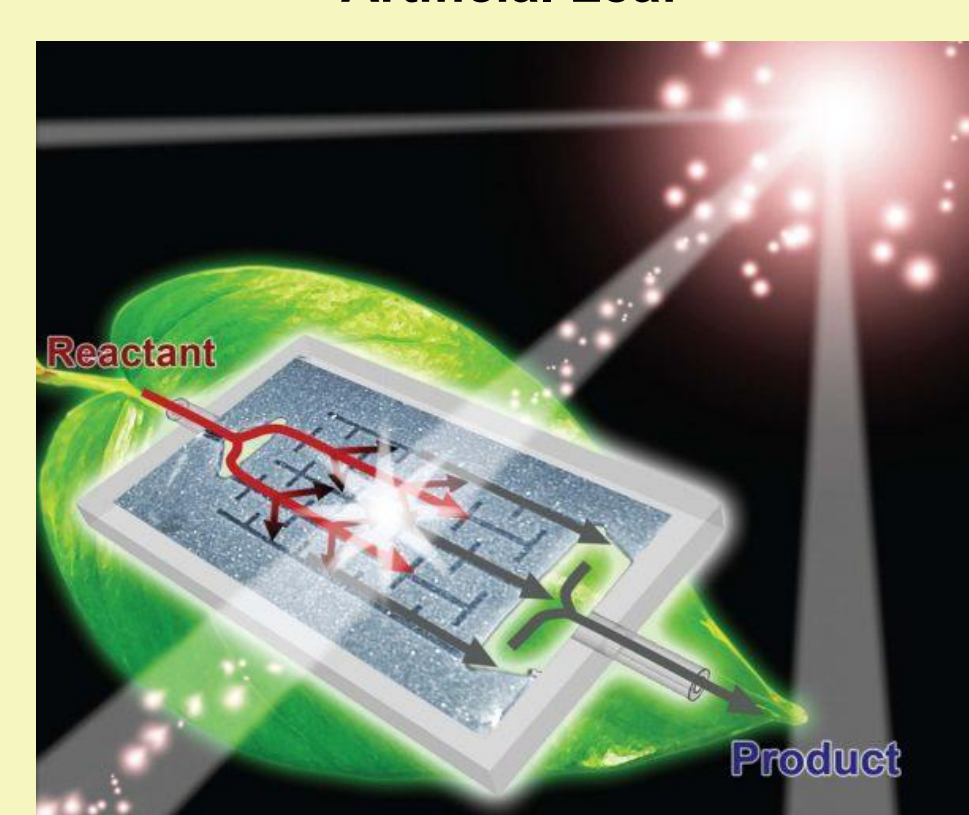


Shay et al. *Lab Chip* (2017)
Shay et al. *Biomicrofluidics* (2020)
Saha et al. *ACS AMI* (2021)
Saha et al. *ACS Sensors* (2022)

Patch on skin for lactate sensing



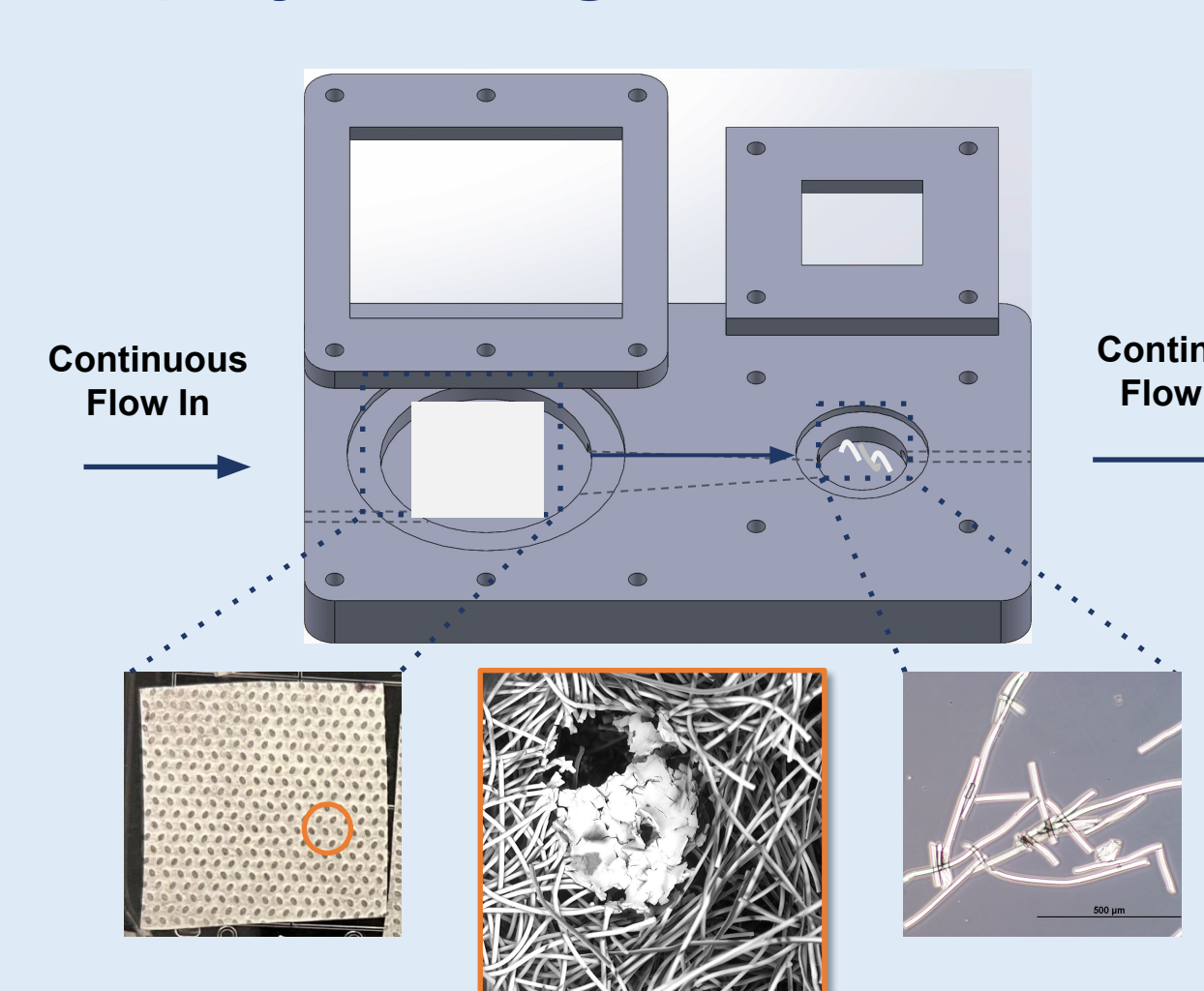
Artificial Leaf



Biomimetic photocatalytic reaction with a hydrogel-embedded microfluidic network

Koo et al. *J. Mater. Chem. A* (2013)
Ucar et al. *Soft Matter* (2012)
Koo et al. *Sci. Rep.* (2013)

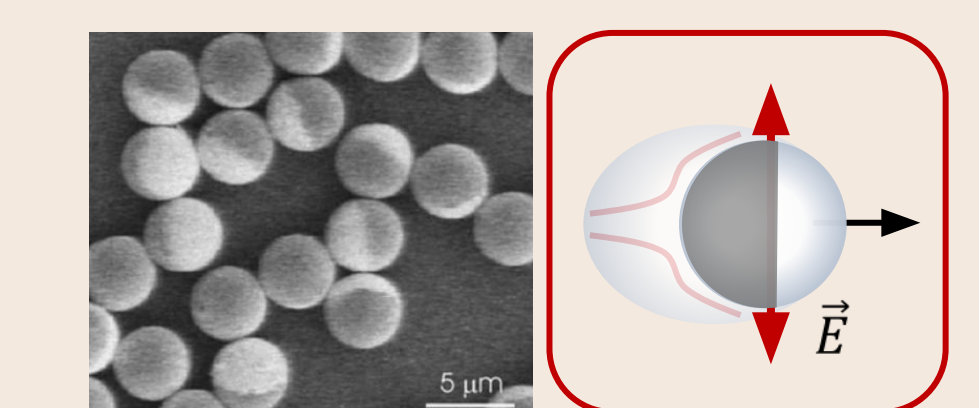
Millifluidic flow device for polymer degradation studies



As polymer degrades, it moves through device to the the second chamber to be collected

Background: Self-propelling particles

AC electro-hydrodynamics allows making novel motile active particles

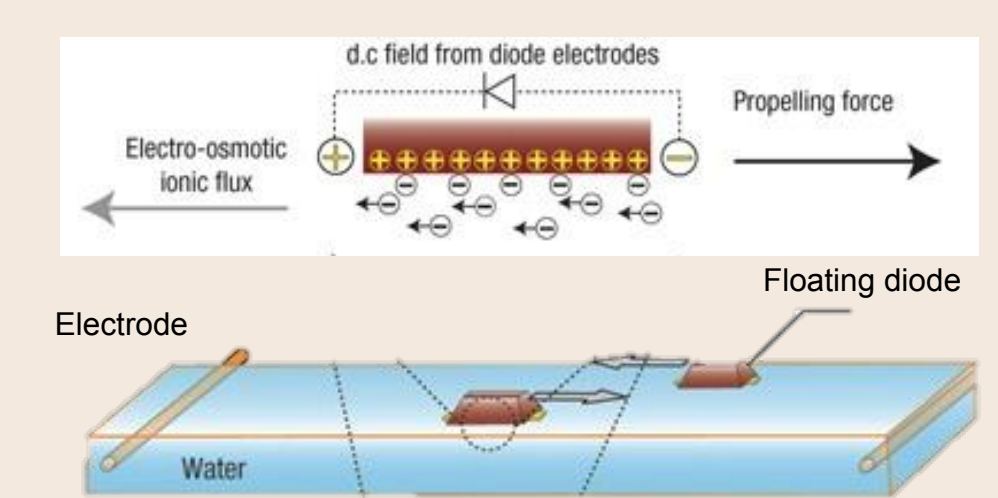


Gangwal et al. *PRL* (2008)

Potential applications

- Pumping/mixing fluids in lab-on-chip
- Drug delivery
- Sensors for toxicity detection
- Cargo pick-up/transportation
- Microrobotics

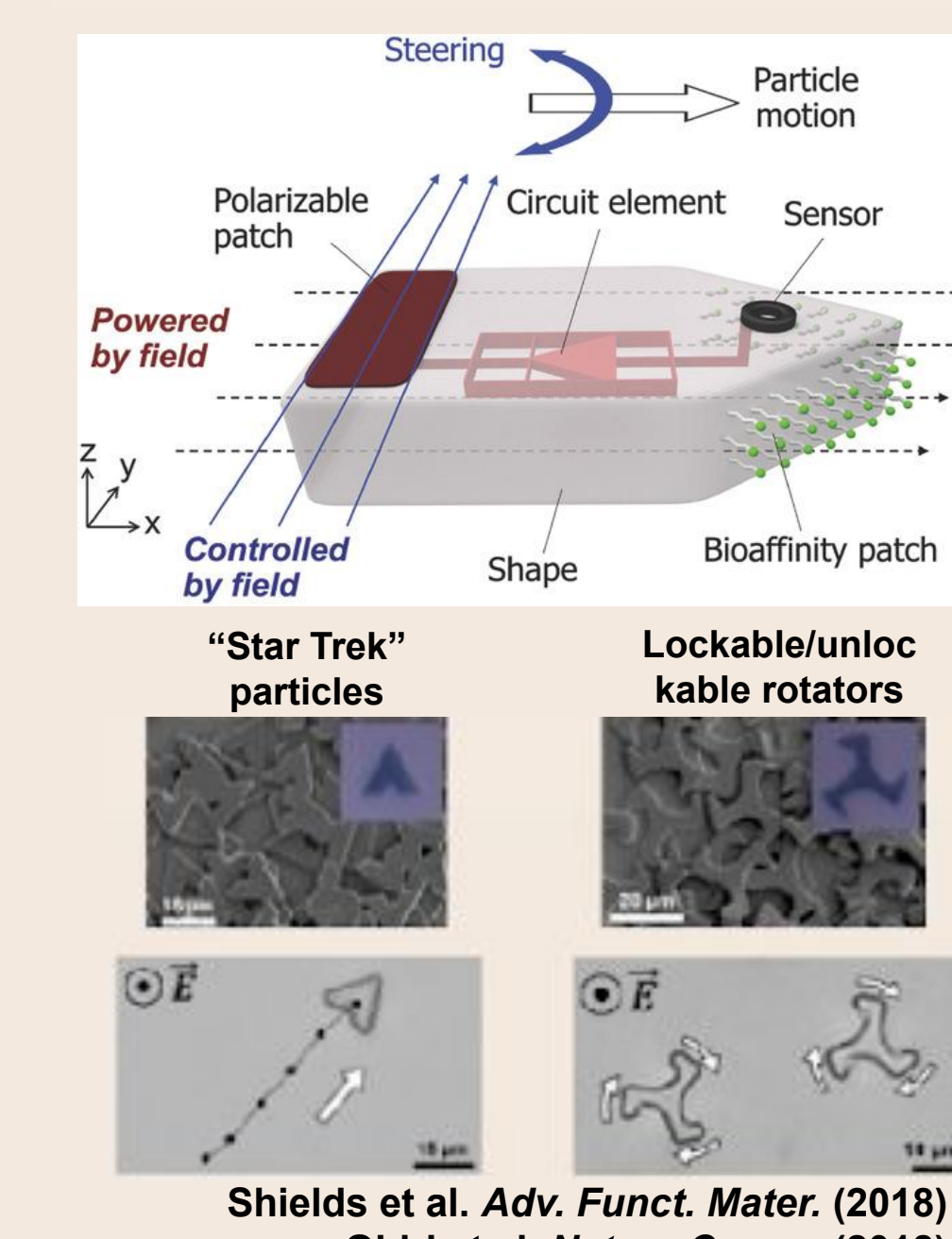
Remote powering/steering of self propelling circuits



AC field driven microdiode propulsion

Chang et al. *Nature Mater.* (2007)
Sharma et al. *Langmuir* (2012)
Sharma et al. *Adv. Funct. Mater.* (2015)

Vision: Autonomous microdevices



Chemically driven active particles

