High-Throughput, Scalable Nanomanufacturing of Nanocomposites via Micellular Electrospray

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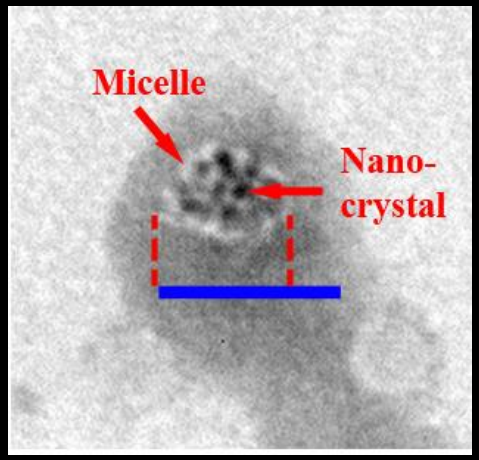

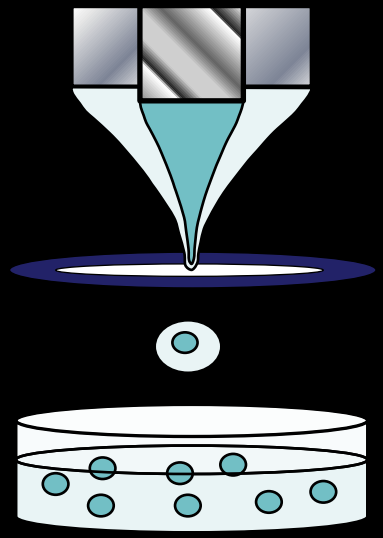

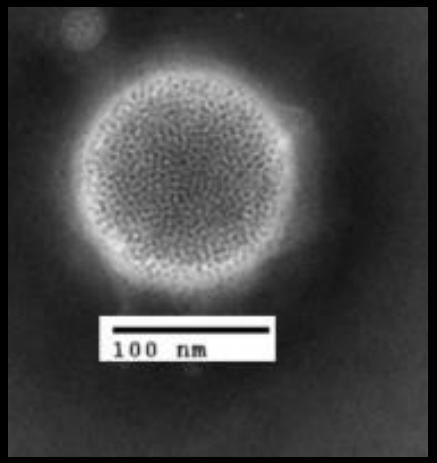

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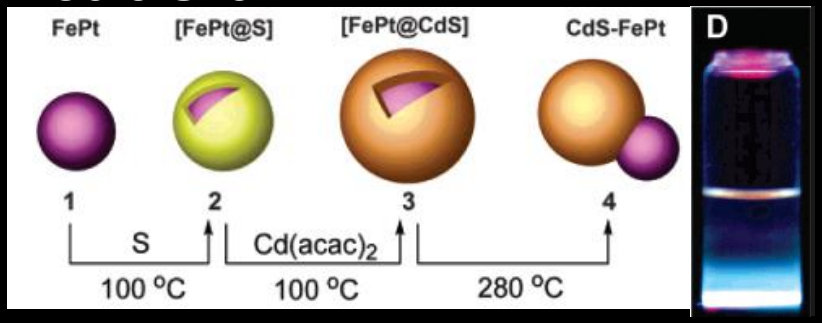
Nanocomposite Particles

<u>Quantum Dots</u>
Broad Excitation
Narrow Emission Bandwidths
Low photobleaching
High Quantum Yield

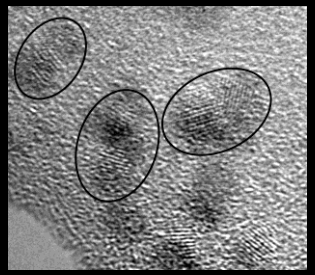
<u>Magnetic Nanoparticles</u>
Reduce T2 relaxation (MRI)
Biocompatible
Biodegradable
Exert force in magnetic field

Core-Shell



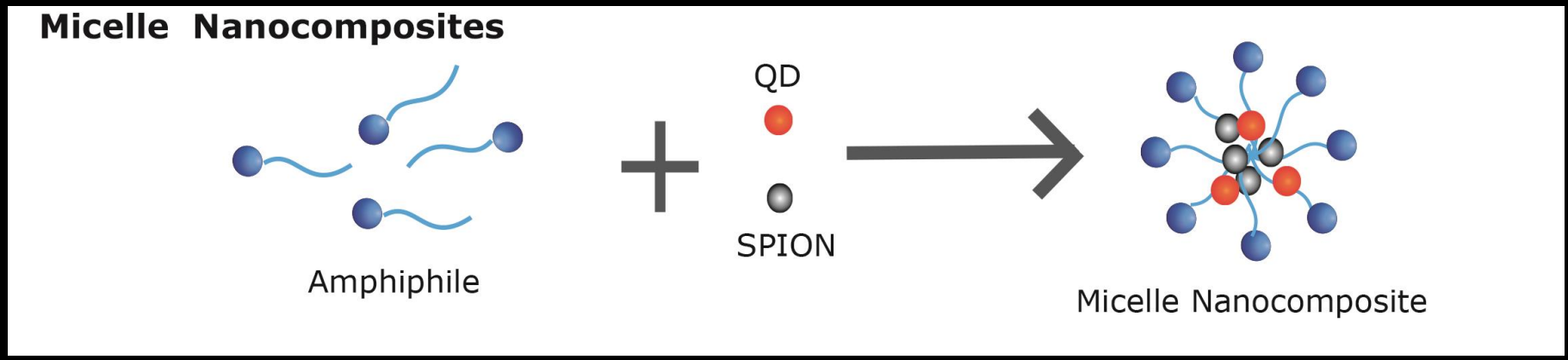
Gu et al., JACS, 2004, 5664

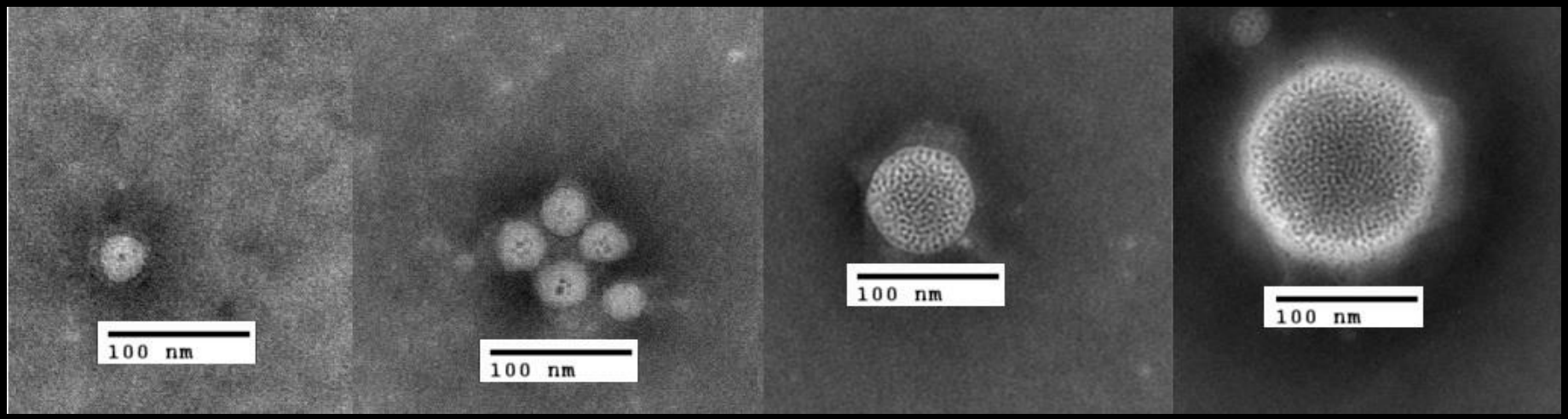
Interfacial Doping



Deng et al., Nanotech., 2010, 145605.

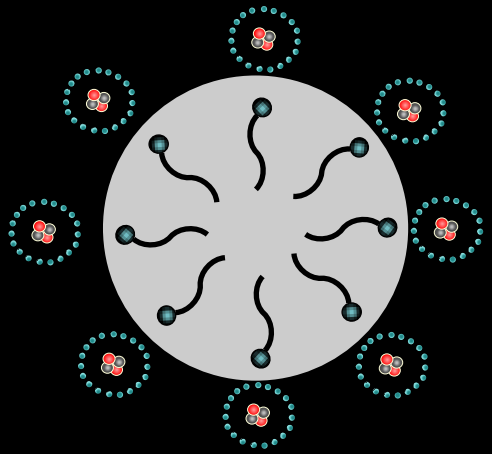
Self-Assembled Micellar Nanocomposites



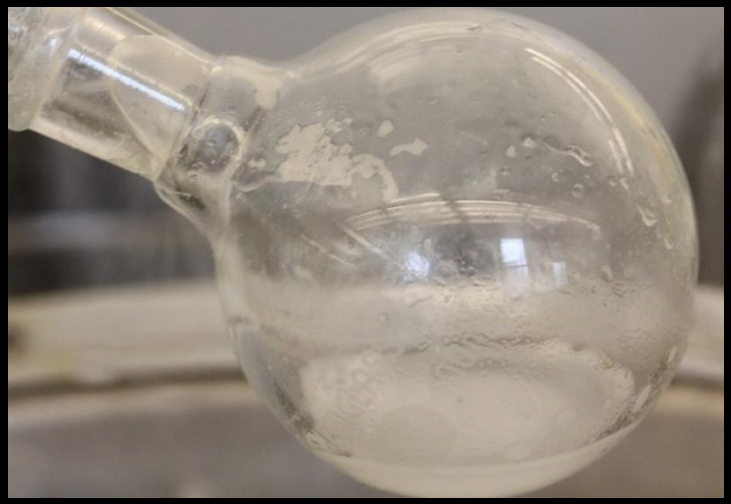


Ruan et al., Nano Letters, 2010, 2220;
Ruan et al. J Nanoeng Nanosys, 2010, 81
Ruan, Winter, Nano Letters. 2011, 941.

Interfacial Instability



1 batch ~ 0.1 mg



Zhu JT, Hayward RC. Journal of the American Chemical Society. 2008;130:7496-502.
Granek R, Ball RC, Cates ME. Journal De Physique Ii. 1993;3:829-49.
Animation by A. Duong

Introduction to Electrospray

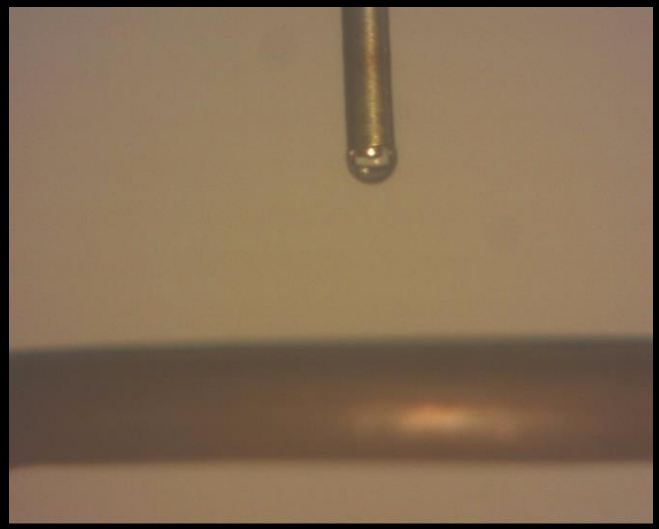
Collaboration with Barbara Wyslouzil, ChBE, OSU

Organic Solvent,
Polymer,
Nanoparticles

Aqueous Solution:
Water, Surfactant

High Positive
Voltage Applied

Ground

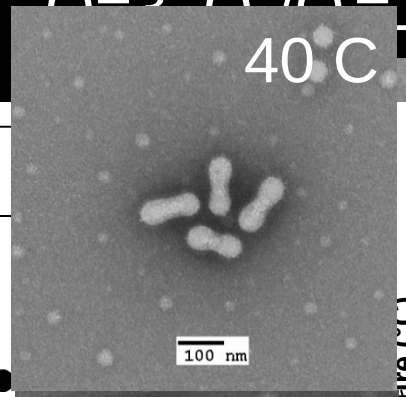


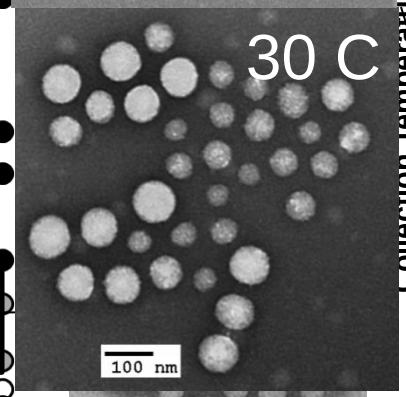
Collection Dish
(Water)

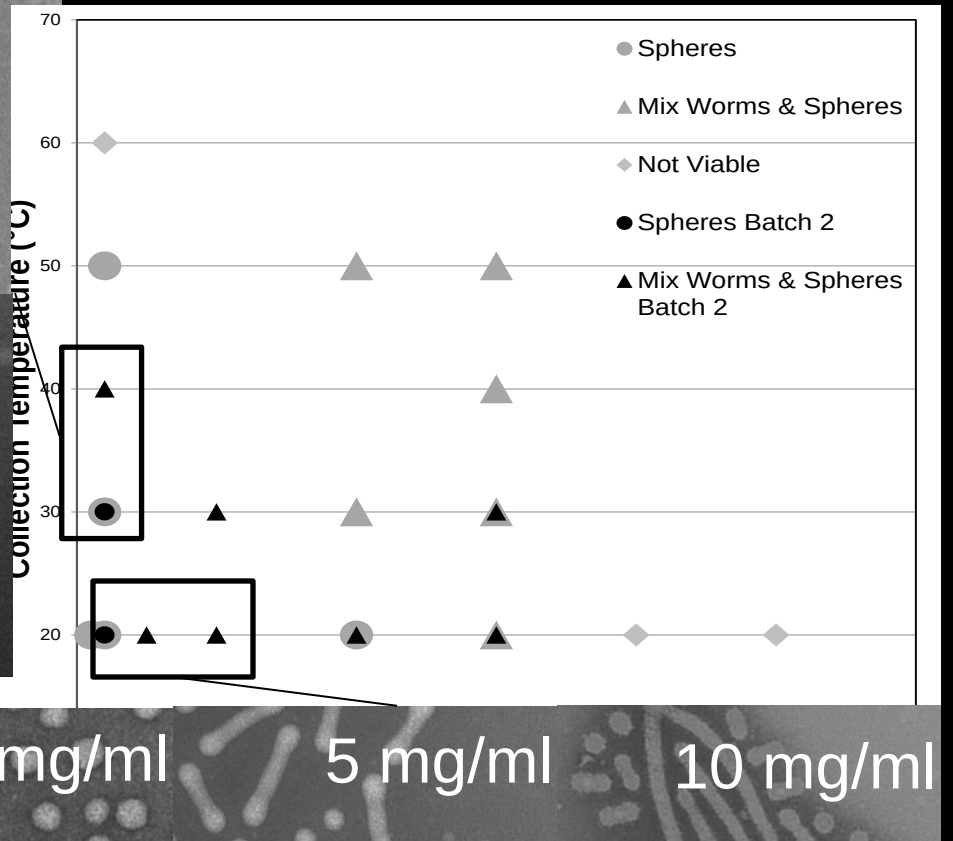
Manuscript in Preparation

Process Optimization

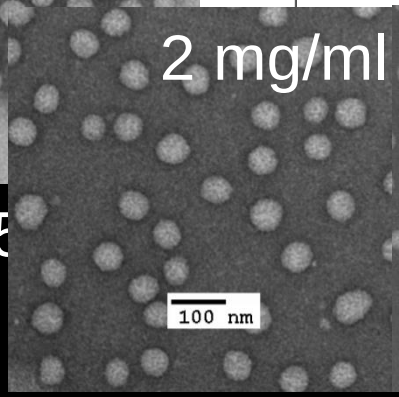
Q=3, Q_i/Q_o=14

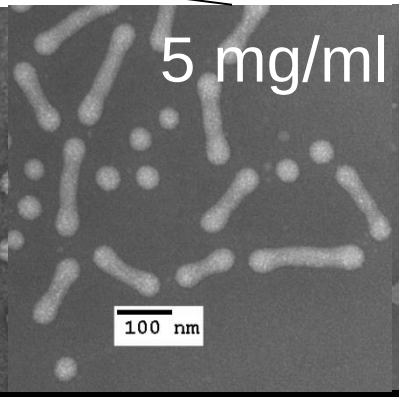


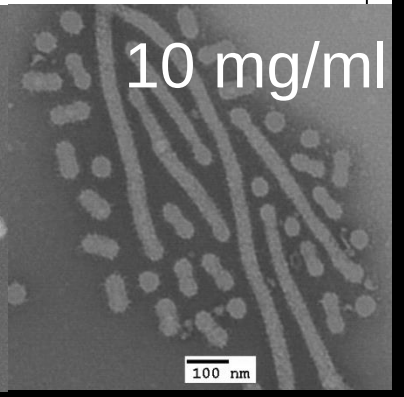




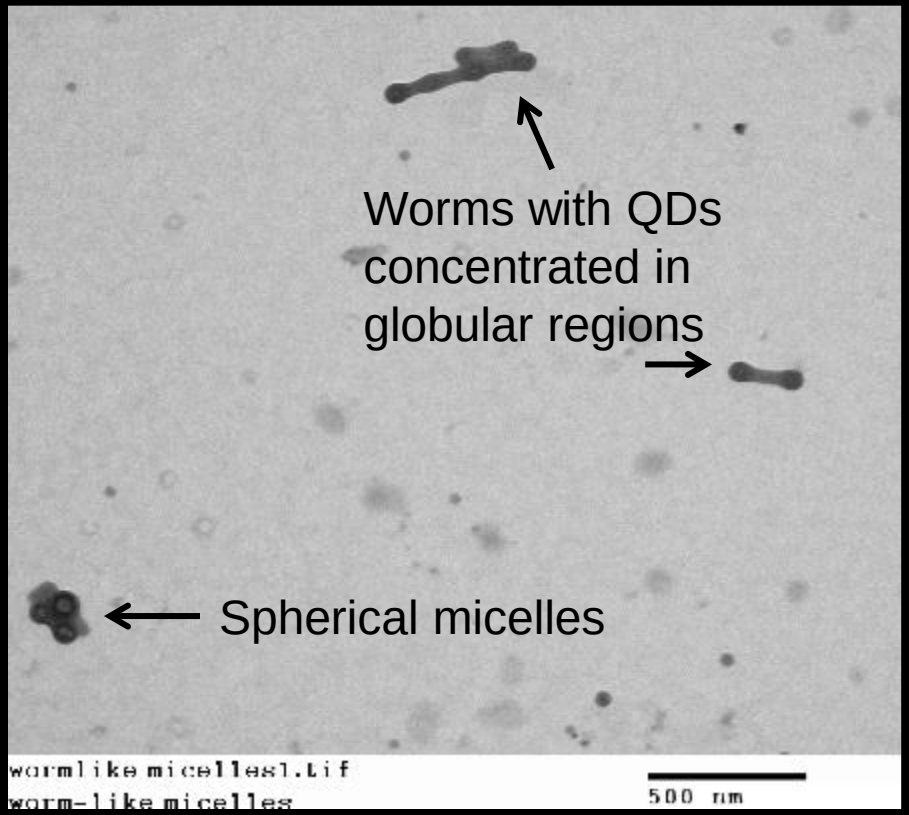
Q=3.5

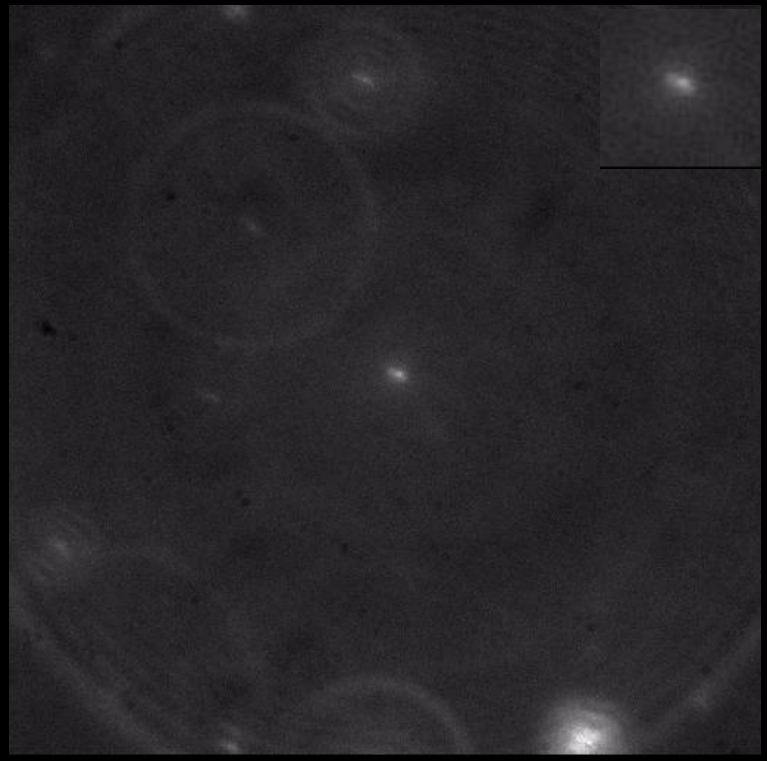




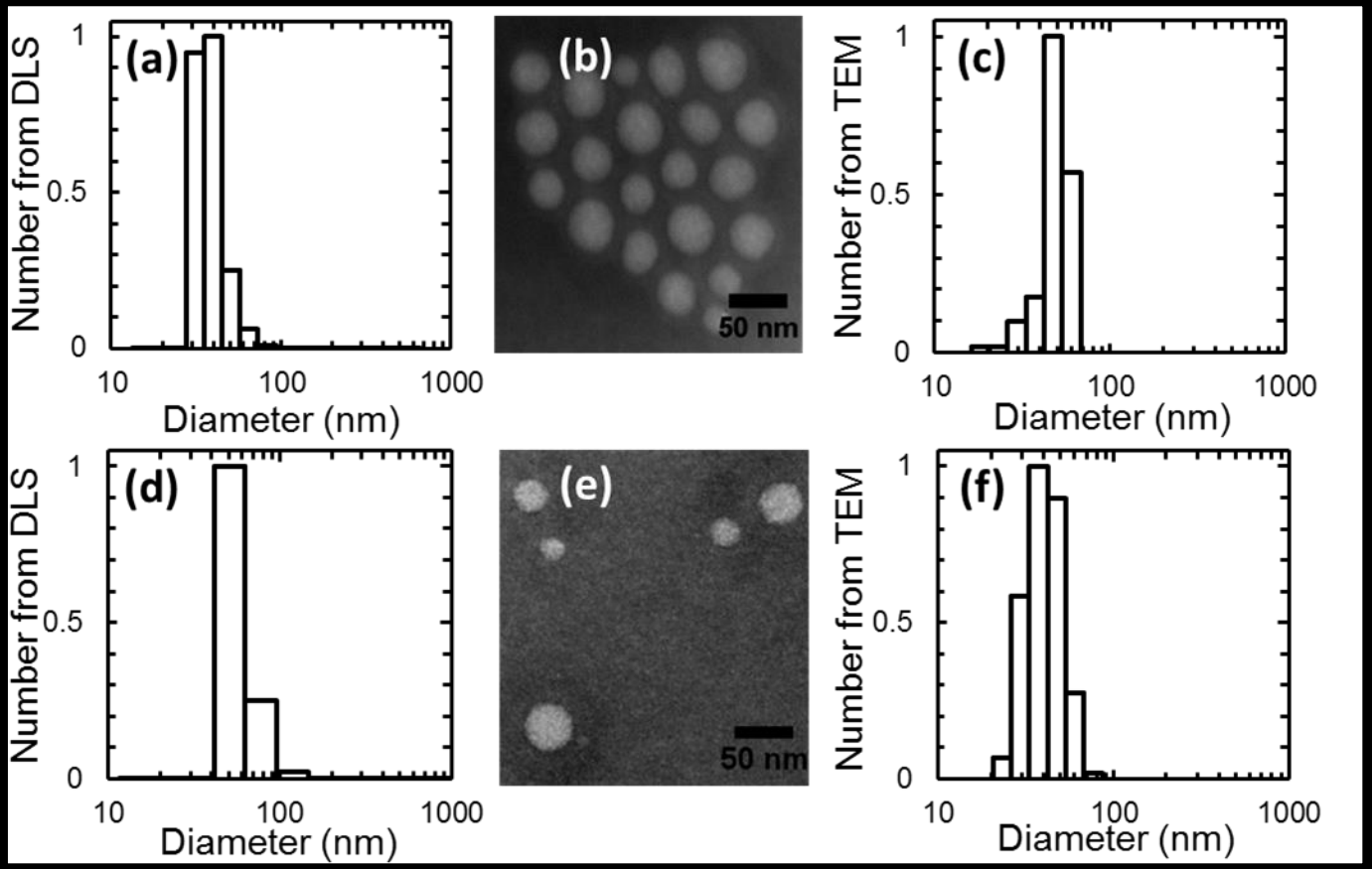


Wormlike Micelles





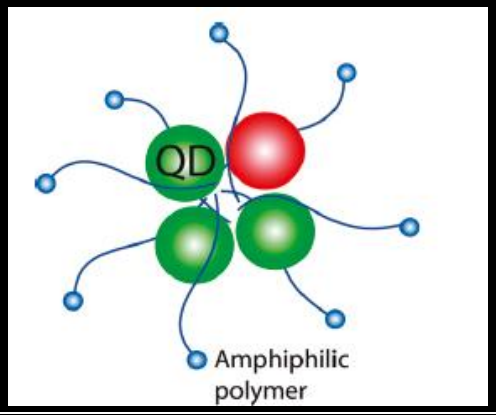
Yield and Size Distribution

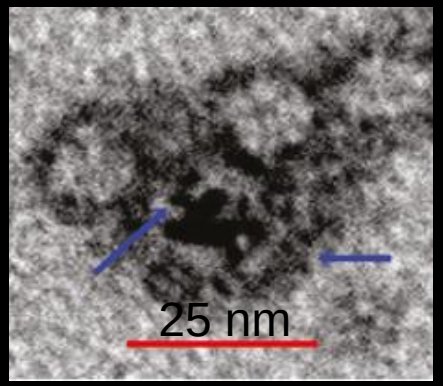


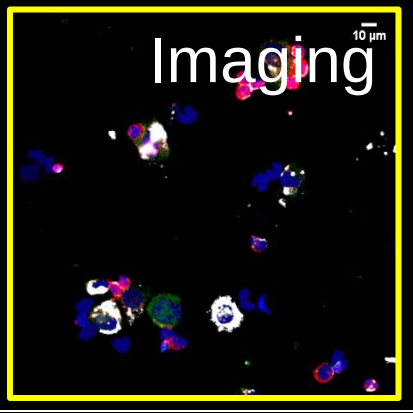
30 fold increase in yield
15% size distribution

Particles Produced and Uses

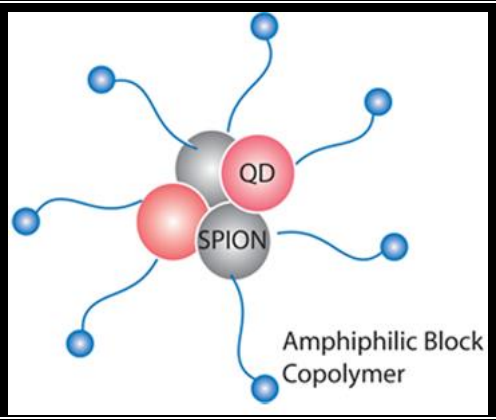
MultiDot: QDs

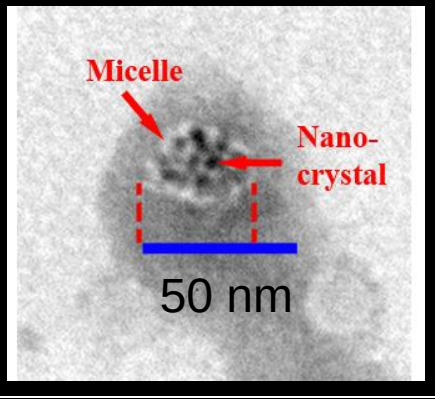


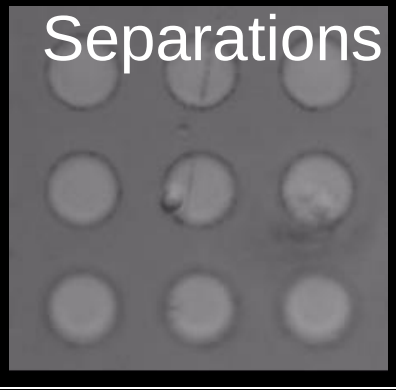




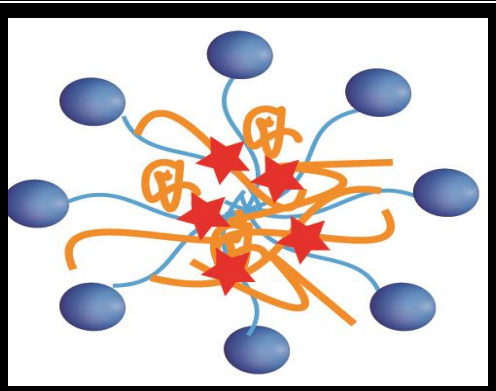
MagDot: Magnetic QDs

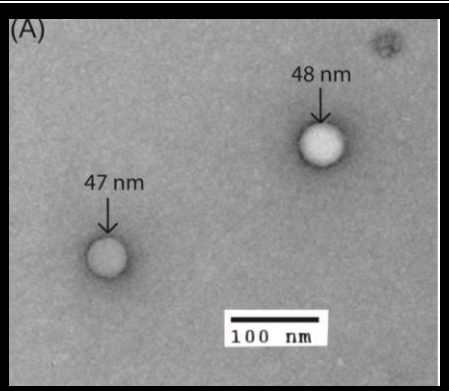


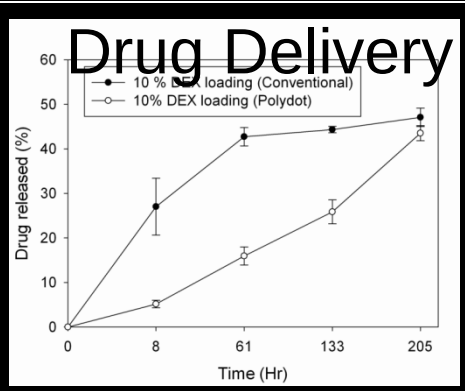




PolyDot: Polymer NPs

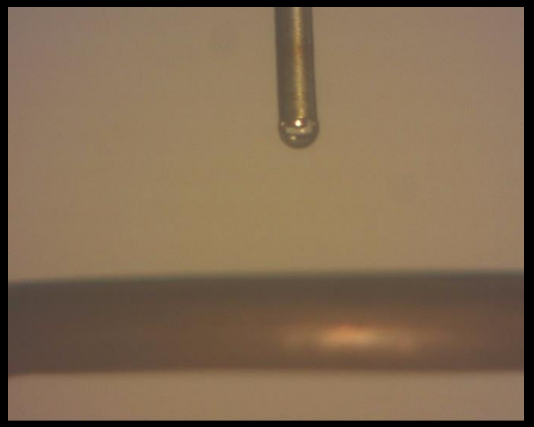




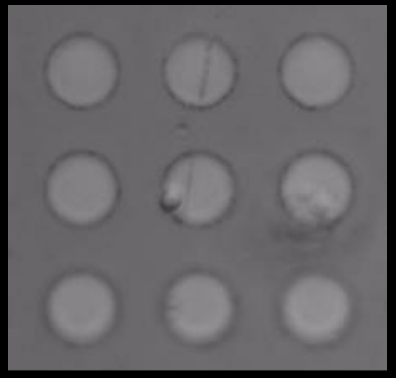


Conclusions

- Micellar nanocomposites can be synthesized by interfacial instability.
- Nanocomposites can be synthesized by electrospray increasing yield and with potential for continuous fabrication.



- Synthesis is robust, with little change in particles produced over a wide range of process parameters.
- Alternative structures can be created by altering polymer characteristics.



- Several types of particles can be produced using this approach.
- Particles have applications in several fields.

The [illegible] Group

Collaborators: Jeff Chalmers (ChBE, OSU), Barbara Wyslouzil (ChBE, OSU), R. Sooryakumar (Physics, OSU), Maryam Lustberg (Med. Oncol., OSU), George Bachand (Sandia), Peter Kner (University of Georgia)

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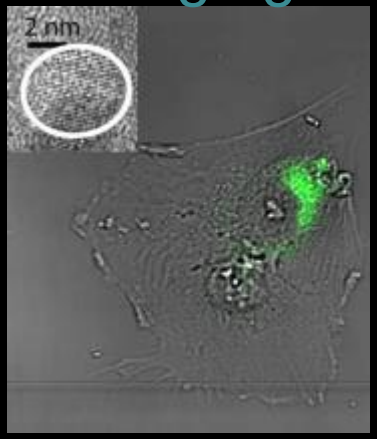
NIH: 1RC2AG036559 – 01

DOE: Center for Integrated Nanotechnologies (CINT)

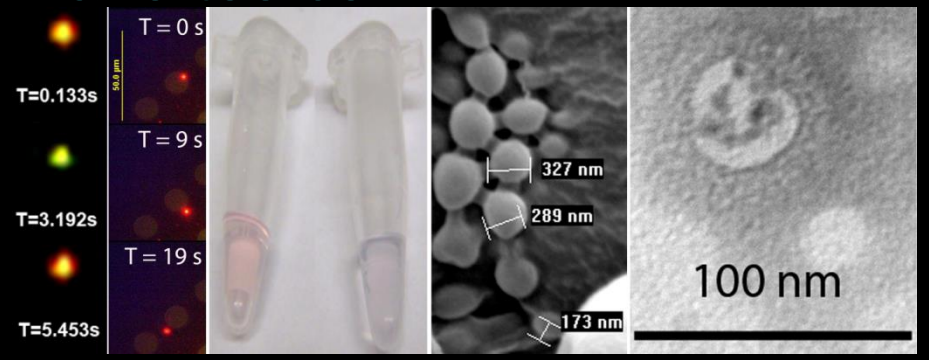
The Ohio State University: Institute for Materials Research, Department of Chemical and Biomolecular Engineering, Women in Philanthropy, H.C. “Slip” Slider Professorship

The Winter Lab at OHIO STATE UNIVERSITY

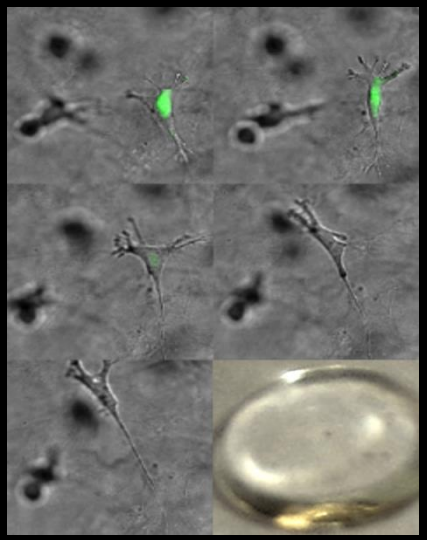
Imaging



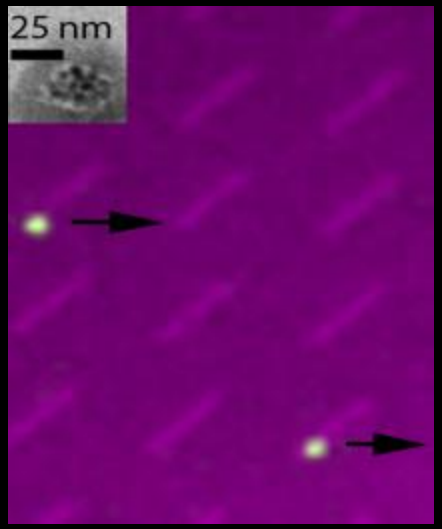
Nano-toolbox



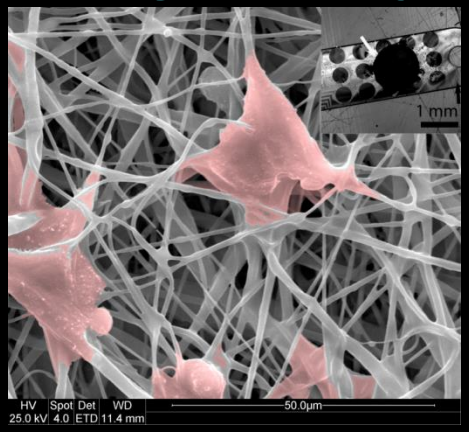
Biomimetics



Manipulation



Drug Delivery



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