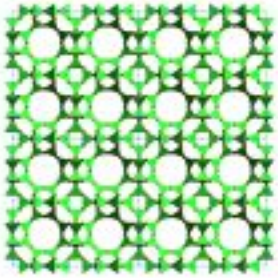
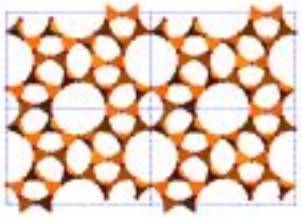
Molecular Sieve Membranes

Zeolites

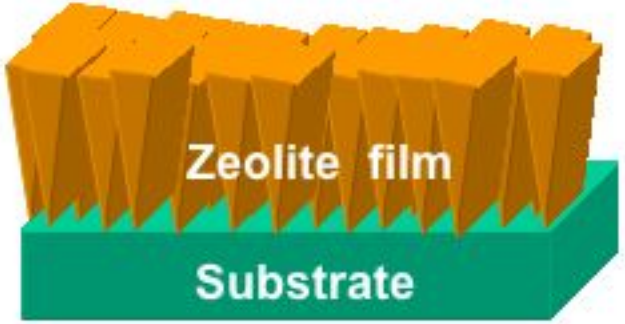
LTA

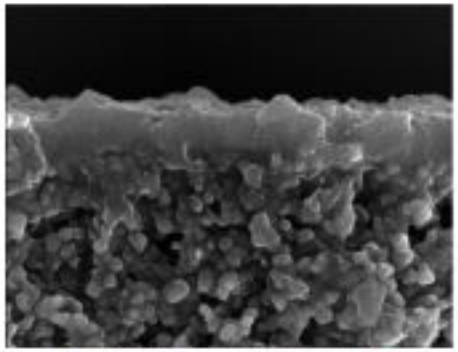


MFI



Supported Zeolite membranes





Applications

Corrosion Protection layers

Separation membranes

Catalytic membranes

Chemical Sensors

Insulation layers

Environmental protection

Nano-technology

:

- Pores of molecular Dimensions
- High thermal and chemical stability

Funded by NSF (CTS-0091406)
NSF (CTS-0103010)
NASA-Microgravity (98 HEDS-05-218)

Science 300, 456-460 (2003)

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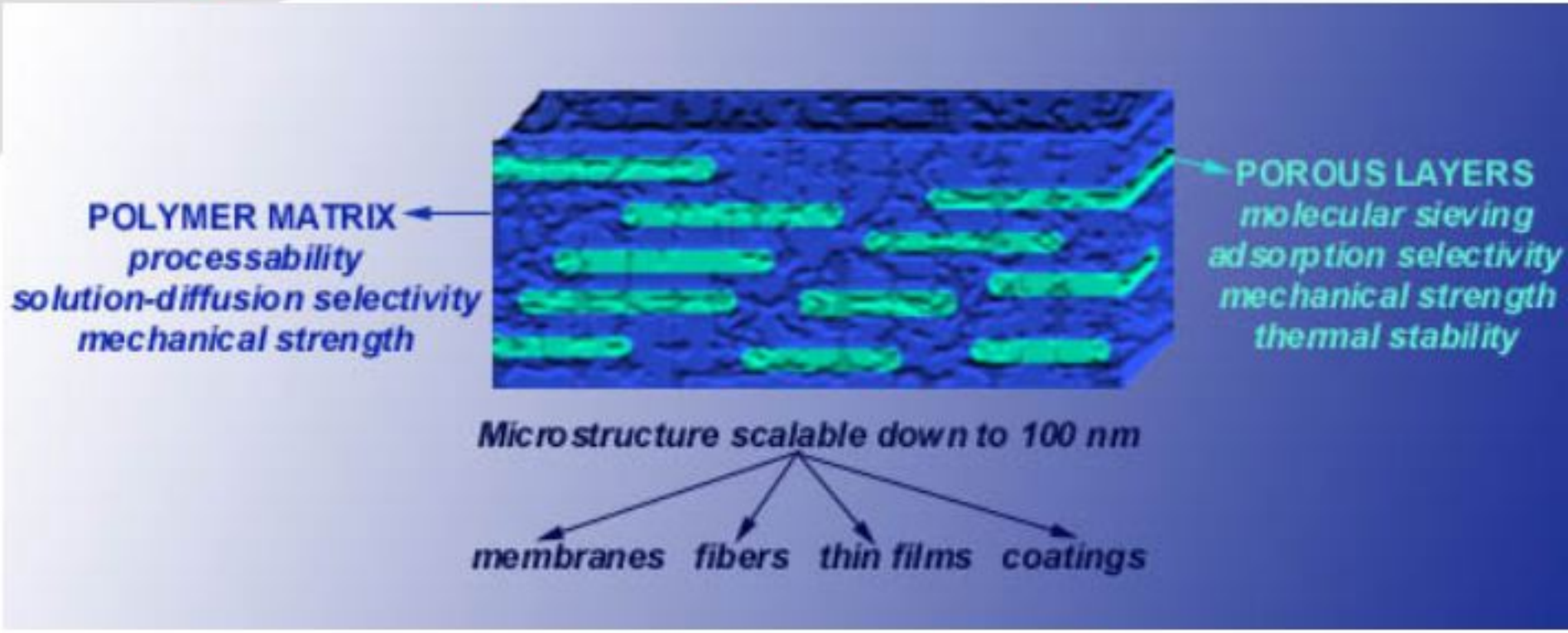
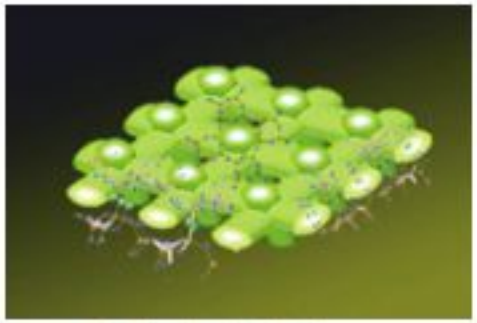
University of Minnesota

Polymer/Microporous-Layer Nano-Composites



The first layered silicate with 3-D microporosity



Nature Materials 2, 53-58 (2003)

In Collaboration with
Professor Eva Marand (Virginia Tech)

Funded by NSF (CTS-0091406)
NSF (CTS-0107488)

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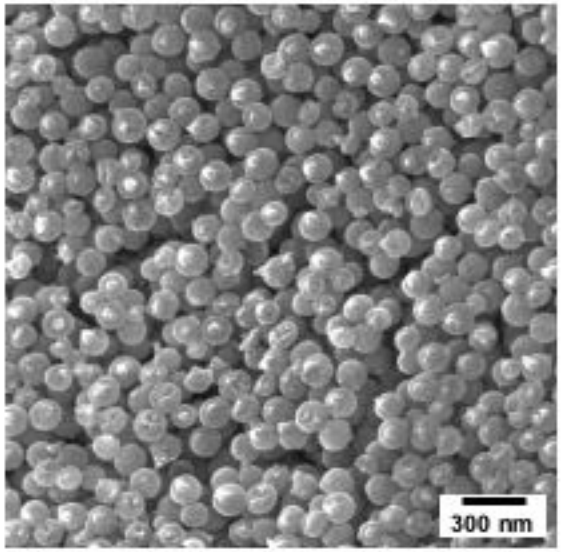
University of Minnesota

Haiyan Ge H. Ted Davis and L.E. Scriven

Cryogenic SEM of nanostructured soft materials --- Latex

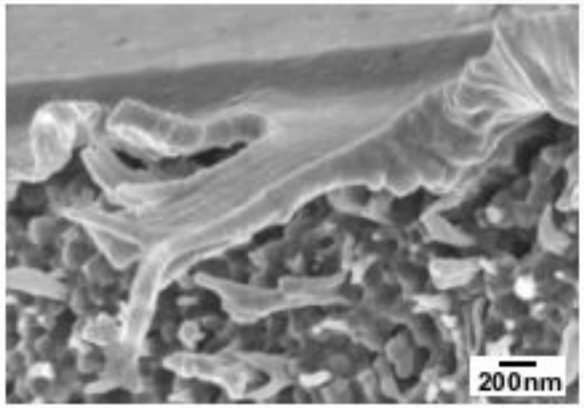
Dept. of Chem. Eng. & Matr. Sci.

- Wide industrial applications in paint, paper, textile, adhesive ...
- Potential application in filter resin, hair gel ...
- Change from colloidal stable suspension into cohere film during drying
- Nanostructure is crucial to coating performance



Haiyan Ge H. Ted Davis and L.E. Scriven

- Characterization of latex by Cryo-SEM
- Investigate microstructure evolution during latex film formation & film properties
- Skinning in latex coating drying



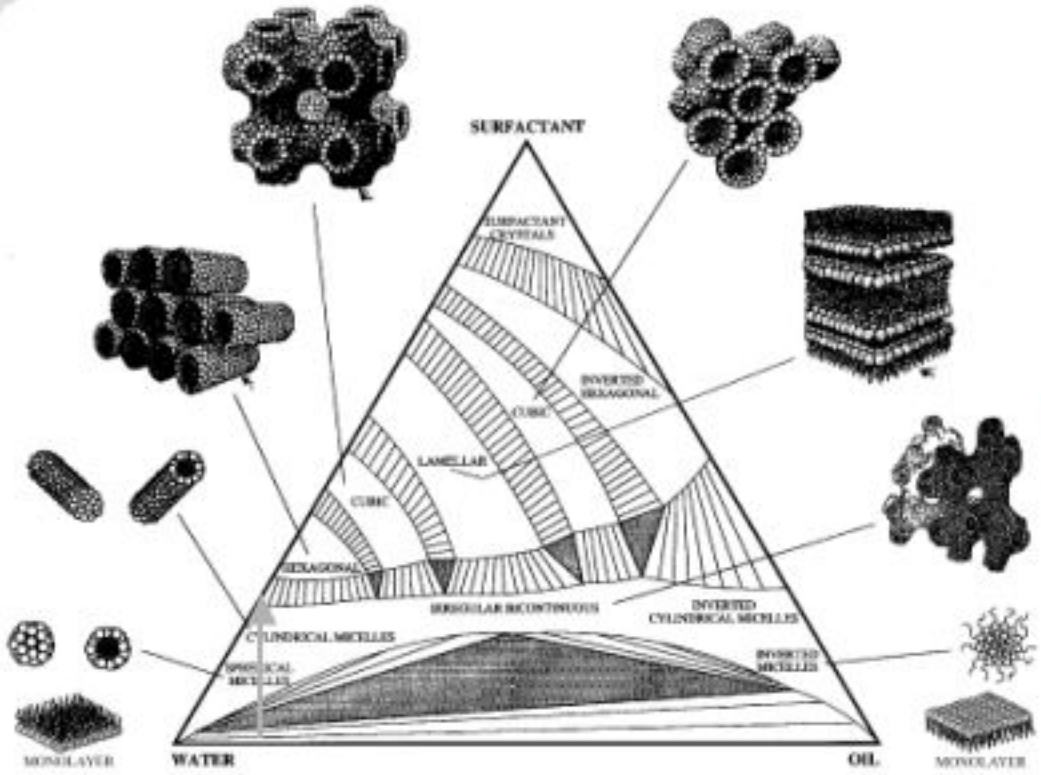
Skinning captured by Cryo-SEM in drying styrene-butadiene latex coating

- Skinning depends on latex particle surface properties, Tg & drying condition...
- Latex particles can stabilize bubble in the coating

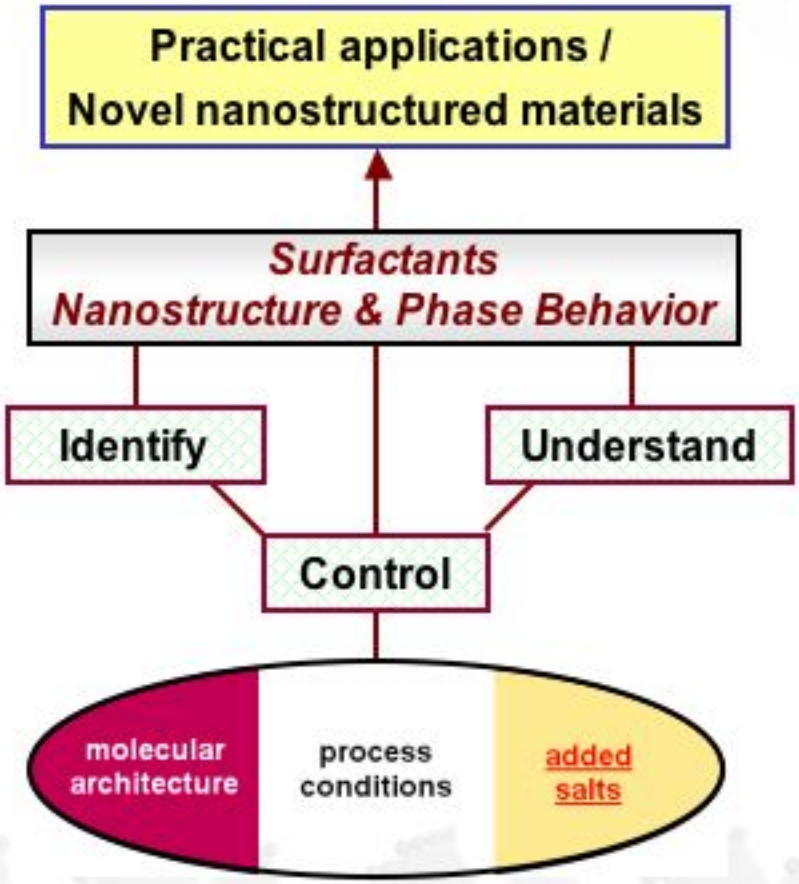
H. Ted Davis, Alon McCormick & Bin Lin

Nanostructure & Phase Behavior of Surfactant Systems

Chemical Engineering & Materials Science



Nanostructure is the crux of liquid's behavior



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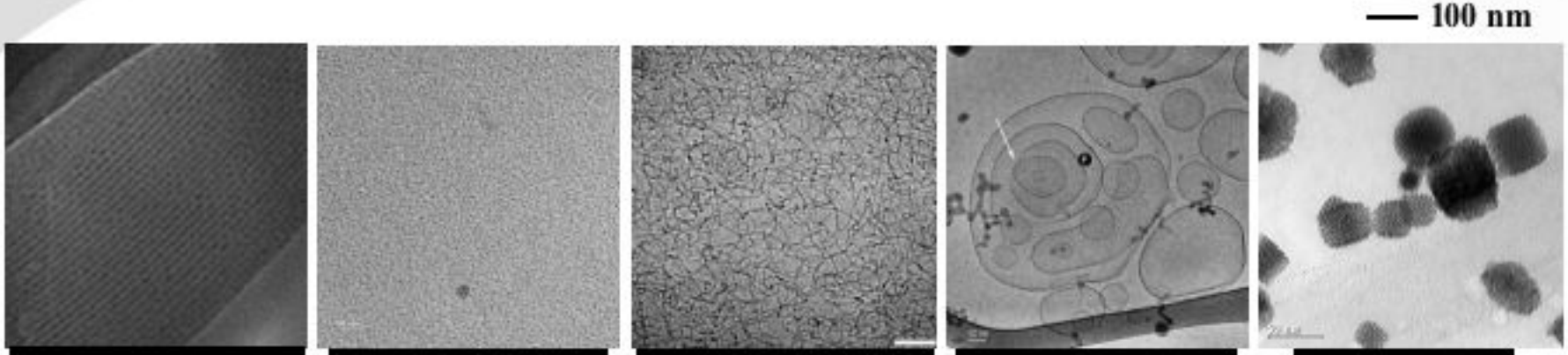
H. Ted Davis, Alon McCormick & Bin Lin

Nanostructure & Phase Behavior of Surfactant Systems

Chemical Engineering & Materials Science



Nanostructure Transformation

Characterization

- ☑ *Scattering Techniques*
- ☑ *Cryogenic Electron Microscopy*
- ☑ *DSC, NMR, etc.*

Understanding

- ☑ *Thermodynamics Theories*
- ☑ *Molecular Simulations*
- ☑ *Multiscale Linking Framework*

Active Control

- ☑ *Molecular Architecture*
- ☑ *Process Conditions (C, T, etc.)*
- ☑ *Additives (salts, etc.)*

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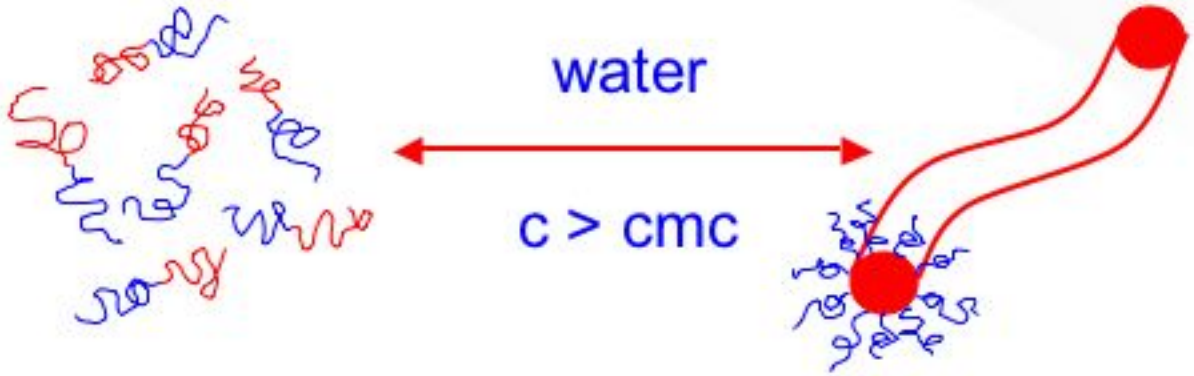
Amphiphilic block copolymers

- Self assembly



- Driving force = shielding of unfavorable interactions

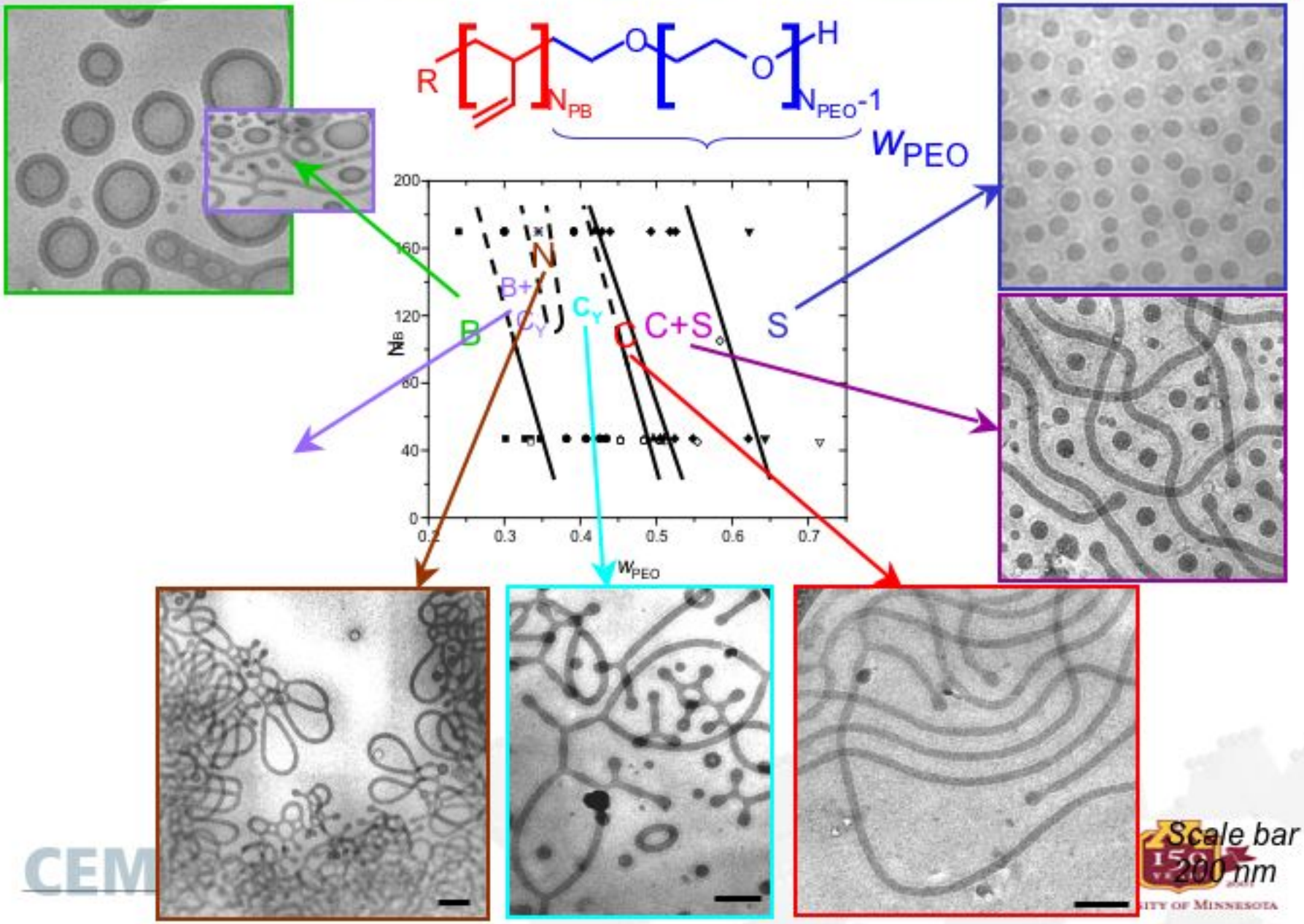
- Block copolymers : complex but advantageous
  - = tailorablity
  - = better properties - mechanical strength

A. Eisenberg and coworkers

Won, Davis and Bates, *Science*, **283**, 960(1999)

- Detergents, Foaming agents, oil well services, Drug-delivery, Biomimetic structures ……

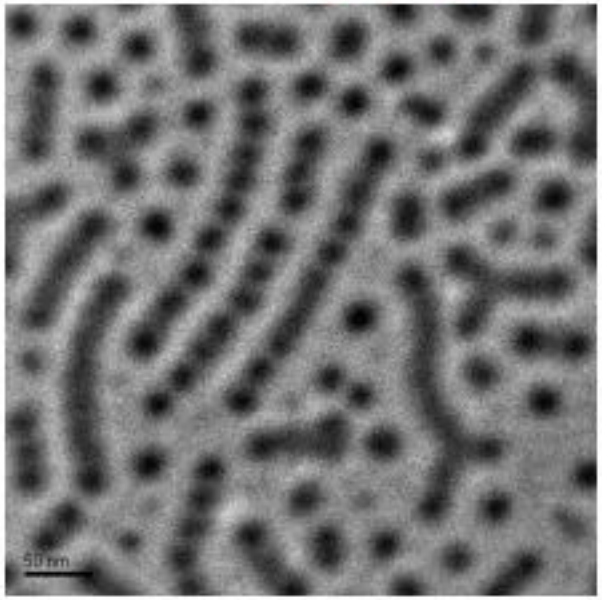
Morphologies



Tim Lodge

Block Copolymer Nanostructures

Departments of Chemistry and Chemical Engineering & Materials Science



Strings of micelles formed by ABC triblock "mikto-arm" star copolymers, imaged by cryo-TEM

- Discrete nanostructures by self-assembly
- Can be used for precision delivery of multiple agents
- Explore strategies for hierarchical self-assembly

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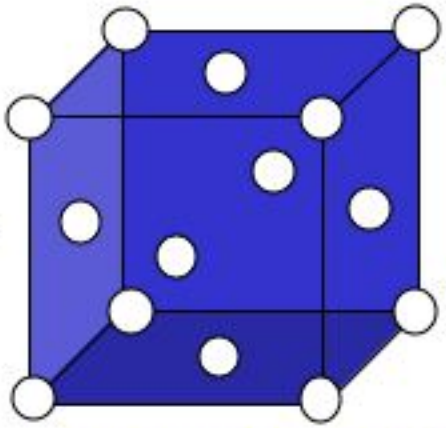
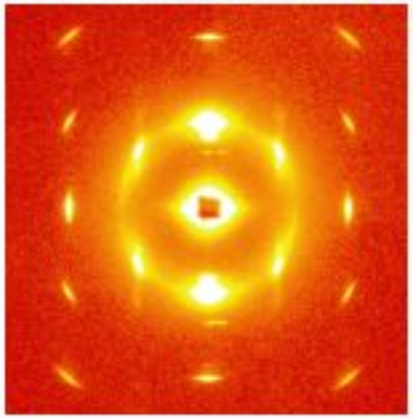
Tim Lodge

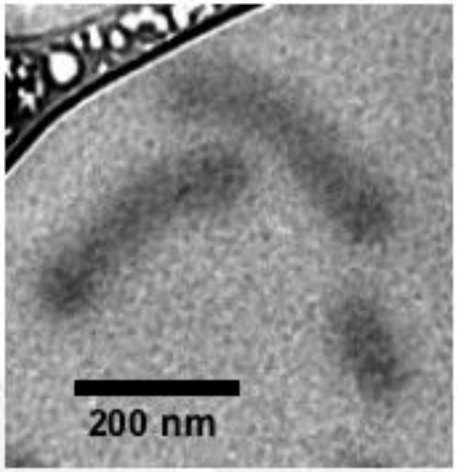
- Control of micellar assembly in 3D
- Applications in templating, photonics, etc.





Fcc superlattice of block copolymer micelles, and SAXS diffraction from shear oriented solution

- Control of micellar shape
- Applications in oil recovery, "green" polymer processing



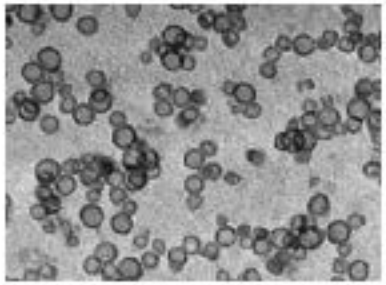
"Sausage micelles" from simple styrene-isoprene copolymers, imaged by cryo-TEM

T. Andrew Taton

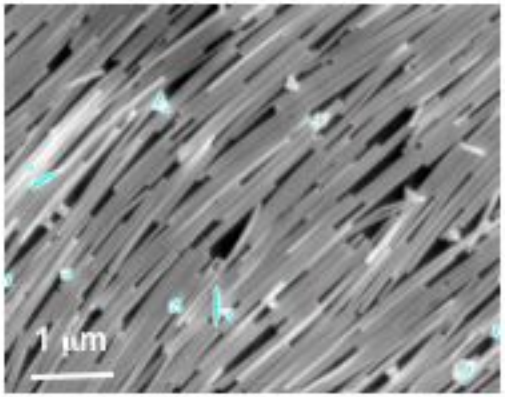
Department of Chemistry

Polymer-Nanoparticle/Nanowire Hybrids

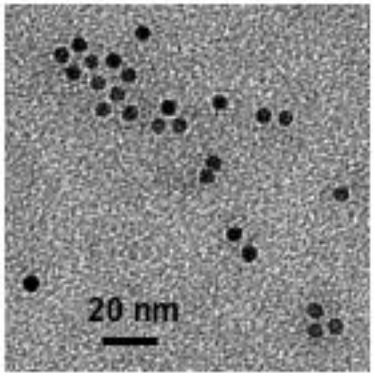
- *Opportunity:* Expanding toolbox of exotic inorganic nanomaterials w/ useable properties
- *Problem:* Surface chemistry, compatibility of many nanomaterials is poor



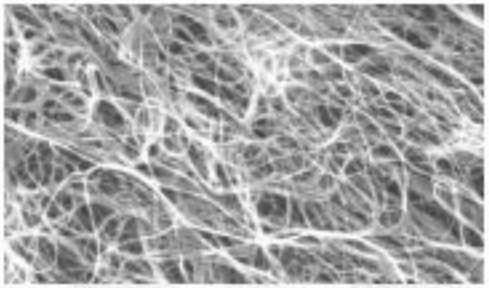
Hollow metal nanoshells



Conductive gold nanowires



Superparamagnetic Fe_2O_3 nanoparticles



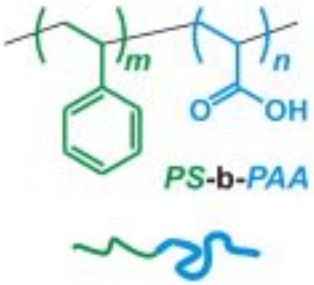
Carbon nanotubes

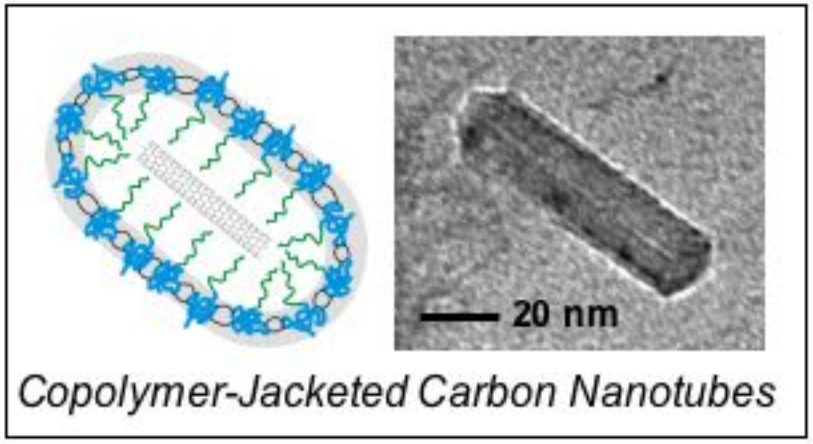
T. Andrew Taton

Department of Chemistry

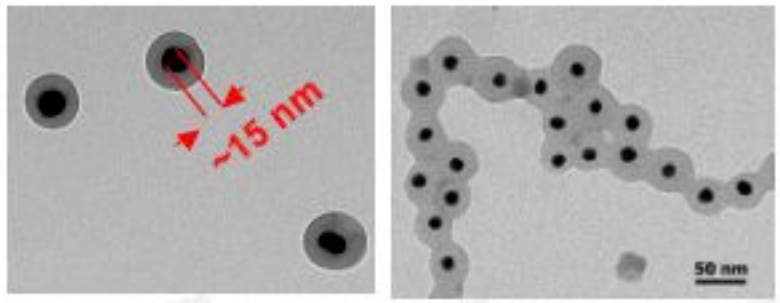
Polymer-Nanoparticle/Nanowire Hybrids

- *Solution:* Assemble copolymer nanostructures with inorganic nanostructures
- *Applications:*
  Bioimaging, labeling
  Drug delivery
  Mechanical reinforcement
  Conductive nanocomposites
  Optical composites





Copolymer-Jacketed Carbon Nanotubes



Copolymer-Stabilized Nanoparticles

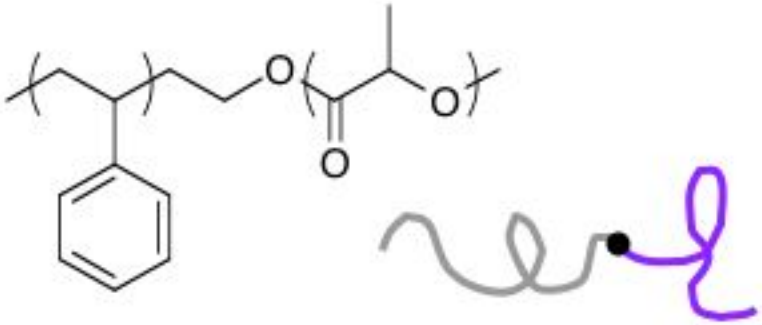
CEMS Chemical Engineering & Materials Science

University of Minnesota

Marc Hillmyer

Functional Nanostructured Polymers
Chemistry Department

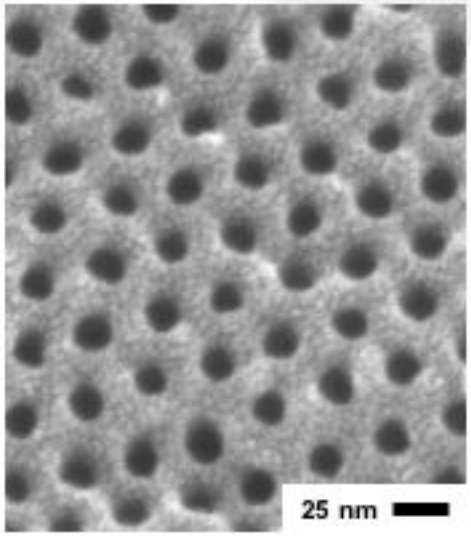
- Block copolymers naturally self-assemble on nanometer length scales
- Chemical control of the materials leads to morphological control
- Variety of functionalities can be readily incorporated
- Applications from templating to catalysis to separations



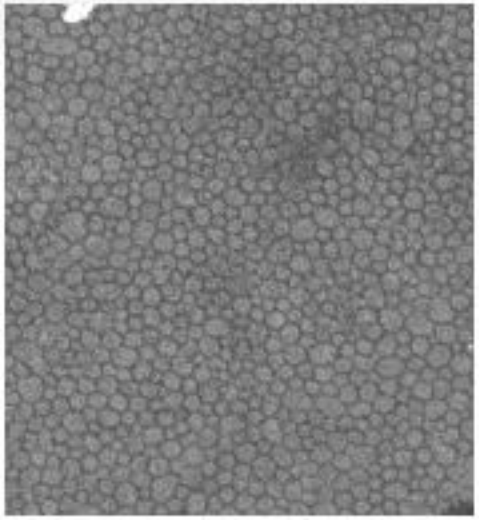
Marc Hillmyer

- Functional nanoporous materials from block copolymer templates
- Physical and chemical property control
- Design and preparation of nanomaterials for novel applications

nanoporous PS



nanodot array



- Successful use as nanodot and nanowire templates
- Organic crystal polymorph selection (e.g., pharmaceuticals)

Collaborations with C. Leighton and M. Ward