Keith Johnston Research Group

Nanomaterials Chemistry/Colloid and Interface Science/Polymer Science

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Nanoparticle and Nanocapsule Interactions with Liq. and Solid Interfaces

Smart polymer nanocapsules for controlled release (subsurface reservoirs, drug delivery) (Guihua Yu)

Oil/water and gas/water interfaces (emulsions and foams) (Prodanovic, DiCarlo, Enick: Pitt)

Solid surfaces (adsorption and transport in porous media, electrocatalysts) (Pennell: Brown, Yu, UT)

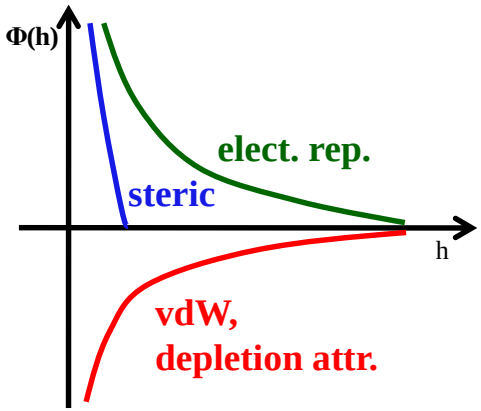
Adv. Fxn'l Nanomaterials (metals, metal oxides, polymers)

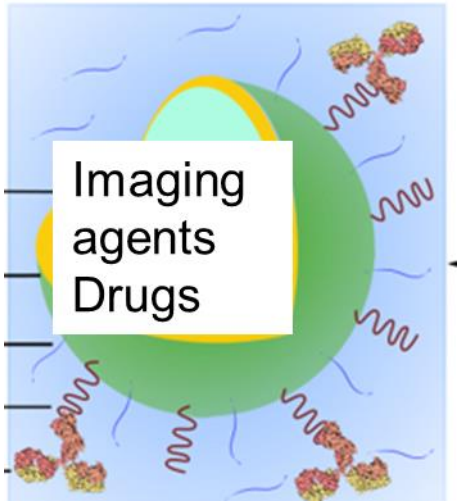
Nanocapsules for cancer imaging (with Truskett and Sokolov: UT MDA Cancer Center)

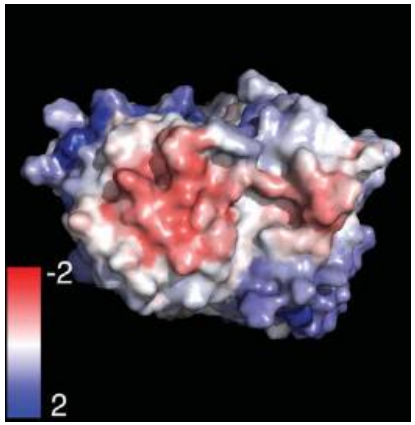
Electrochemical energy storage (oxygen evolution, oxygen reduction reactions) (Guihua Yu, UT Mat. Sci.)

Monoclonal antibody stability and drug delivery (colloid and polymer science)

Morphology , protein-protein interactions, statistical mechanics and rheology, SAXS (Truskett)

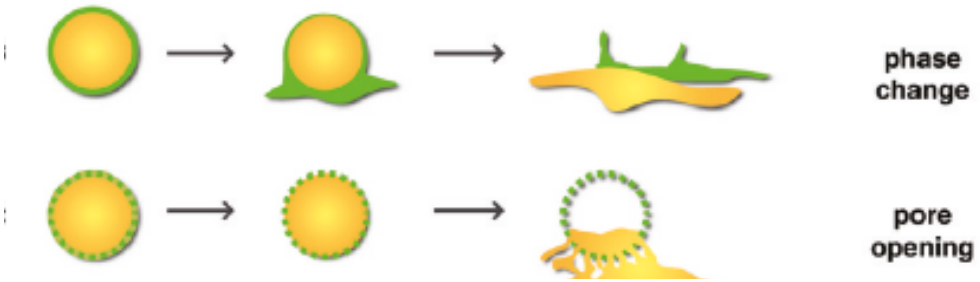






Electrostatic

Controlled release of chemicals with stimuli responsive nanocapsules (energy applications and drug delivery)



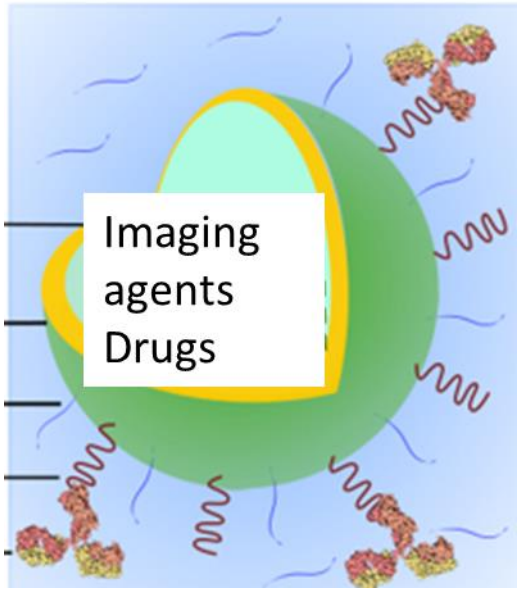
T goes above Tg or Tm of shell

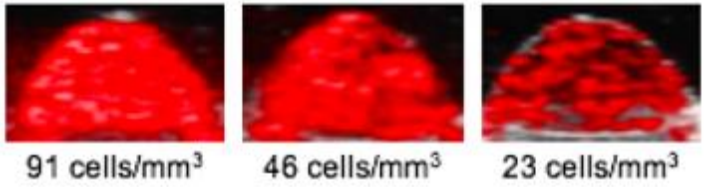
Mixture of polymers
One shrinks with heat leading to pores

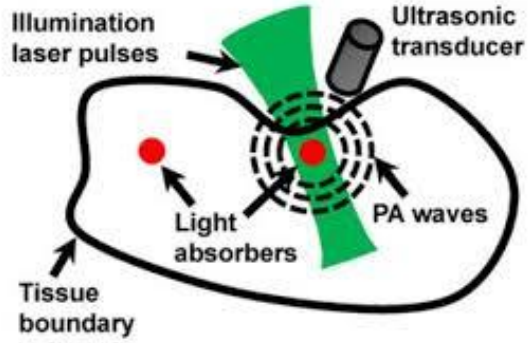
Esser Kahn, Moore 2011

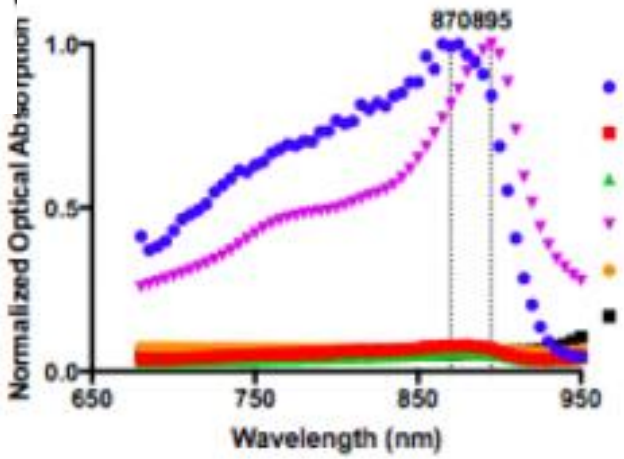
- T, pH, salinity, mechanical forces
- Use chemicals more efficiently, raise oil production and in greener manner (crosslinkers for conformance control, enhanced oil recovery chemicals)
- Coat capsules with polymers for colloidal stabilization and migration in reservoirs
- Cancer imaging project with polymersomes: use acid pH in endosomes for release

Design of platform polymersomes with colloid and polymer science: advance imaging and therapy goals









Austin: Johnston and Truskett

Houston: UT MD Anderson Cancer Center Sokolov
Photoacoustic imaging: cells ovarian cancer cells

Objectives: Controlled size of polymersomes

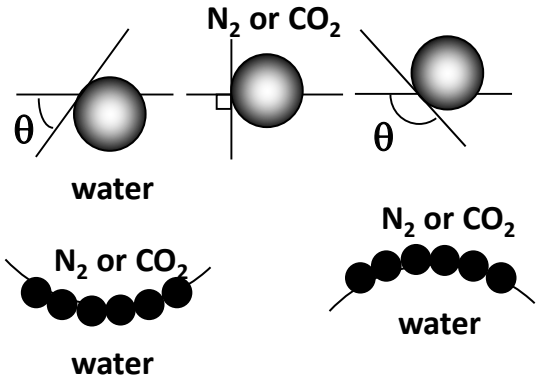
Platform particles, nontoxic, stable for 24 hours, clearable, FDA approved materials

mAbs targeting of particular cancers: click chemistry azides with alkynes

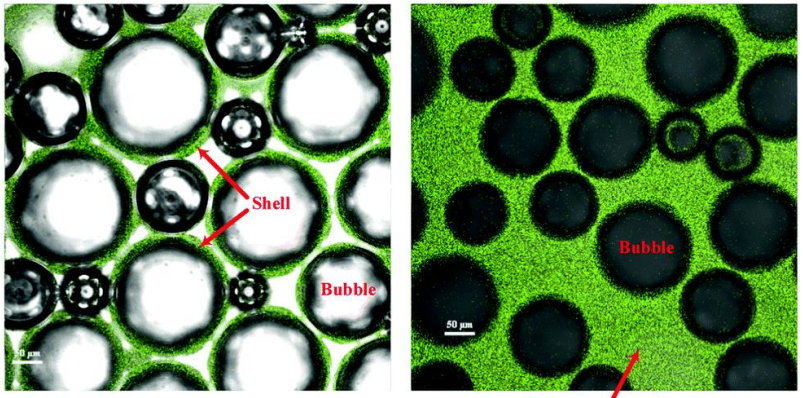
Cocktails of imaging agents and drugs: easy to load in capsules

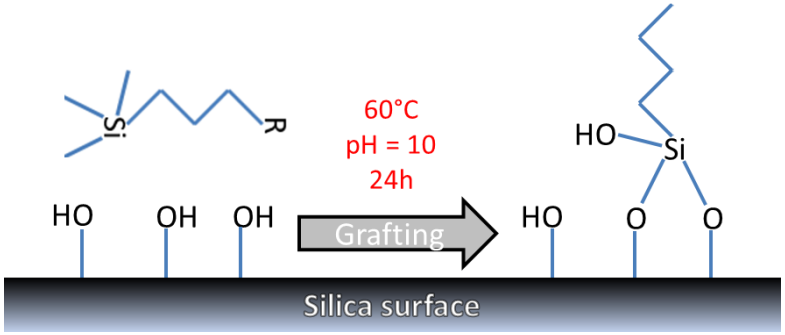
Changes define biological processes in endosomes (example of future goal)

Designing Interfacial Properties of Nanoparticles/Polymers/Surfactants: Foams, Wettability Alteration and Advanced Materials



$$E = \pi r^2 \gamma_{ow} (1 \pm \cos\theta)^2$$





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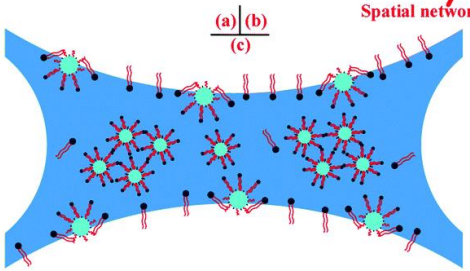
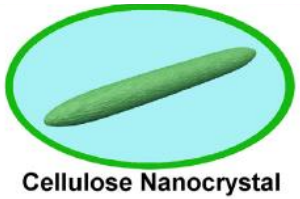
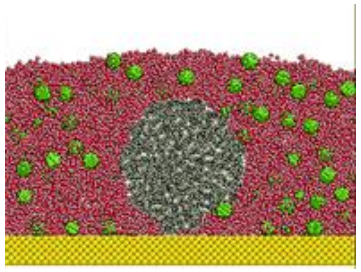




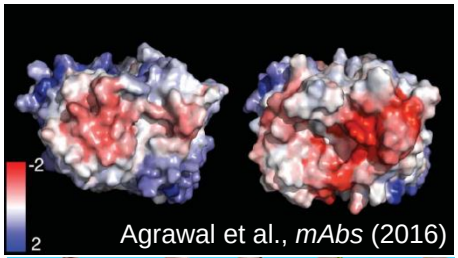


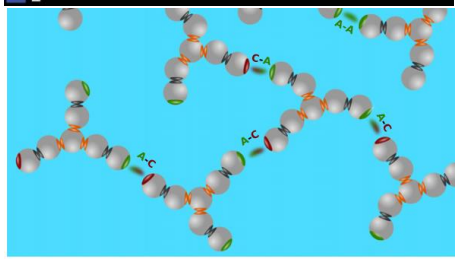
Nanoparticle synthesis/surface modification:
NMR, TEM, θ, static and dynamic γ
Nanoparticle colloidal stability: DLS, SAXS
Nanoparticle adsorption and assembly
Interfacial and bulk rheology
Foam morphology and rheology

Applications:
Subsurface CO2 sequestration, oil recovery, green fracking
Relevant in many fields: materials, energy, electrocatalysts, environment

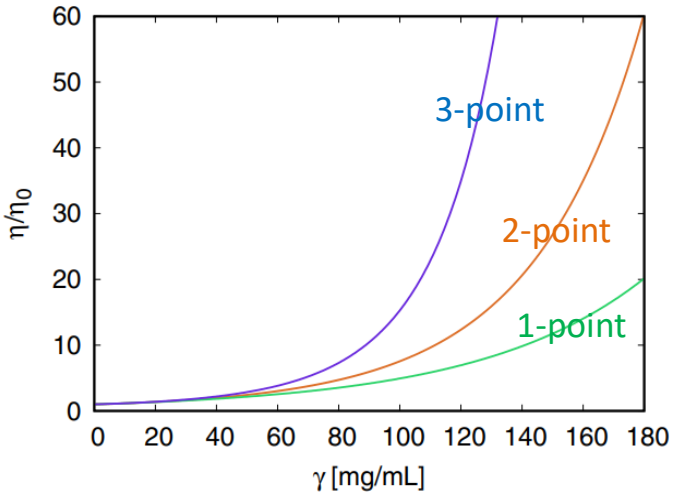
Understanding Protein-Protein Interactions/Rheology at High Conc.

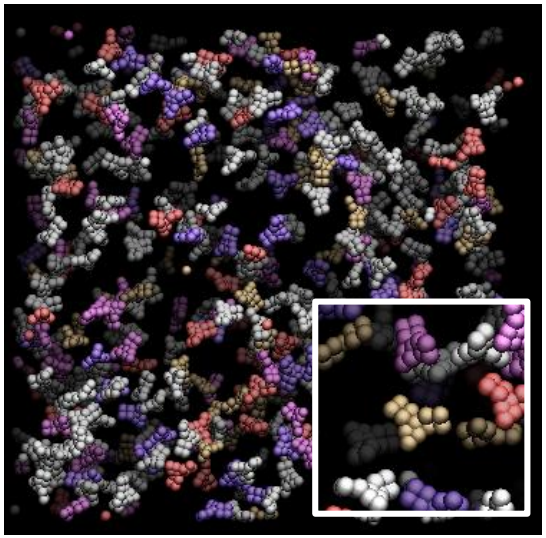
- **Provide fund. and mechanistic understanding of protein stability and viscosity at high concentrations**
  - measurements/MD simulations of interactions and "clustering"
  - Effect of mAb structure, pH, ionic strength, cosolutes

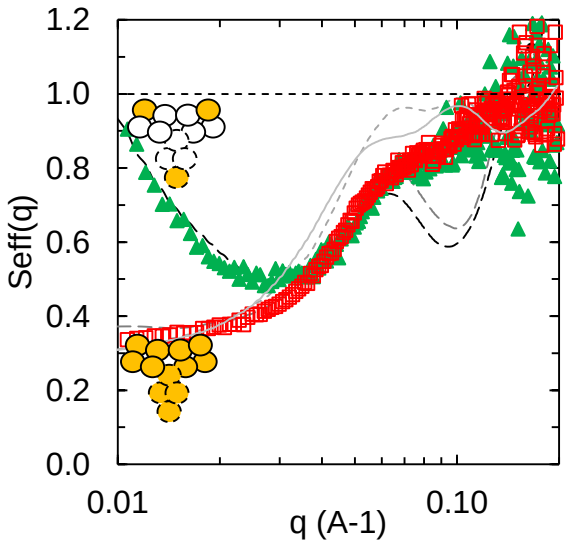




Kastelic et. al, *J Mol Liqs* (2017)







Characterize protein clusters in terms of protein-protein interactions for 125 to 250+ mg/mL mAb (reversible oligomers)

- 12 bead model and Yukawa model (screened elect. attr.)
- Static structure: small angle X-ray scattering, static light scattering
- Dynamic structure: dynamic light scat., shear rheology

Potential application for discovery/developability, protein processing, storage, and drug delivery

Nanoparticles at interfaces
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NSF Inspire Program
DOE CFSES, DOE NETL Advanced Energy Consortium, AbbVie, Pfizer, Merck

Welch Foundation
Abu Dhabi Nat. Oil. Co.
Total
GOMRI, NSF CBET,
NIH

Destination of PhD Students

Gupta	Virginia Tech.
Balbuena	Texas A + M
Meredith	Ga. Tech.
Yates	U. Rochester
Da Rocha	Virginia Tech.
Lee	U. S. California
Ziegler	U. Florida
Lu	Nat. Univ. Singapore
Elhag	Petroleum Inst. (Abu Dhabi)

Shah	Pfizer
Pham	Sematech
Chen	Abbott
Dickson	Exxon-Mobil
Smith	Exxon-Mobil
Overhoff	Schering-Plough
Engstrom	Bristol-Meyers-Squibb
Matteucci	Dow
Gupta	Exxon-Mobil
Tam	Bristol-Meyers-Squibb
Patel	Lam Research
Ma	Dupont
Miller	Medimmune
Slanac	Dupont
Murthy	Roche
Chen	Dow
Xue	Ecolab
Borwankar	Bristol-Meyers-Squibb
Worthen	Exponent
Hardin	Exponent
Hung	Bristol-Meyers-Squibb
Dear	Bristol-Meyers-Squibb