Keith Johnston Research Group
Nanotechnology/Colloid Science/Interfaces

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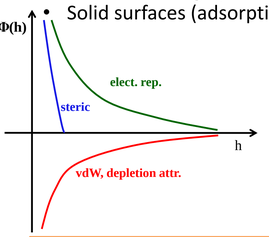
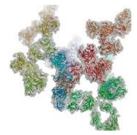
Research Areas

Protein stability and drug delivery
- Morphology and protein-protein interactions
- Rheology: subcutaneous injection

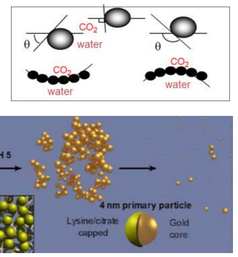
Advanced Functional Nanomaterials (metals and metal oxides/polymers)
- Control morphology/crystallinity via nucleation and growth in sol'n
- Colloidal stability (ligands and polymers on the surface)
- Optical, magnetic and electrocatalytic properties = f (morphology)
- Biodegradable photonic Au nanoclusters for cancer imaging

Nanoparticle Interact. with Liq. and Solid Interfaces
- Oil/water and gas/water interfaces (emulsions and foams)
- Solid surfaces (adsorption and transport in porous media)





Lilyestrom (13)



Graduate Student Contact Information

Bart Dear (Proteins)
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Shehab Alzobaidi (Subsurface)
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Caleb Alexander (Electrochem.)
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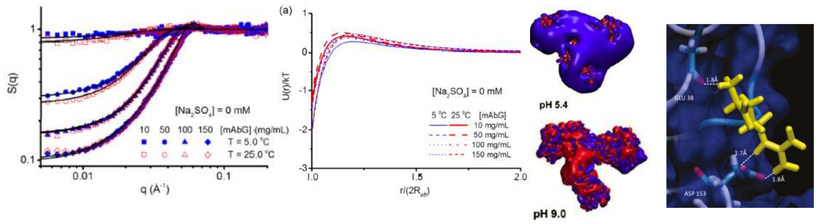
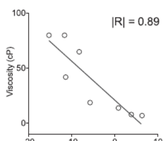
Low viscosity protein solutions for subcutaneous injection

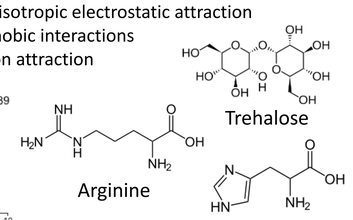
Protein stability and drug delivery: (Graduate Students: Bart Dear, Jessica Hung)

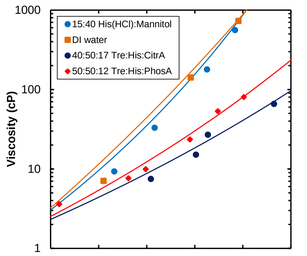
- >20% of all biopharmaceuticals in clinical trials are mAbs
- Treat cancer, autoimmune diseases, allergies and more
- Small spacings at high conc – specific short-ranged attraction cause association and high viscosity
  - Hydrogen bonds, anisotropic elect. attraction
  - Hydrophobic interactions

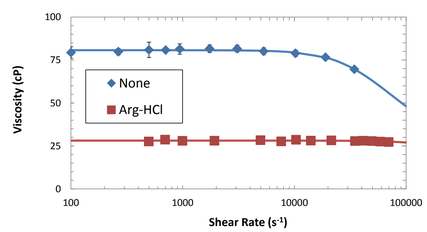


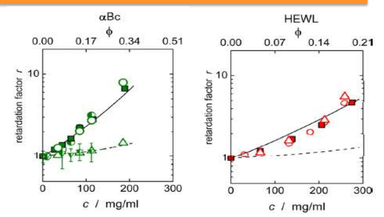
- Use co-solutes to mitigate attractive interactions to lower viscosity
  - Local anisotropic electrostatic attraction
  - Hydrophobic interactions
  - Depletion attraction



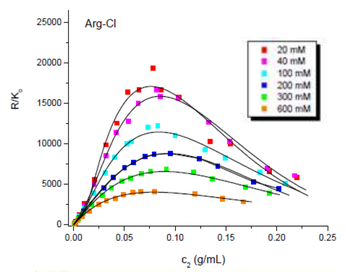


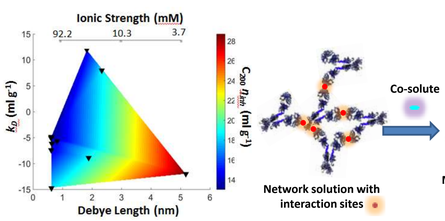


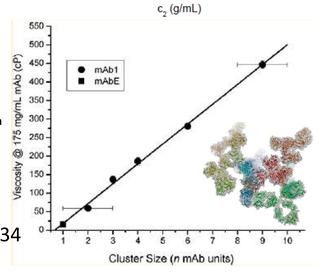




- Co-solutes, ex. (Arg), can be used to weaken interactions, reducing association and thus viscosity
- Techniques to measure mAb association
  - Light scattering (DLS, SLS, SAXS)
  - Rheology/Viscosity vs. shear rate







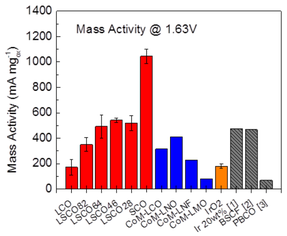
Recent publications:
Dear, et al., *Pharm. Res.*, 2017, 34, 193-207
Borwankar, et al., *Ind. Eng. Chem. Res.*, 2016 55, 11225-11234
Hung, et al., *J Membr. Sci.*, 2016, 508, 113-126
Borwankar, et al., *Soft Matter*, 2013, 9, 1766-1771

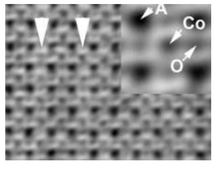
Nanomaterials for Electrocatalysis

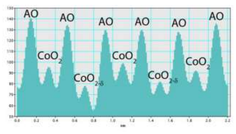
Nanomaterials for electrocatalysis: (Graduate student: Caleb Alexander, Will Hardin, Tyler Mefford)

Oxygen Evolution Reaction (OER)

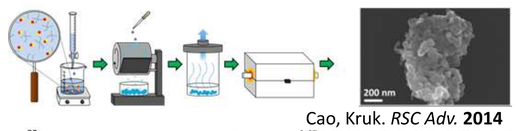
$4OH^- \rightarrow 2H_2O + 4e^- + O_2$



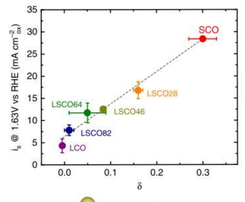


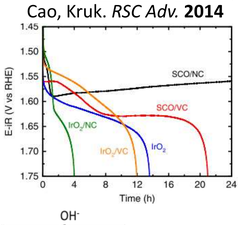


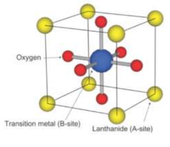
High Surface Area Means High Rate



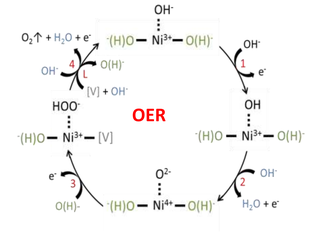
Cao, Kruk. *RSC Adv.* **2014**

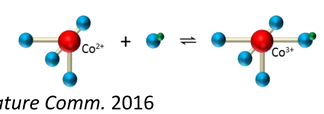






Metal 3d and **Oxygen 2p** density of states should **overlap**!



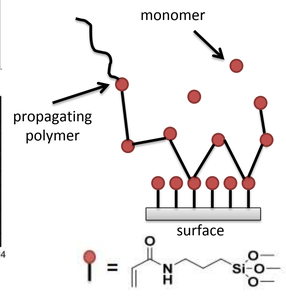


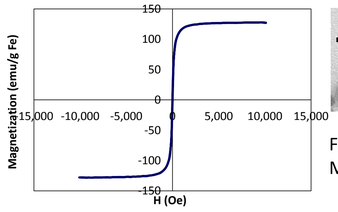
Recent publications:
Hardin, Johnston, K.P. et al., *J. Phys. Chem. Lett.* 2013
Hardin, Mefford, Johnston, K.P. et al., *Chem. Mater.* 2014, *Nature Comm.* 2016
Mefford, Hardin, Johnston, K.P. et al., *Nature Mater.* 2014

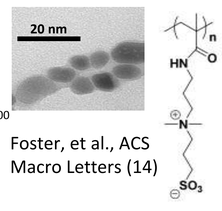
Subsurface Nanotechnology

Subsurface nanotechnology: (Graduate student: Shehab Alzobaidi, Carson Da, Chola Dandamudi)

Zwitterionic Polymer/Magnetite Hybrids with High Magnetic Susceptibility and Mobility at High T and Salinity

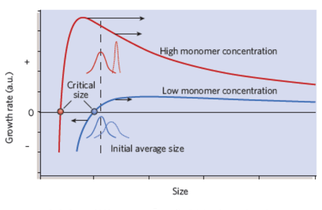


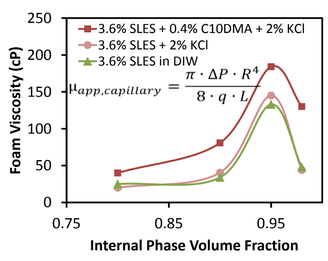


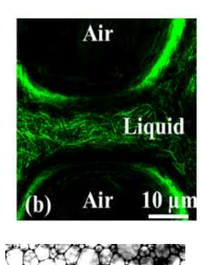


Foster, et al., ACS Macro Letters (14)

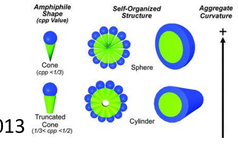
Wormlike Micelles Impart Viscoelasticity for Ultra Dry Foams

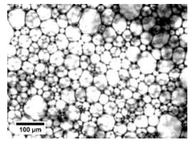






- 208 trillion m^3 of CH_4 in shale
- 2~5 million gallons of water/well for disposal

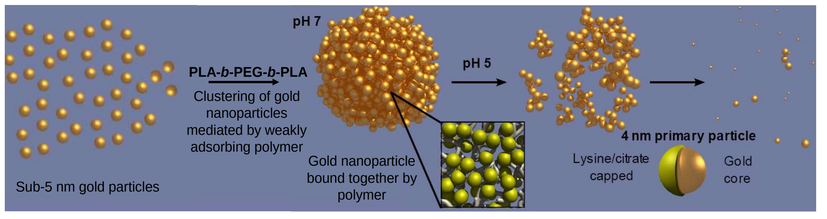




Recent publications:
Foster, et al., *Langmuir*, 2014
Bagaria, et al., *ACS Appl. Mater. Interfaces*, 2013

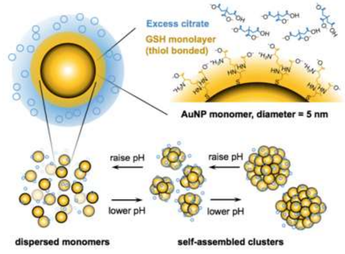
Biodegradable Gold Nanoclusters for Imaging & Therapy

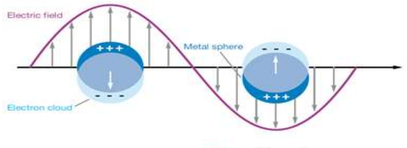
Biodegradable Au nanoclusters for imaging/therapy: (Graduate student: Ehsan Moaseri)

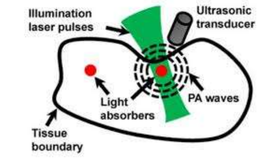


- **Tune colloidal interactions to form nanoclusters**
  - Colloidal assembly based on free energy model
  - Close spacing of gold particles produces intense NIR extinction
- **Design reversibility and lack of protein adsorption for clearance**

Johnston, Sokolov, Truskett, Stover: ACS Nano (13), JACS (13), JPChem (14), Langmuir(16)







Recent publications:
Stover, et al., *J. Phys. Chem.*, 2014, 118, 14291-98
Murthy, et al., *ACS Nano*, 2013, 7 (1), 239-251