SHELL SEMINAR SERIES

CHEMICAL & BIOLOGICAL ENGINEERING

Soft Matter Stabilization at Challenging Conditions for Drug Delivery and Energy Applications

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ABSTRACT Fundamental colloid and interface science plays a key role in protein drug delivery and in the design of novel soft matter for energy applications. For processing and subcutaneous delivery of monoclonal antibodies (~10 nm colloidal particles) it is challenging to achieve low viscosities and high stabilities at high concentrations from 100 to 300 mg/ml. Advancements in this field are being guided by a deeper understanding of protein-protein interactions and morphology with small angle X-ray scattering (SAXS) and static and dynamic light scattering. In the field of bionanotechnology, clinical translation of photoacoustic imaging (PAI) of cancer has been limited by the lack of sensitive near infrared (NIR) contrast agents with low toxicity. To address this challenge, we have formed novel hierarchical nanocomposite materials with exceptionally high payloads by tuning the interfacial interactions. In particular, 50 nm "J aggregates" of FDA approved indocyanine green (ICG) with strong NIR absorbance and PAI contrast are encapsulated at high loadings within small 77 nm polymer vesicles (polymersomes) composed of poly(lactide-co-glycolide-b-polyethylene glycol) (PLGA-b-PEG) bilayers.

For subsurface oil and gas energy applications, novel concepts are presented to stabilize soft matter including nanocapsules, emulsions, and foams with strategically designed nanoparticles, surfactants, polymers and polyelectrolytes. The challenges associated with high salinities and temperatures are being addressed with fundamental studies of colloidal and interfacial interactions including the rheological behavior. Ultra-stable gas/water foams may be formed with nanoparticles by tuning the viscoelastic properties of the aqueous phases. The development of subsurface applications such as CO2 sequestration/enhanced oil recovery, nanocapsules for controlled release and green waterless fracture fluids will have enormous implications for global energy development and environmental impact for at least the next couple of decades.

BIO **Dr. Keith Johnston** received his PhD in 1981 in chemical engineering at the University of Illinois (with Chuck Eckert) and joined UT after a year at Sandia National Laboratories. His awards include the Allan P. Colburn Award and Award for Excellence in Industrial Gases Technology from AIChE, and he was named by AICHE in a list of "One Hundred Chemical Engineers of the Modern Era." He is a member of the US National Academy of Engineering and is a Fellow of the Am. Inst. of Medical and Biological Engineers. He directed UTs activities in the NSF Science and Technology Center: Environmentally Responsible Solvents and Processes through 2009. He conducts fundamental research combining materials chemistry, colloid and interface science and polymer science to guide the development of applications in a wide range of fields including drug delivery, biomedical imaging/therapy, electrocatalysis in energy storage and colloid and interface science for foams and capsules in subsurface energy production. He has discovered/co-discovered various nanomaterials including water/CO2 microemulsions, silicon nanowires, and highly active perovskite electrocatalysts and supercapacitors. He has made significant contributions in the field of nanotechnology for subsurface green energy production which includes CO2 sequestration, improved oil recovery, magnetic nanomaterials for electromagnetic imaging of reservoirs, nanocapsule delivery and greener fracturing with low water utilization.

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