Structural Effects of the Hydrophobic Surfactant Proteins on Lipid Bilayers

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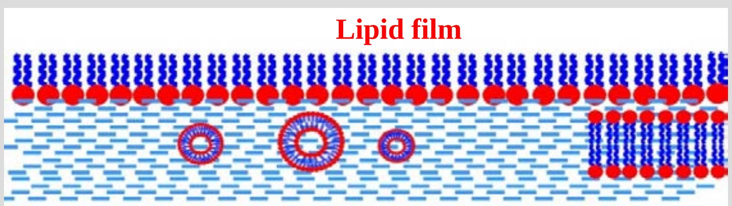
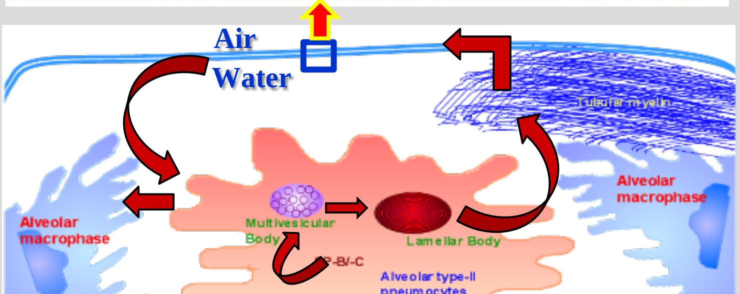
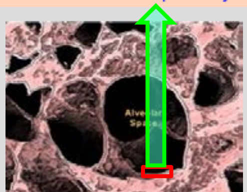
Goal: Determine the structural changes produced by the proteins that allow rapid adsorption

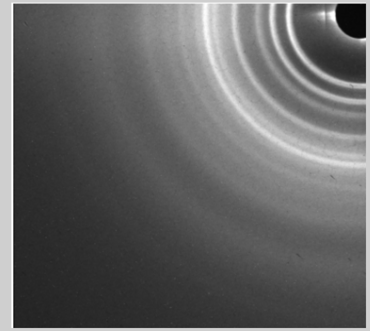
Pulmonary surfactant lowers surface tension in the alveoli of the lungs, preventing alveolar collapse and maintaining bronchial functionality. Two essential hydrophobic proteins, SP-B & SP-C, promote rapid adsorption by the surfactant lipids to the air/water interface.

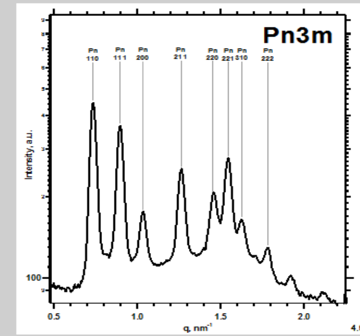


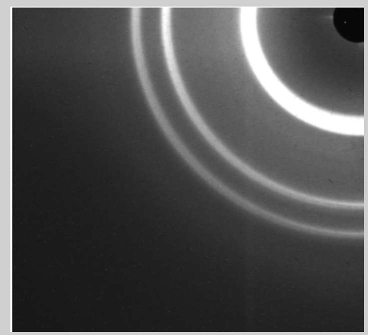


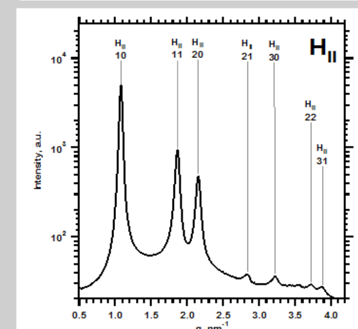


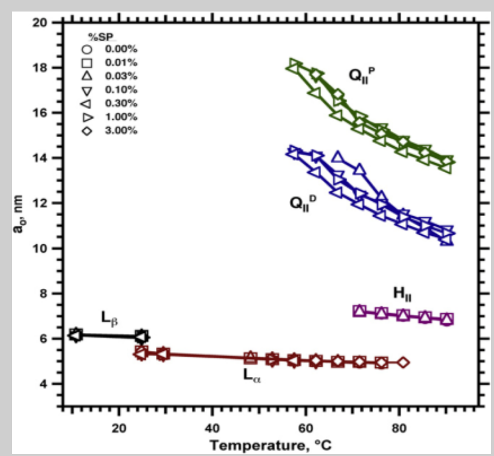
Alveolus in the Lung











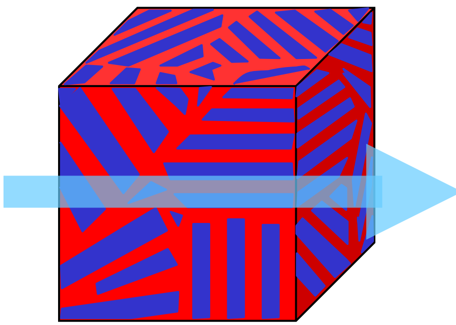
Small amounts of protein induce lamellar lipids to form curved structures.

Transport in Nanostructured Materials

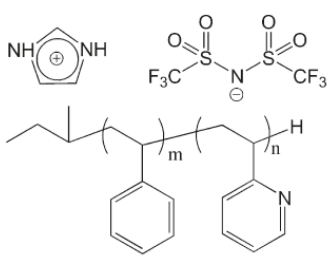
J.M. Virgili; A. Panday; E.D. Gomez; N.S. Wanakule; S.A. Mullin; N.P. Balsara & J.A. Pople

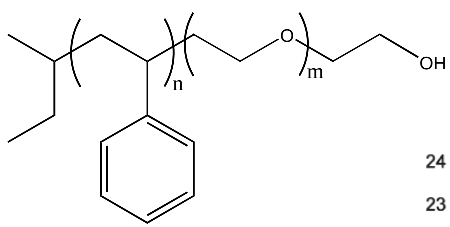
Long-term Goal: Understand how randomly oriented grains affect transport properties of relevant species

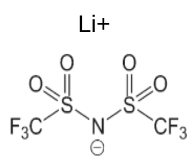
Current Goal: Characterize morphology and transitions of nano-structured poly(styrene-block-2-vinylpyridine) block copolymers

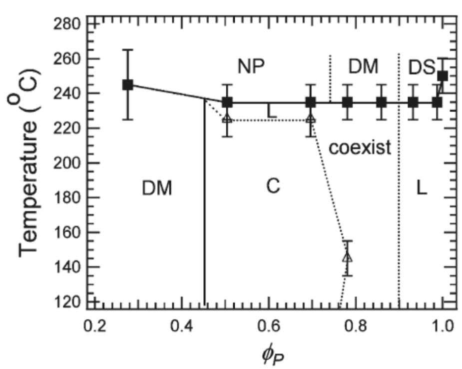


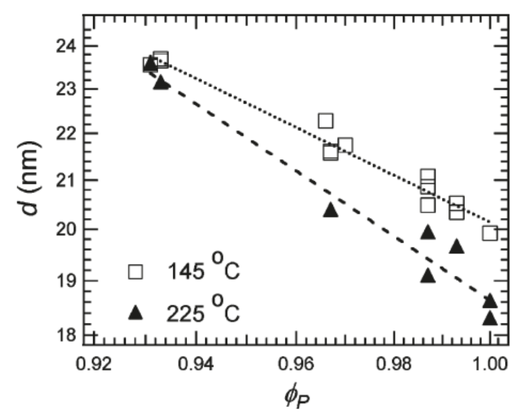
Findings: Macro-phase of copolymer displays stable coexistent mesophases of lamellar and hexagonally cylindrical morphologies as a function of volume fraction of a selectively solvent ionic liquid

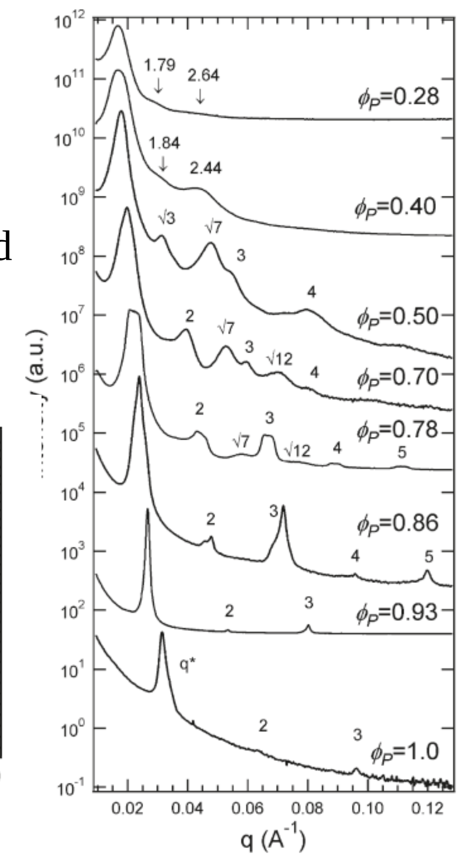






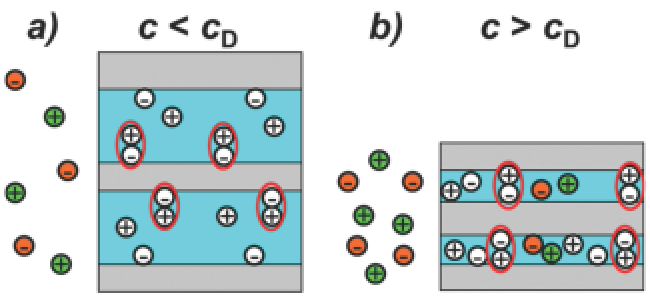






Transport in Nanostructured Materials

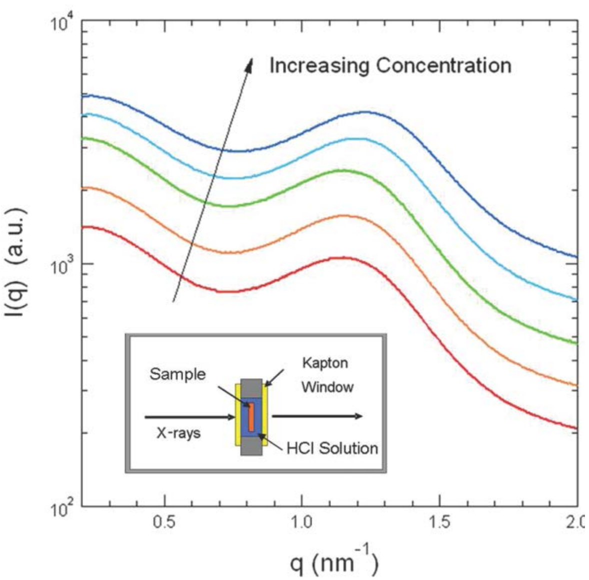
K.M. Beers, D.T. Hallinan, X. Wang, J.B. Kerr; N.P. Balsara & J.A. Pople

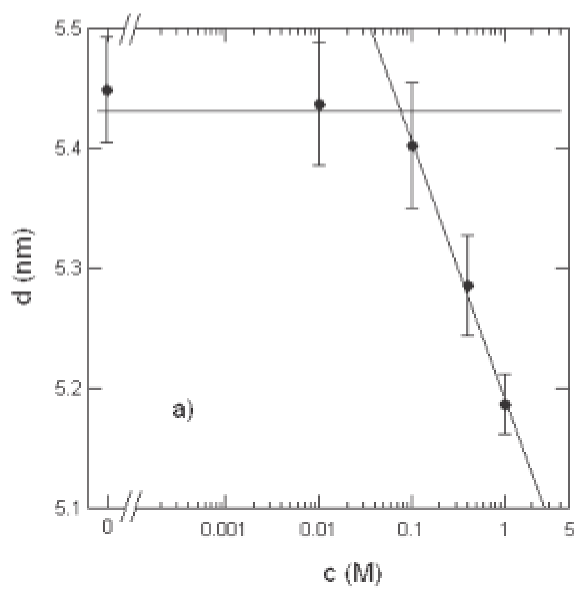


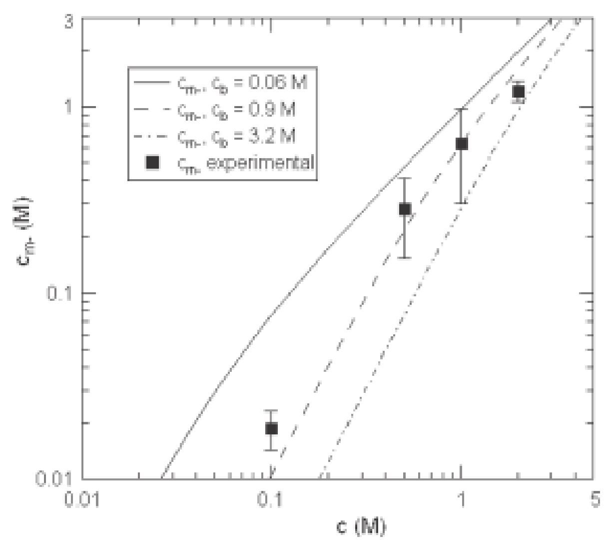
Long-term Goal: Understand how randomly oriented block copolymer grains affect transport properties of relevant species

Current Goal: Use SAXS to study how polymer membranes respond to external electrolytes. This tool can provide information on the charged state of the hydrated membrane.

Findings: Swelling the commercial membrane Nafion in external electrolyte showed that there is a large fraction of condensed counterions. Extension of this technique to block copolymers and how this effects performance is underway.



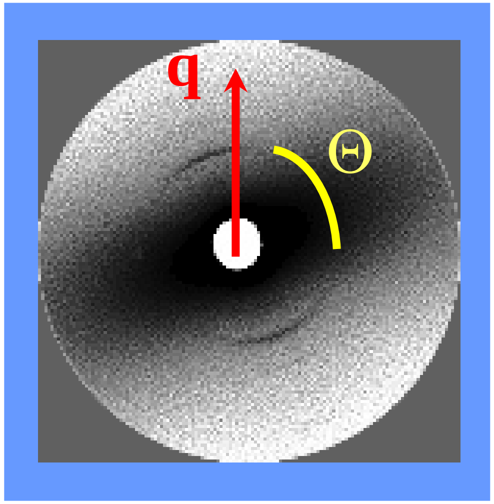




Mineral Deficiencies in Teeth

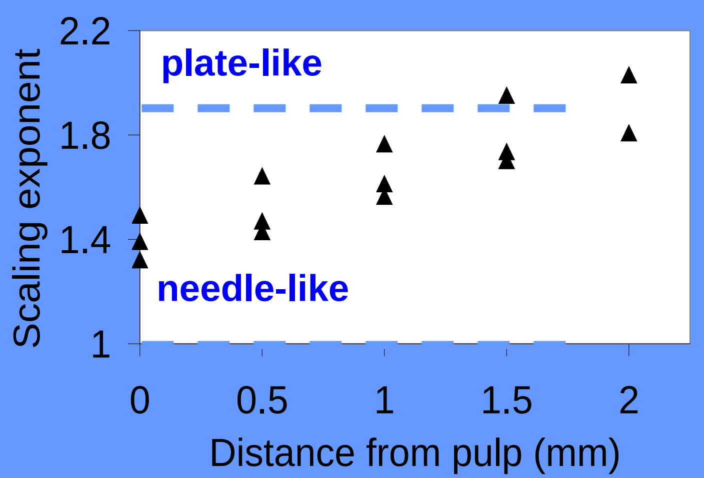
J. H. Kinney & J. A. Pople

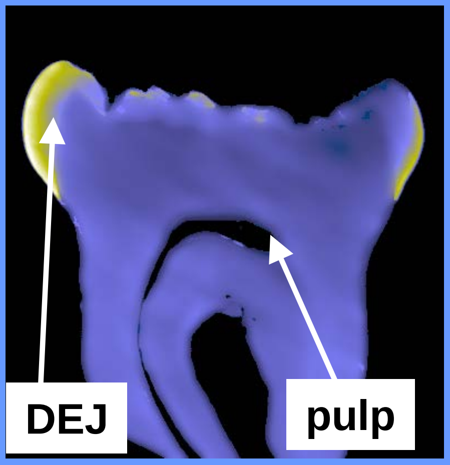
Goal: To explore mineralization in caries lesions in order to understand caries development, arrest, and treatment. SAXS patterns will reveal presence or absence of gap-zone mineralization within the collagen fibrils, as well as average mineral crystallite size, orientation, and shape

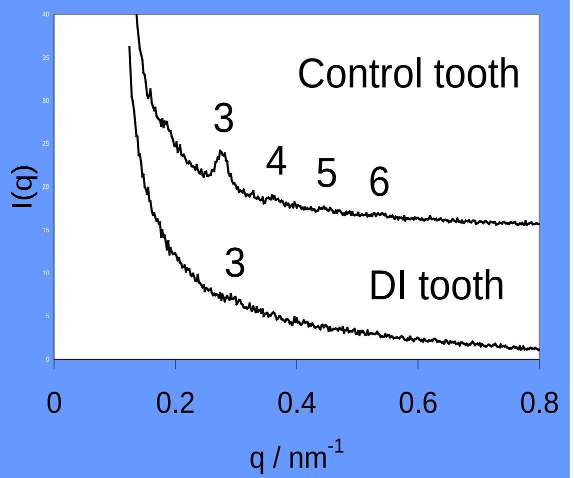


Findings: Teeth affected by the genetic Dentinogenesis Imperfecta (DI) condition do not display the scattering peak associated with presence of intra-fibrillar mineral, which absence can be linked to mechanical deficiency

SAXS data also reveal a change in fractal dimension of the dentin in progression from the pulp to the Dentin-Enamel Junction (DEJ), indicating a development from a more needle-like to more plate-like morphology with age





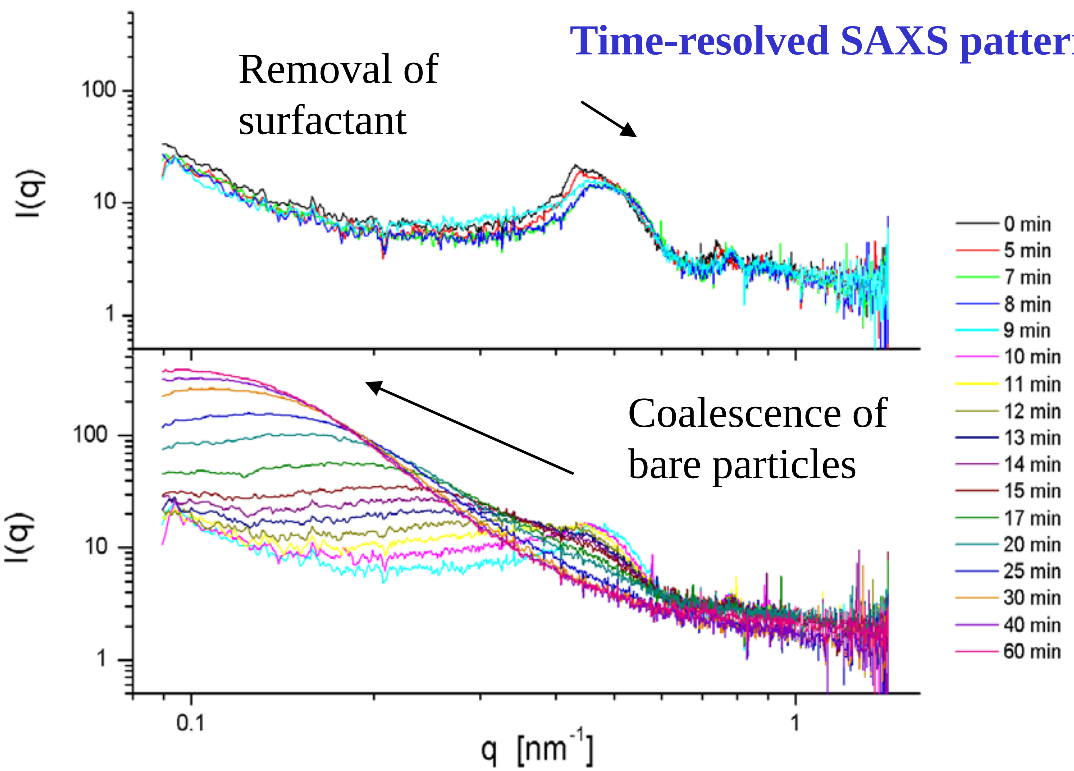


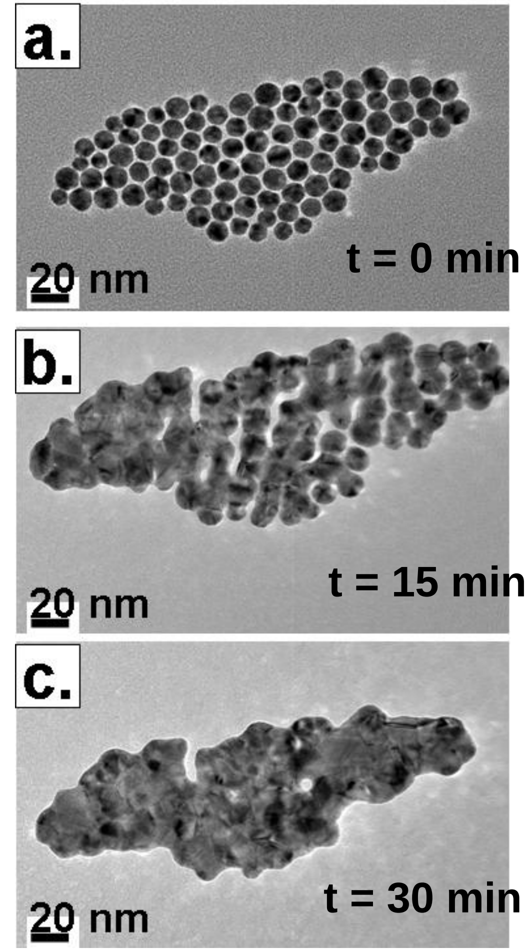
Coalescence of Gold nanoparticles

T. H. Lim, R. D. Tilley, B. Ingham, C. J. Dotzler & M. F. Toney

Goal: Understand the coalescence behavior and kinetics of surfactant-coated Au nanoparticles (d ~ 10 nm). Coalescence of the particles has been observed in a transmission electron microscope (TEM) on time scales of the order of ~30 minutes.
Time-resolved SAXS at various temperatures enable us to follow the coalescence process and relate this to TEM and modeling results.

Time-resolved SAXS patterns; 320ºC

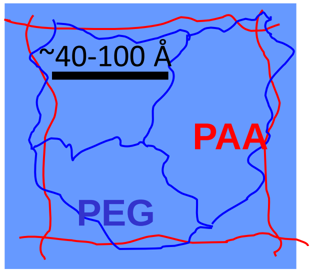




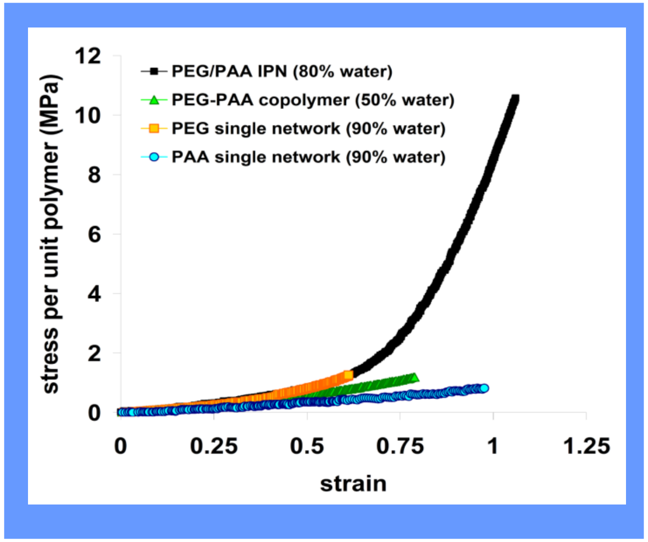
Coalescence of Au nanoparticles observed *in situ* in a transmission electron microscope

SAXS Characterization of High Strength Interpenetrating Network Hydrogels

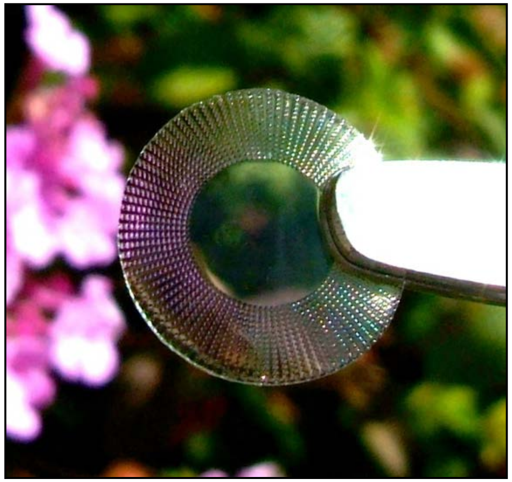
Dale Waters, Kristin Engberg, Shira Kelmanovich, Rachel Parke-Houben, Masaki Yanagioka & Curt Frank



AA monomer is added to polymerized PEG & PAA is polymerized to form an interpenetrating network with the PEG. Result is a viscous gel with much higher elastic modulus and tensile strength than the copolymer PEG-PAA gel. Resulting hydrogel can be employed for medical devices, e.g. artificial cornea or cartilage. Correlation length of interpenetrating gel is determined from SAXS data

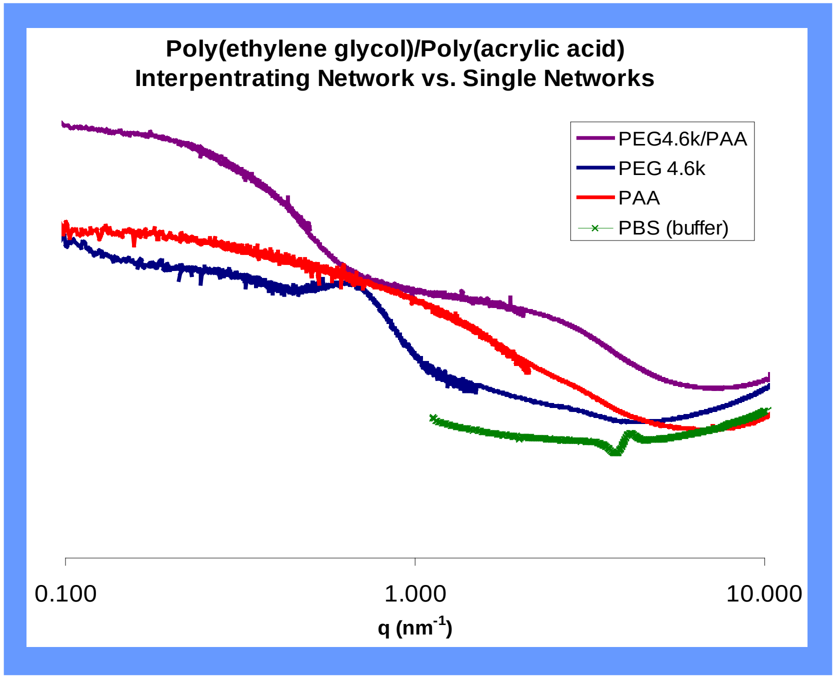


Goal: To understand the structure of a PEG-PAA hydrogel and perform *in-situ* tensile testing to characterize structure as a function of tensile properties



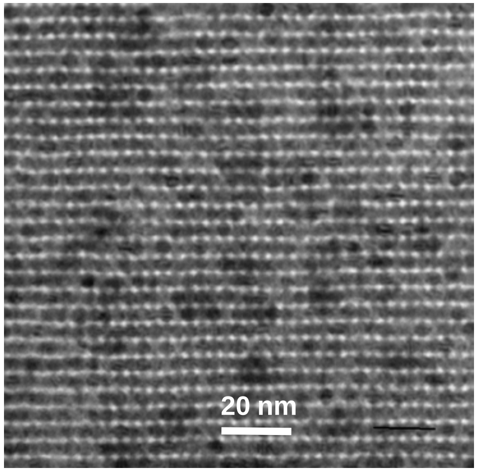
Artificial Cornea

- Core consisting of PEG/PAA with a photo-lithographically patterned skirt.
- Porous skirt designed to allow cell integration into the device

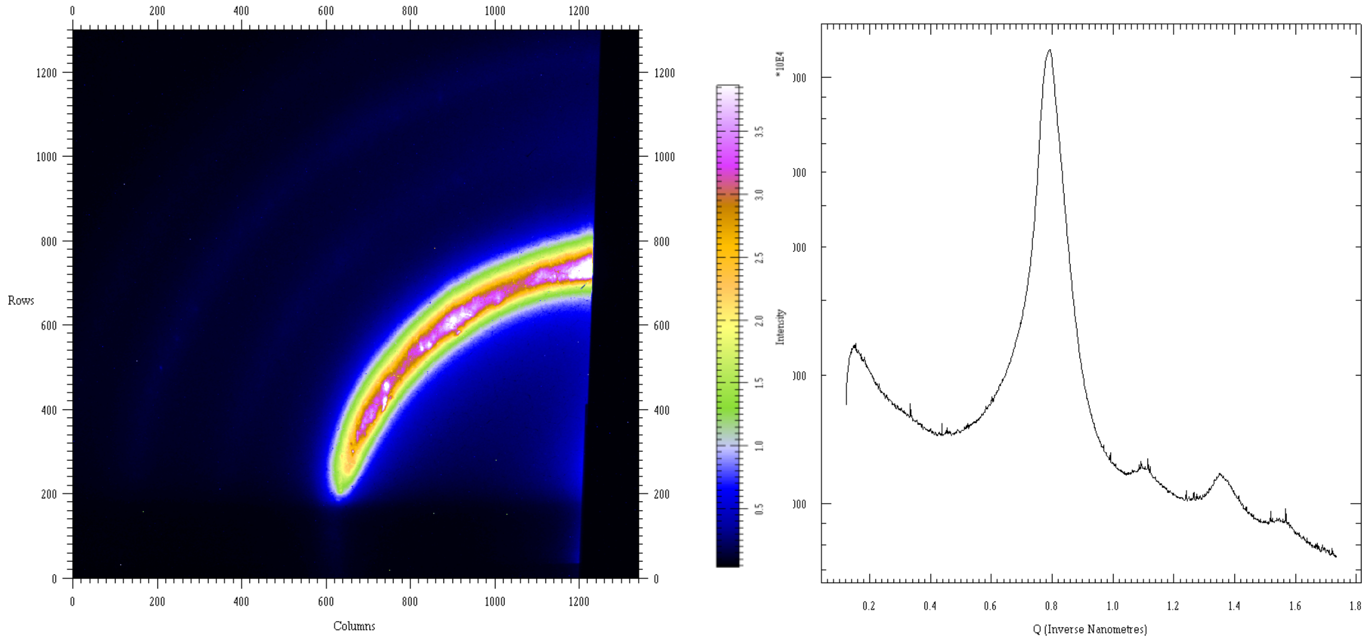


Self-Assembled Nanoparticle Superlattices

S.T. Taylor, P. Case and M. F. Toney



Goal: The goal of the work is to establish synthesis-structure-property relationships in nanoparticle superlattice films formed by chemical self-assembly. SAXS is utilized in concert with transmission electron microscopy (TEM) to unambiguously determine structure, morphology, and the nature of ordering in these films.



Above: TEM images of ordered nanoparticle superlattices formed by evaporation-driven self-assembly

Left: SAXS patterns reveal nature of long-range ordering in supported films