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Soft matter, rheology, and interfacial phenomena

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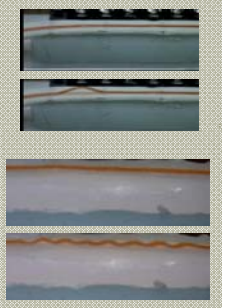
Texturing surfaces

- Some octopuses and cuttlefish have amazing camouflage abilities. They can change color, but they can also reversibly change the texture of their skin. How do they do that? We believe that a skin-buckling mechanism is involved. We are also mimicking surface texturing at the flip of a switch.

Where's the cuttlefish?

Octopus with glued o-rings for skin testing

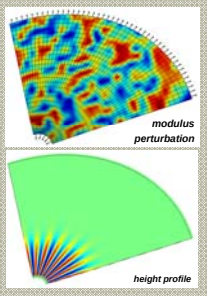
Papillae expressed on cuttlefish



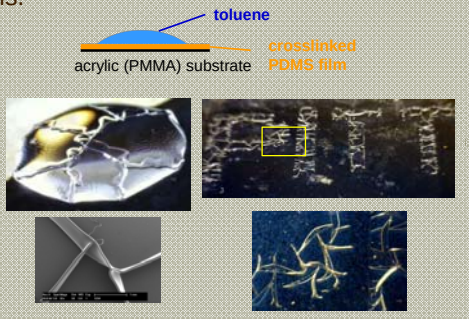
Synthetic papillae using SMA/elastomer composites

Thin film buckling phenomena

- Thin films can show wrinkles, creases, and folds. Being instabilities, they are all difficult to predict. We are developing direct numerical simulation methods for prediction. We also seek to use buckling phenomena to measure the mechanical properties of thin films.



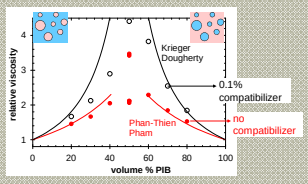
FEM simulations of complex buckling phenomena



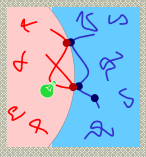
Swelling-induced delamination folding without (left) or with (right) adhesion patterns

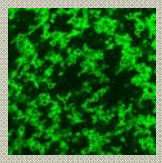
Structure and rheology and interfaical phenomena in multiphase systems

- Multiphase systems, e.g. emulsions, suspensions, and foams, are commonplace. We are interested in blends of immiscible polymers and the effect of interfacially-active species (copolymers or particles) on the structure and flow behavior.

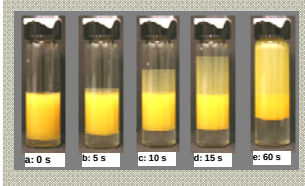


Surface-active species raise emulsion viscosity by immobilizing the interface

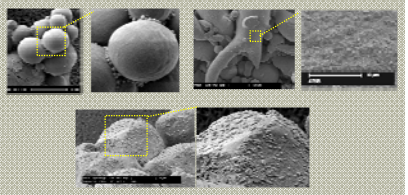




Reactive compatibilization with multifunctional species crosslinks the interface. The blends show gel-like behavior.



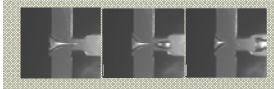
Irreversible adsorption of particles at the liquid/liquid interfaces causes film climbing



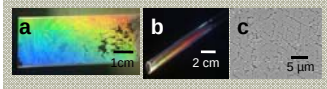
Particles can bridge across drops or can jam drops into highly non-spherical shapes

Other research

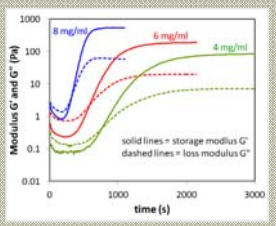
- Manufacturing complex particles with molten polymer microfluidics
- Rheological properties of hydrogels derived from ExtraCellular Matrix (ECM) proteins (with Prof. Steven Badylak)
- Photonic crystal sensors (with Prof. Sanford Asher)
- Emulsion electrospinning
- Renewable polymers



Microfluidic bubble formation with undiluted polymer melt



2D Photonic crystal fabrication (with Prof. Asher, Chemistry)



Gelation of extra-cellular matrix (ECM) proteins followed rheologically. Higher concentration accelerates gelation and gives stiffer gels (with Prof. Badylak, MIRM)

Contributors: Derek Breid, Sourave Chatterjee, Hsinling Cheng, Candice Deleo, Jeffrey Martin, Shailesh Nagarkar, Jiani Niu, Shu-Che Peng, Matthew Wolf, Rachmadian Wulandana, Jiantao Zhang

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