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Microfluidics assisted gelation, cell encapsulation, biosensing, and diagnostic imaging

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Abstract: Microfluidics has emerged in recent years as a versatile method of manipulating fluids at small length-scales, and in particular, for generating and manipulating micron size droplets with controllable size and functionality. For example, many research groups developed microfluidics devices for cell encapsulation, and synthesizing functionalized polymer microspheres and inorganic nanoparticles with precise control over their shapes and sizes. In this talk, I will showcase 3 examples on microfluidics based approaches.

(1) A novel droplet microfluidics method to image oxygen in single islets (pancreatic cells) for glucose sensing. Individual islets and a fluorescent oxygen-sensitive dye were encased within a thin alginate polymer microcapsule for insulin secretion monitoring. The sensing system operated similarly from 2-48 hours following encapsulation, and viability and function of the islets were not significantly affected by the encapsulation process. This approach should be applicable to other cell types and dyes sensitive to other biologically important molecules.

(2) A one-step droplet microfluidics based method to fabricate radiopaque alginate microgels for localized diagnostic imaging applications. $BaSO_4$ nanoparticles as imaging agent were in-situ synthesized during the solidification of alginate droplets and uniformly distributed inside the Ba–alginate microgels. Ba–alginate microgels show sharp X-ray image, confirming they can be used as X-ray visible embolic materials. This one-step procedure is green, simple, and can be adopted to design similar facile route to synthesize other inorganic nanoparticles uniformly distributed in alginate microgels. Alginate microgels with different shapes can be fabricated with proper hydrodynamic conditions.

(3) Shear-induced structures (SIS) are known to form in flows of wormlike micellar solutions. In simple shear cases these structures (SIS) are temporary and disintegrate upon cessation of the flow; while in certain mixed-flow cases these flow-induced structured phases (FISPs) are stable and long-lived. Here, we study the flow of micellar solutions (both ionic and non-ionic surfactants) in a microfluidic device containing an array of microposts and explore the gelation mechanism with biomarker encapsulation applications.

Biography: Amy Shen received her Ph.D in Theoretical and Applied Mechanics from University of Illinois at Urbana-Champaign in October 2000. She was a postdoctoral fellow at Harvard University from 2000-2002. Amy Shen is an associate professor in Mechanical Engineering and Chemical Engineering at University of Washington and served as the director of soft matter and microfluidics laboratory. Amy's research is focused on the complex fluids, rheology, biomaterials and self assembly that can find application in the nanotechnology, biotechnology, and energy related materials. Amy is an honor member of Phi Kappa Phi and Pi Tau Sigma. Amy received Ralph E. Powe Junior Faculty Enhancement Award in 2003 and the National Science Foundation's CAREER Award in 2007. Amy is also a Fulbright Scholar from 2013-2014.