Microfluidics and Nanofluidics for Fluid Property Measurements: Mixture Phase Envelope, Minimum Miscibility Pressure, Diffusivity and Solubility

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The worlds' smallest fluids technologies, microfluidics and nanofluidics, have much to offer the worlds' largest fluids challenges in energy and the environment. In this talk I will outline our group's efforts in microfluidics and nanofluidics for fluid property measurement. Microfluidics can offer speed, control, multiplexing, as well as high temperatures and pressures, all while providing measurements relevant to fluids at the bulk scale. In this area I will outline our work in diffusivity, solubility and minimum miscibility measurements performed for oil and gas and industrial CO2 applications. Demonstrating the potential for multiplexed measurements, I will present our phase chip – the full phase diagram for a mixture in 1000 independent chambers, each at a unique temperature and pressure condition. This is, to our knowledge the first full visualization of a phase diagram to date. In contrast to microfluidics, nanoscale confinement can result in deviations in fluid properties. Nanoscale-specific fluid properties are important for a range of applications, and the recent emergence of unconventional oil recovery in the US has motivated nanoscale hydrocarbon phase measurements in particular. Here I'll outline the methods we developed to perform phase measurements at scales as low as 8-nm confinement, and our recent applications in this area. I'll close with some thoughts on our current directions in this area.