Our mission is to better understand how soft materials and complex fluids deform and flow in response to externally applied forces. We achieve this through experimental study of model materials with well-defined chemical and physical structures and through rheometry coupled with in-situ flow visualization. This work is sponsored by NSF, Procter & Gamble, and the ACS Petroleum Research Foundation.

**Polymeric Materials for High-Performance Concrete**

Water released from hydrogel particles used as internal curing agents leads to beneficial reductions in volumetric shrinkage and cracking of concrete.

Water-penetrating zone
- Cement
- Aggregates
- Cracks

Water-saturated zone
- Poly(acrylamide) (AA)
- Poly(acrylamide-co-acrylic acid) (AA-AM)
- Hydrated spherical particles

Hydrogel particle chemistry, shape, and size are controlled through different synthesis methods. Swelling behavior is strongly dependent on hydrogel chemistry (AA-AM).

Addition of hydrogel particles significantly reduces mortar shrinkage, even at low water-to-cement (w/c) ratios.

Despite voids remaining from deswollen hydrogels, mortar strength increased at 28 days, implying more complete curing and less microcracking from shrinkage.

**Flow Behavior of Polymer and Surfactant Solutions**

Shear rheometry measurements are used to quantify the flow behavior of polymer solutions used for enhanced oil recovery.

![Graph showing viscosity vs. shear rate for polymer solutions](image)

**Rheo-Physical Instruments To Visualize Flow Fields**

Custom-built flow visualization equipment allows for rheometry data to be collected and directly correlated with a sample’s macroscopic deformation response.

- **Particle tracking velocimetry** (for transparent samples), used to detect shear banding and fracture in self-assembled polymer gels.

![Diagram of particle tracking velocimetry](image)

- **Ultrasonic speckle velocimetry** (for opaque samples), used to detect wall slip in model cement pastes.

![Diagram of ultrasonic speckle velocimetry](image)