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Establishing the mechanical properties of microgel particles

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Introduction
Materials that contain soft particles are often used in applied and fundamental studies and also in practical applications, as depicted in Fig 1. These soft particles can be modelled using microgels which are spherical porous polymeric gels, shown in Fig 2A.

Mechanics of these materials?
The single particle properties are key to understand their behavior at the macroscopic level. The important mechanical properties of a single particle are the compressive modulus (K), shear modulus (G) and the time scale for size change (τsize). The τsize depends on the porosity, applied pressure and on the solvent viscosity.

Determine the compressive modulus
The compressive modulus (K) is the resistance of a particle to a volume change K = V dP/dV. We probe it by applying an osmotic pressure and measuring the volume change under a microscope or, for small particles, using dynamic light scattering, as shown in Fig 2A,B.

Determine the shear modulus
The shear modulus G, is the resistance of a particle to a shape change G = F/A Δx. This can be determined by deforming the particle under simple shear. A method to do this is capillary micromechanics. This method measures both the G and the K, an overview is given in Fig 3. This method is limited by the resolution of the microscope.

Determine the time scale
The required time for a particle to stabilise in size after applying a uniform pressure is τsize. This can be determined by applying an osmotic shock and measuring the volume using a microfluidic device, as shown in Fig 4.

Conclusions
Determining the properties of sub micron microgel particles is still a challenge. Larger particle however can be completely analysed by the mentioned techniques.

References
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