

Colloidal Microgels - Untapped Potential?

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Editorial

Colloidal microgels are discrete cross-linked polymeric nanoparticles that may be prepared from a range of different monomer types [1]. These monomers may confer dispersion sensitivity to a wide range of stimuli including temperature, pH, salinity and the addition of co-solvents [2]. Microgels are spherical and are typically in the size range from 50 nm up to 1000 nm. They are prepared by a polymerization of a monomer or monomers in the presence of a cross-linker. By varying the ratio of the cross-linker to monomer they can be prepared having either a relatively tight structure or a relatively loose one. What makes microgels of great interest is their ability to undergo a conformational change in response to a stimulus of the aforementioned structure. In a “good” solvent environment microgels expand to maximise the polymer-solvent interaction and in a “poorer” solvent they contract. This conformational change is usually reversible and is illustrated schematically in Figure 1.

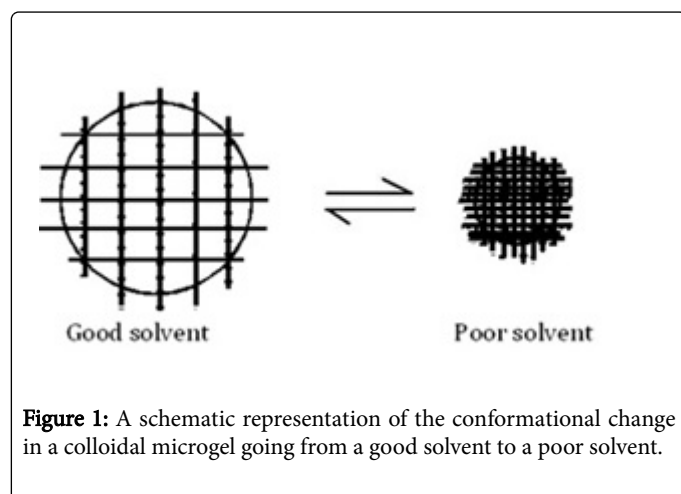


Figure 1: A schematic representation of the conformational change in a colloidal microgel going from a good solvent to a poor solvent.

In an expanded conformation the interstitial spaces in the microgels are filled with solvent and sometimes when used as a delivery system also small solutes [3]. When the solvent conditions worsen the polymer-polymer interactions dominate over the polymer-solvent. As a result the solvent is excluded from the interstitial spaces and the microgel shrinks. As microgels are spheres and the volume reduces by the cube of the radius, this exclusion of solvent can result in a large particle volume change. The volume change is illustrated in Figure 2. As a result of these dramatic volume changes microgels have interesting viscosity characteristics and stability behavior.

At concentrations of the order of 5% and above colloidal microgels in their expanded conformation have the viscosity of putty with all of the solvent located within their internal structure.

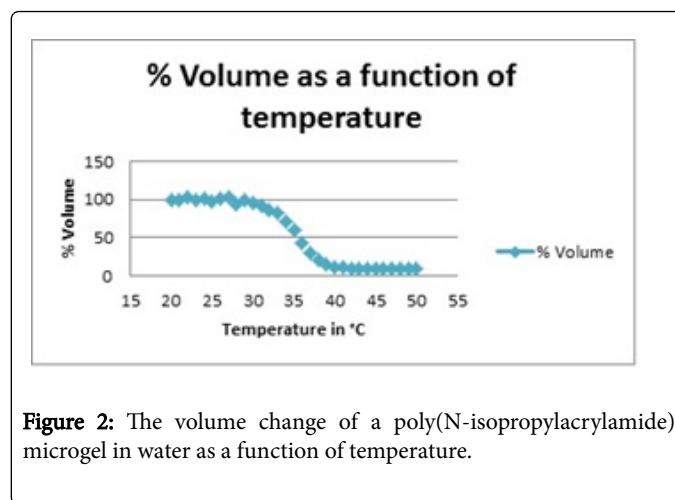


Figure 2: The volume change of a poly(N-isopropylacrylamide) microgel in water as a function of temperature.

Following a conformational change the microgel releases the solvent and the viscosity decreases significantly with the dispersion becoming mobile. This process is fully reversible by e.g. in the case of poly(N-isopropylacrylamide) microgels at low temperature e.g. 20°C they are putty like and at 40°C they become very mobile.

With respect to colloid stability, in a swollen conformation the microgels are effectively solvent matched in terms of their Hamaker constant hence they have no van der Waals attractive forces. In effect therefore colloidal microgels in their swollen conformation are almost always colloidally stable and hence dispersed. When the microgel is in a collapsed conformation, the solvent is largely excluded and the particles become hard sphere like. As a result the microgels may be readily aggregated by either a DLVO mechanism or by depletion forces [3].

Finally colloidal microgels behave like micro sponges, absorbing solvent and solutes, including drugs, and release them when squeezed i.e. their conformation changes.

In colloidal microgels we have the opportunity to custom prepare particles with interesting viscosity characteristics, tunable dispersibility and a controllable delivery system. Such materials should find a wide range of useful commercial applications.

References

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