

## Scientific highlights

# Photosensitive gelatin

Employing photodestructible surfactants in gelatin-based aqueous gels presents novel possibilities for controlling colloidal and aggregation properties. Light-triggered breakdown of the gelatin-bound photosurfactant aggregates causes dramatic changes in viscosity and aggregation.

Gelatin is a commodity chemical owing to low-cost, gel-forming, film-forming and surface-active properties. Amongst other applications in food and formulations, gelatin is an important component of photographic emulsions. In such complex systems surfactants are also added, and these interact with gelatin forming surfactant-gelatin complexes (SGCs), which influence surface tension and rheology during coating and wetting processes. As such SGCs have received considerable attention because of their ability to impart significant changes to interfacial, rheological and physicochemical properties [1,2].

Surfactant-gelatin complexes are stabilized by strong electrostatic interactions between anionic surfactant headgroups and cationic residues on the gelatin strands. Physical cross-linking of gelatin strands by micelles has been used to explain significant increases in viscosity over pure gelatin solutions [1,2]. The system composition, as well as temperature, strongly influences the rheological and aggregation behaviour.

Here it is shown that SGCs can be made light-sensitive by introducing a photodestructible surfactant, and then incident UV light can be used to control viscosity and aggregation. Breakdown of the photo-degradable surfactant sodium 4-hexylphenylazosulfonate (C6PAS) via UV has been shown to affect colloid and interface properties [3], since two non-surface active photoproducts are formed.

After UV irradiation the physical appearance of the C6PAS-containing SGCs changed: samples turned from yellow to brown owing to the photochemistry of C6PAS, and there was an obvious reduction in viscosity (figure 1) [4].

Viscometry and small-angle neutron scattering (SANS) on D22 (figure 2, table 1) analyses have been employed to study changes in viscosity and aggregation properties of the photosensitive SGCs [4].

As shown in figure 2, in the presence of C6PAS the initial scattering at low Q seen for gelatin

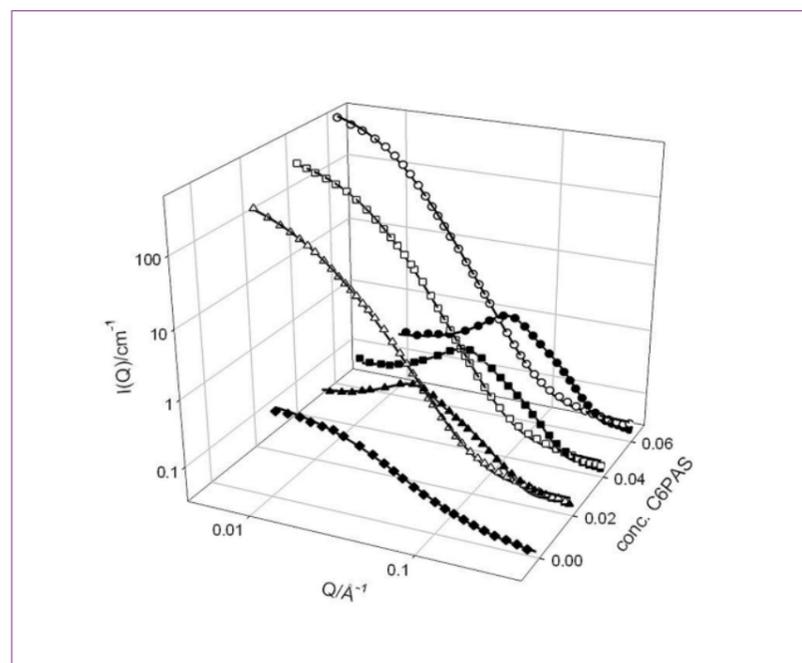


Figure 1: Physical appearance of 10 wt% gelatin plus 0.03M C6PAS samples at 41°C before (lower sample) and after irradiation (top).

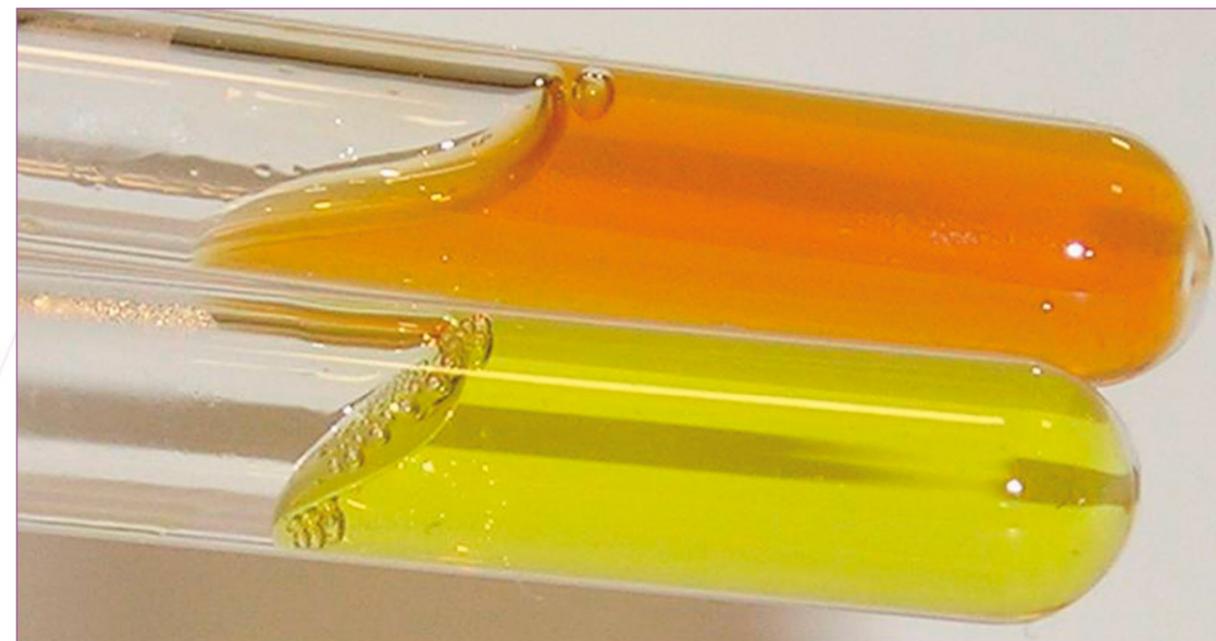


Figure 2: SANS data from D22 and model fitting analyses for 5% gelatin (♦) and a series of C6PAS-SGCs in D<sub>2</sub>O. Before irradiation filled, and after irradiation empty markers.

alone (♦) disappeared, which suggests that gelatin has undergone a dramatic change in configuration on complexation with the photosurfactant. Prior to irradiation the scattering profile changes progressively with increasing surfactant concentration, and these pre-UV data could be fitted as charged ellipsoidal micelles [4].

There are two distinct micellar environments in SGCs: micelles bound on the gelatin strands and free aggregates in the background solvent [1,2]. Hence, the ratio free bound micelles depends on the surfactant concentration. The apparent increase in micelle size with decreasing surfactant concentration is due to surfactant micelle binding to gelatin. However, in the most concentrated sample there are no obvious contributions of gelatin to the overall scattering. This is consistent with a saturation of the gelatin network and as consequence more C6PAS is present as background equilibrium micelles in the water.

After irradiation the aggregation increases and the changes are consistent with a transition from ellipsoidal charged micelles to extended sheet-

like aggregates. For the post-irradiated C6PAS-SGCs strong logarithmic scattering is observed, which may be accounted for by a model for monodisperse, randomly-oriented lamellar stacks. As shown in table 1 there is apparently a growth in stack thickness with concentration.

Non-irradiated			
C6PAS Conc	R <sub>1</sub> (Å)	R <sub>2</sub> (Å)	Micelle charge □
0.02	17	82	30
0.04	16	62	17
0.06	15	54	16

UV irradiated	
C6PAS Conc	t (Å)
0.02	110
0.04	180
0.06	290

Table 1: Fitted parameters for SANS from 5 wt% gelatin C6PAS SGCs. R<sub>1</sub> and R<sub>2</sub> are ellipsoid radii and t is the sheet thickness.

A novel approach to control rheological and aggregation properties of aqueous gelatin-containing systems has been presented. The use of UV as a rheo-structural trigger means the transitions can be induced externally, without need for gross changes in thermodynamic or internal composition variables. Photodegradation of C6PAS in gelatin presents a novel approach to controlling aqueous gel properties with possible applications requiring rheological switches. Further details can be found in reference [4].

### References:

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- [3] J. Eastoe and A. Vesperinas, *Soft Matter*, 1 (2005) 338
- [4] A. Vesperinas, J. Eastoe, P. Wyatt, I. Grillo and R.K. Heenan, *ChemComm.* (2006) 4407

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