Supplementary Information

SI1 Refractive Index Calculation

PNiPAM Concentration

The largest difference in refractive index in the system will be between films with the highest and lowest concentration of PNiPAM monomer per unit volume. The highest concentration of monomer may occur for a 1% film of soft microgels that are highly packed, with negligible gaps between microgels in each layer. Given that the microgels are incompressible however, this concentration will be the same as that in a bulk PNiPAM gel – approximately 10% PNiPAM, 90% water. The refractive index of NiPAM at 20 degrees is 1.495[ref DOI: 10.1039/C4SM01222D *Soft Matter*, 2014, **10**, 7297-7305], compared to 1.333 for water. With a linear mixing estimation, the refractive index of the total system will be 1.348.

For the lowest concentration, observed in a film dimple with microgels spread at the interfaces, a microgel layer of 400nm in a 6000nm film may have a concentration of 1.334. This difference of 1% leads to a difference of 1% in film thicknesses.

Wavelength

More important for accurate analysis is the wavelength dependence of the refractive index of the water in the system. This is accounted for in the MATLAB analysis script. The temperature of water was taken as 21.5°C, and the values for the refractive index were taken from [Daimon and Masumura APPLIED OPTICS / Vol. 46, No. 18 / 20 June 2007].

SI2 Particle Counting

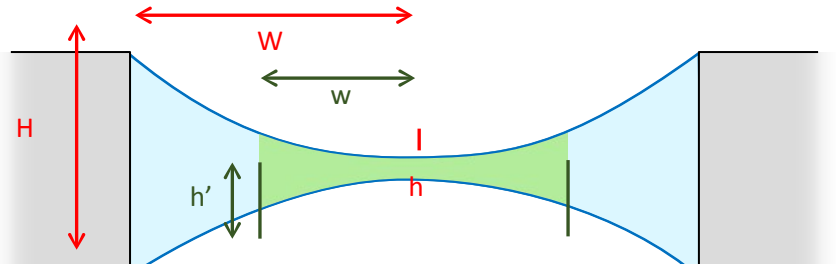


Figure S1: *Cross-section of thick initial film, modelled as two spherical caps. Volume considered in film particle counting shown in green. W is the width of the film holder, and H is its height. w is the width of the volume considered in the calculation. h is the central thickness of the film, and h' is its thickness at the edge of the volume considered.*

Geometry

Volume of spherical cap of width $2w$ and height $\frac{1}{2}(h^{'} - h)$:

$$V_C = \pi\frac{(h^{'} - h)}{12}(3w^2 + \frac{1}{4}(h^{'} - h)^2)$$

Total volume of the film section shown:

$$V = \pi w^2 h' - 2V_C$$

Result from measured and stated values: $V = 1.05 \times 10^{-10}\, m^3$

Microgel Counting: Thick Film

The number of microgels per unit volume was measured at 0.01%wt concentration using fluorescent microgels in a confocal microscope, and is given by $n_{0.01} = 1.76 \times 10^{16} m^{-3}$.

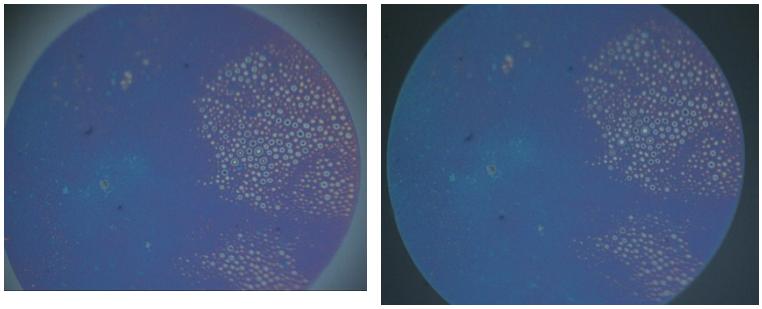
Table S1 provides the total number of microgel particles in the thick film for both 0,1 and 1% wt samples.

Concentration	1.0%	0.1%
Eq. for number of microgels in system	$n_{0.01} \times 100 \times V$	$n_{0.01} \times 10 \times V$
=> Number of microgels	2x10^8	2x10^7

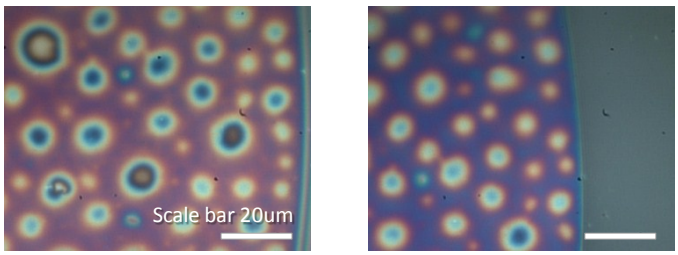
SI3 Heterogeneous thickness in the thin foam films made with 5% mol BIS microgels at 0.1% wt

In some cases, the thickness of the films is not homogeneous and the depleted zones appear only in the thinnest regions. However upon pressure removal the contact angle is the same over the whole perimeter of the film.

a



b



c

Thin film during adhesion test, 5% mol BIS, 0.1% wt. A. One can see that the film thickness is not homogeneous. The holes nucleate only on the right part of the film. As the pressure is reduced (right image), the meniscus appears dark as the adhesion angle increases. The angle increases uniformely around the film. B. During pressure reduction, the holes seem to refill with liquid coming from the meniscus. C. The adhesion angle increases.