Supporting Information:

Cavitation rheology involves inducing a single cavity via a syringe needle into the sample and measuring the critical pressure at physical instability. The pressure of this instability is directly related to the elastic modulus of the sample and depends on the inner radius of the syringe needle.[i,ii] A similar technique is already known for the determination of the surface tension of liquids. The critical pressure P_c of the growing bubble in the liquid is defined as:

$$P_c = \frac{2\gamma}{r} \qquad \text{(a)}$$

where γ is the surface tension between the injecting liquid and the surrounding fluid and r is the inner radius of the syringe needle. The inflation of a cavity into elastic solids needs additional energy to deform the surrounding solid, besides the surface energy.[iii] This leads to a critical pressure P_c for the spontaneous inflation of the cavity at the tip of the needle:

$$P_c = \frac{2\gamma}{r} + \frac{5}{6}E_c \qquad \text{(b)}$$

where E_c is the critical elastic modulus of the solid.[iv,v]

Figure 1 shows an exemplary analysis of cavitation rheology results for the sample with 0.1 wt% incorporated microgel at 40 °C. The critical pressure P_c is plotted as a function of 1/r. The data points are fitted linearly and the critical elastic modulus can be calculated from equation (b). The y-axis intercept is a = 13.4. This leads to a critical elastic modulus E_c of 16.1 kPa.

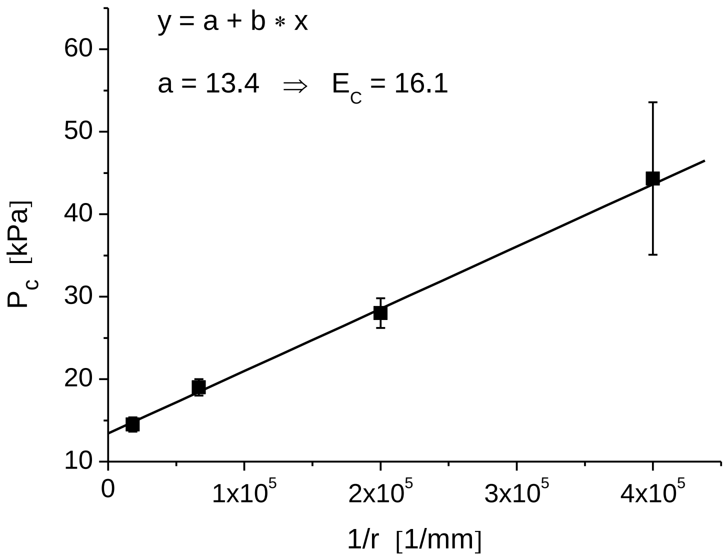

Figure 1: Exemplary analysis of cavitation rheology results from composite materials with 0.1 wt% incorporated microgel at 40 °C. The critical pressure P_c is plotted as a function of 1/r. The error bars show the standard deviations.

[i] J. A. Zimberlin, A. J. Crosby *J. Polym. Sci.Part B: Polym. Phys.* **2010**, 48, 1423-1427.
[ii] S. Kundu, A. J. Crosby *Soft Matter* **2009**, 5, 3963-3968.
[iii] Y. Lin, C. Hui *Int. J. Fract.* **2004**, 126, 205-221.
[iv] A. Gent, D.J: Tompkins *J. Appl. Phys.* **1969**, 40, 2520-2525.
[v] A. Gent *Int. J. Non-Linear Mech.* **2005**, 40, 165-175.