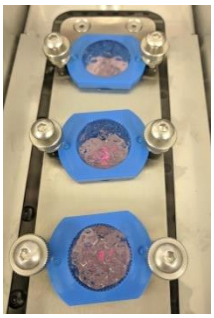
Mechanical Testing of Superabsorbent Polymer (SAP) Gels during Swelling using ElastoSens™ X3

Testing the bulk mechanical properties of superabsorbent polymer (SAP) gels during swelling may be challenging using traditional testing instruments. In this application note, the viscoelastic properties of SAP gels were measured using the ElastoSens™ X3. This instrument measures the mechanical properties of materials non-destructively and with no contact using low frequency vibrations. Being very simple to use, the ElastoSens™ X3 is suitable for both R&D and QC labs.

In this study, SAP particles were weighted and dispensed into the sample holders of the ElastoSens™ X3. 6g of demineralized water were then poured into the sample holders to initiate the swelling of the SAP. The weight of SAP particles was changed in order to vary the maximum swelling ratio. The precision of measurements was first evaluated (Fig. 1). The effect of the swelling ratio on the elasticity of SAP gel was then studied (Fig. 2). These data were processed to observe the effect of the swelling ratio on the gel elastic shear modulus after 4 minutes and the absorption time (Fig. 3 & 4). The effect of the solution's pH on the gelation profile of SAP gels was also investigated (Fig. 5). Finally, the incremental swelling of a SAP gel (obtained by successive addition of water) was tested by measuring the evolution of the shear elastic modulus at each level of swelling ratio (Fig. 6).



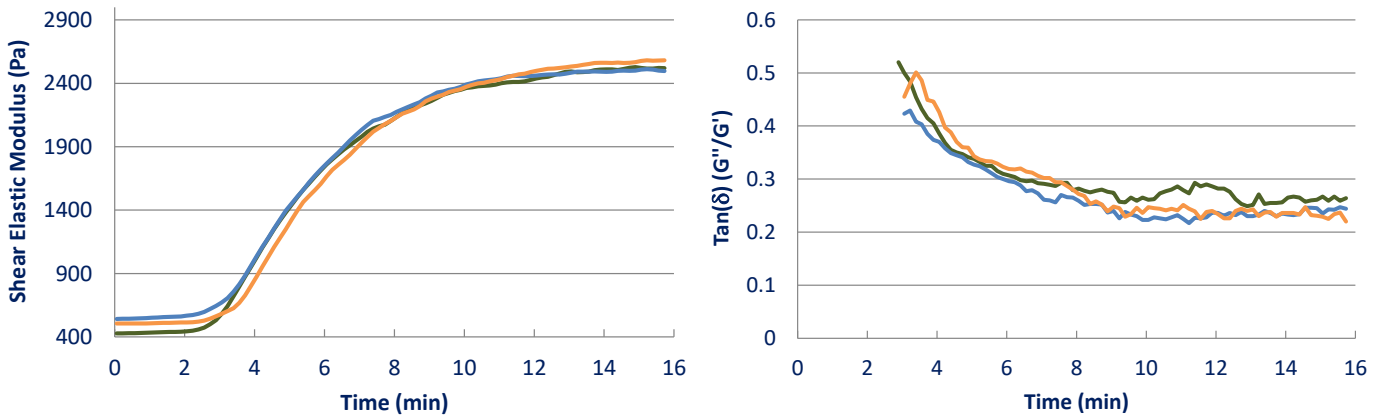


Fig.1 Time evolution of the shear elastic modulus G' (left) and tan(δ) (right) of three samples of a SAP gel during the absorption of demineralized water (max. swelling ratio was 200 g/g). Repeatability of measurements of G' at the plateau was ±2%.

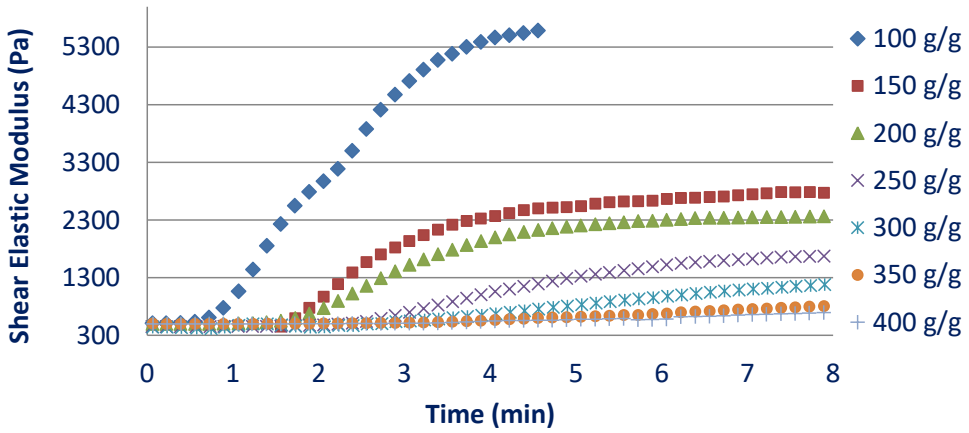


Fig. 2 Time evolution of the shear elastic modulus (G') of SAP gels during swelling as a function of the maximum swelling ratio. The swelling ratio was varied from 100 g/g to 400 g/g with increments of 50 g/g.

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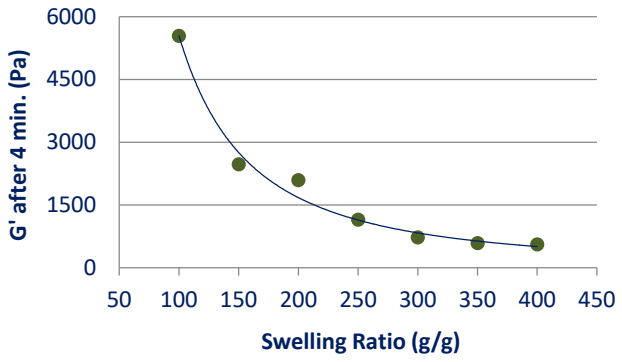

Fig. 3 Effect of the maximum swelling ratio on the shear elastic modulus (G') after 4 minutes of absorption.

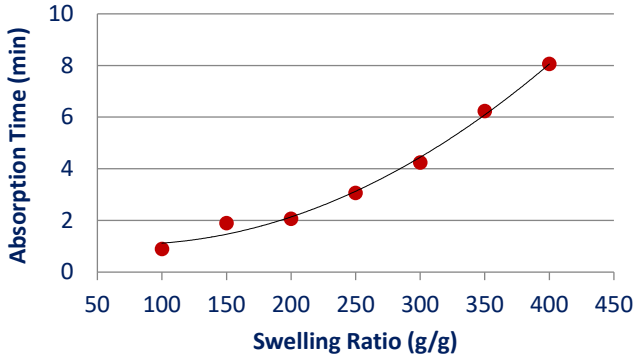

Fig. 4 Absorption time (time required to reach an elasticity of 700 Pa) as a function of the maximum swelling ratio.

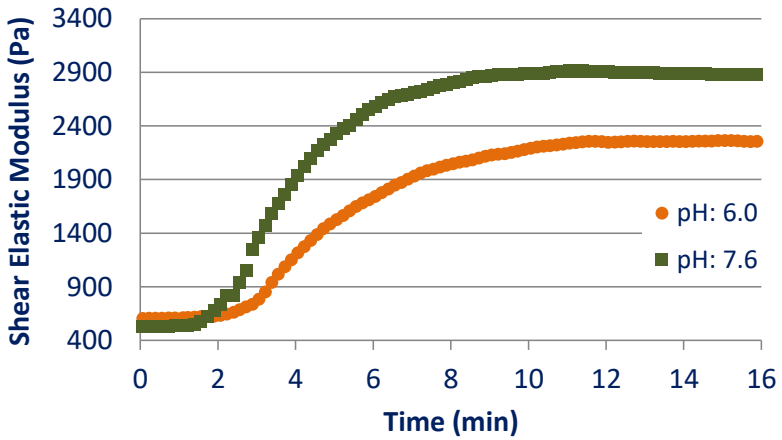

Fig. 5 Time evolution of the shear elastic modulus of SAP gels as a function the absorbed water solution's pH (max. swelling ratio: 200 g/g).

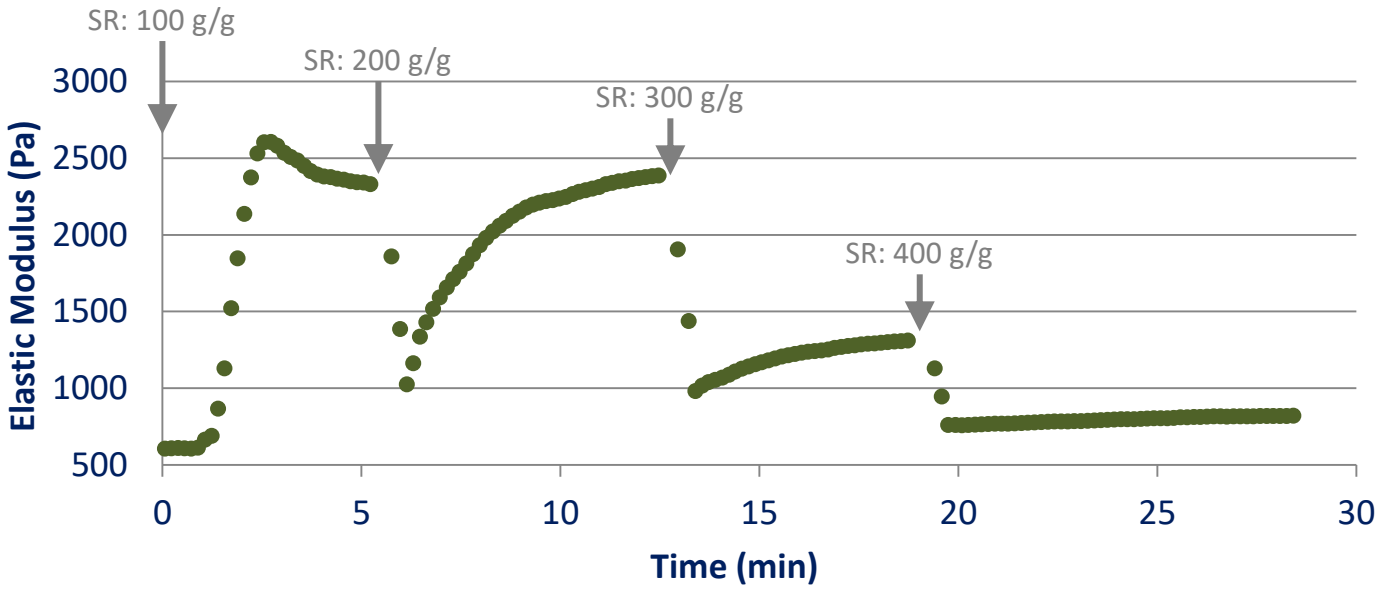

Fig. 6 Time evolution of the shear elastic modulus G' of a SAP gel during incremental absorption of demineralized water. Water was incrementally added to get a maximum swelling ratio of 100 g/g (added at 0 min.), 200 g/g (added at 5 min.), 300 g/g (added at 13 min.) and 400 g/g (added at 19 min).