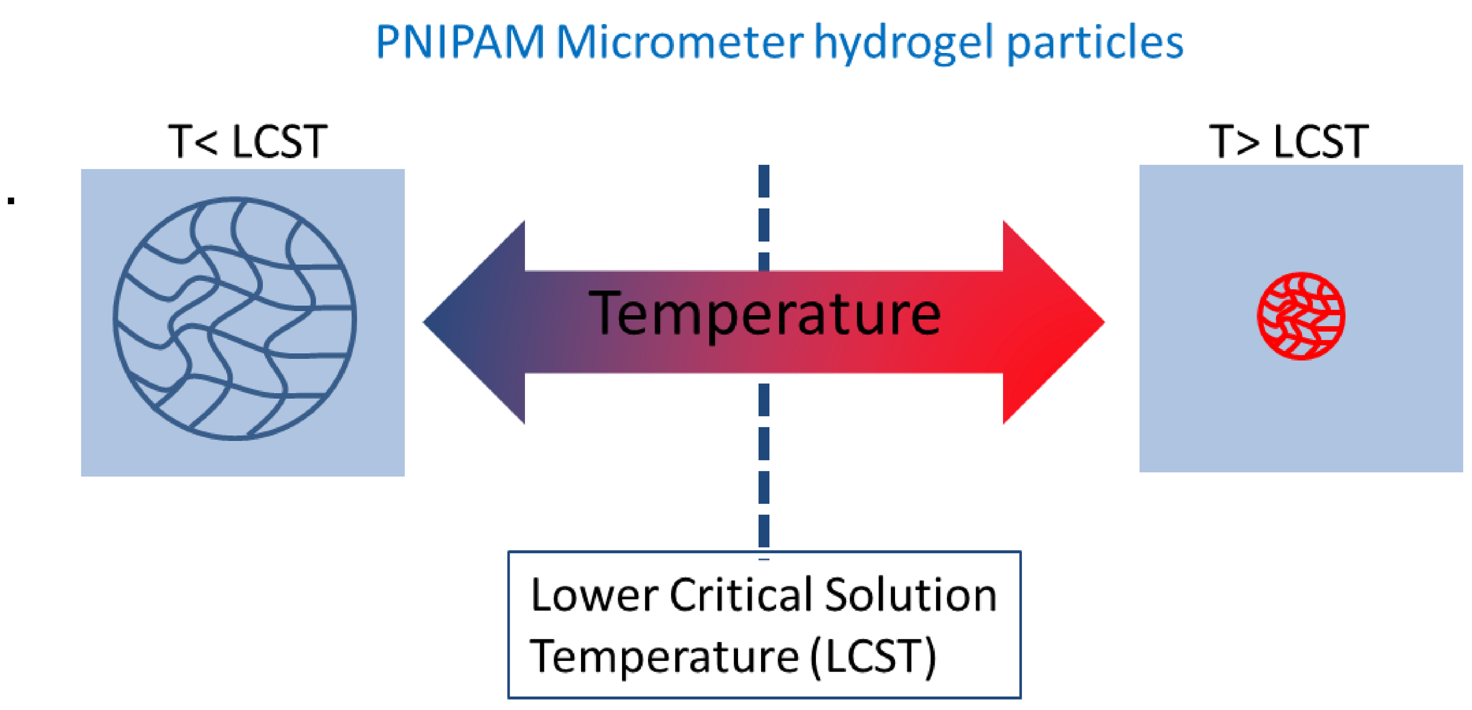
Micromechanics of temperature sensitive microgels

Micromechanics of temperature sensitive microgels

P. Voudouris and H. M. Wyss
Eindhoven University of Technology, Department of Mechanical Engineering

Introduction

•Over recent years, stimuli responsive materials have been developed which respond to changes in their solvent conditions. One of the most common type of stimuli-responsive materials is a class of materials called hydrogels—low density cross-linked polymer networks in water. Microgels are important materials for both basic science and engineering and have wide applications from the study of phase transitions to the delivery of drugs. These micron and sub-micron particles, made of hydrogel materials, respond to solvent conditions. The most common microgels are environmentally sensitive, responding to temperature and pH.
Our material of interest, poly (N-isopropylacrylamide) or PNIPAM, undergoes a deswelling transition above a critical temperature. The deswelling behavior of this polymeric material has been thoroughly studied in ensemble microgel systems as well as in bulk hydrogel samples.

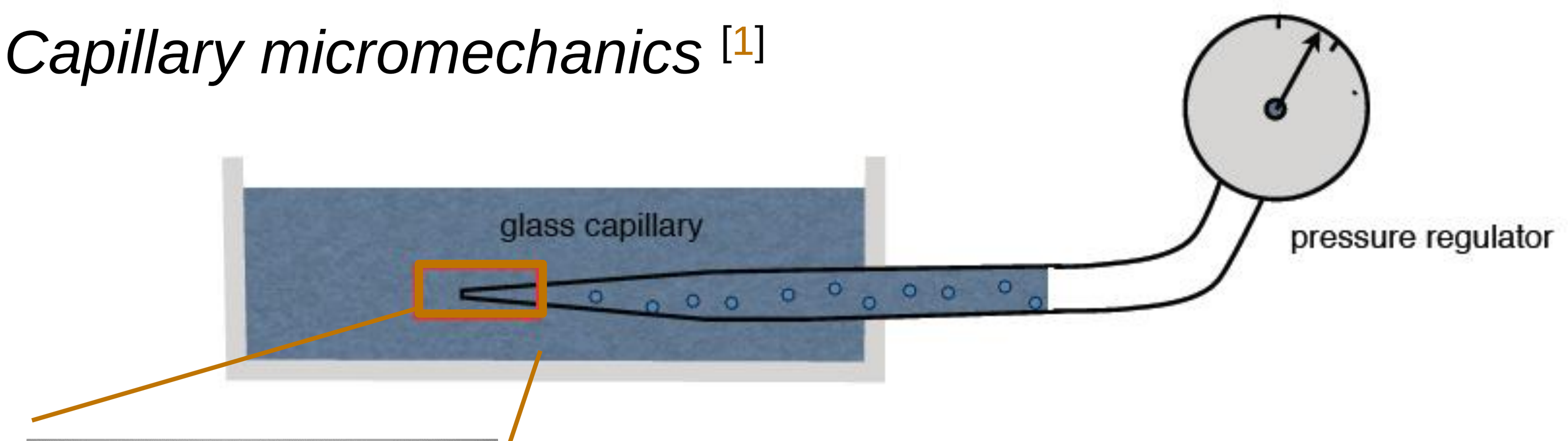


Aim of Study

On this work we present measurements of the (linear) ***elastic properties*** of ***single microgel particles*** at different temperature, using the recently developed capillary micromechanics technique.[2]

Method

Capillary micromechanics [1]



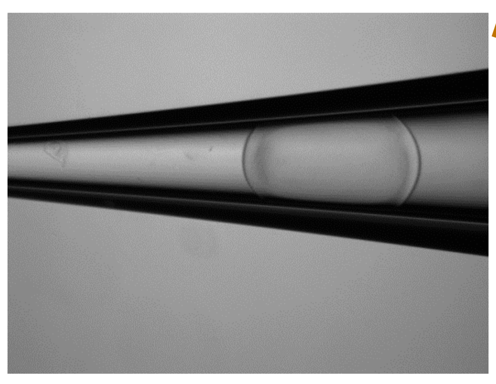
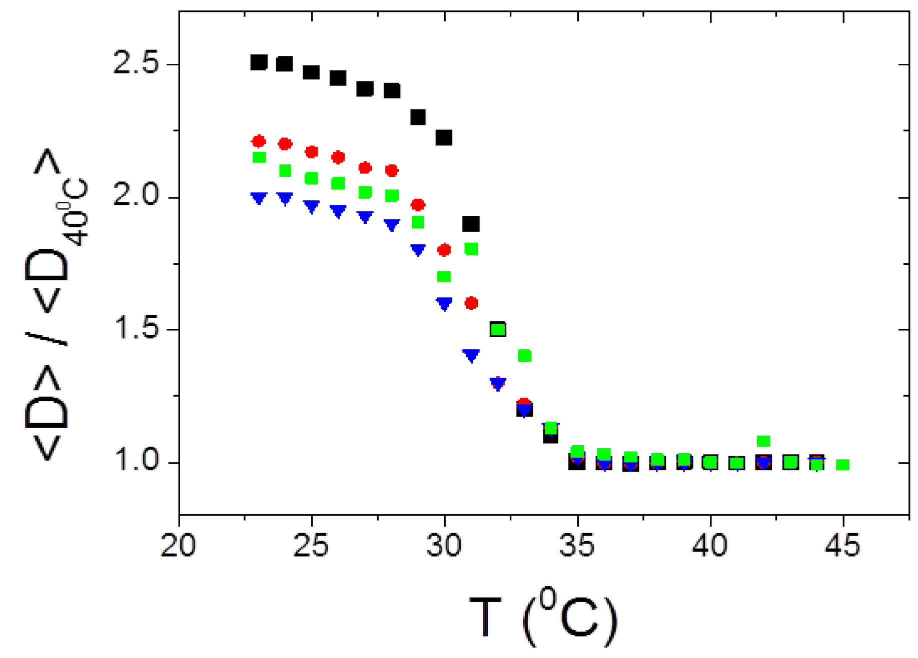


Image analysis on the particles trapped at the end of the tip under different hydrostatic pressures.

K (Pa) Elastic Compressive modulus (Volume changes)
G (Pa) Elastic Shear modulus (Shape changes)

Synthesis and Characterization of Microgels

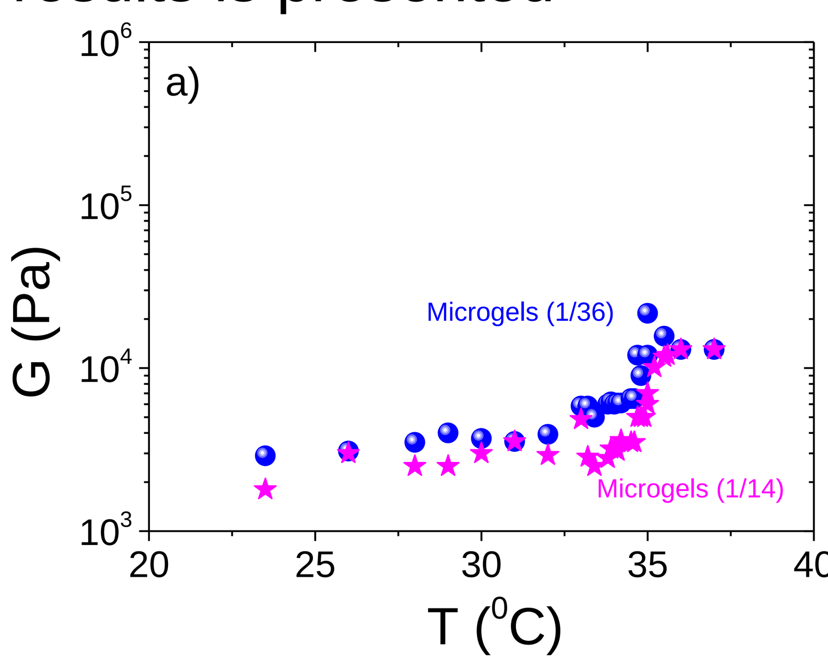
PDMS microfluidic devices were used to generate uniform emulsion drops containing the monomer a crosslinker and a photoinitiator. The synthesis of the particles was then achieved by inverse emulsion polymerization. By varying the crosslinker / monomer concentrations different batches of PNIPAM particles were prepared, where we expect to have different stiffness. At the following figure the size of the particles as a function of temperature is pressented.

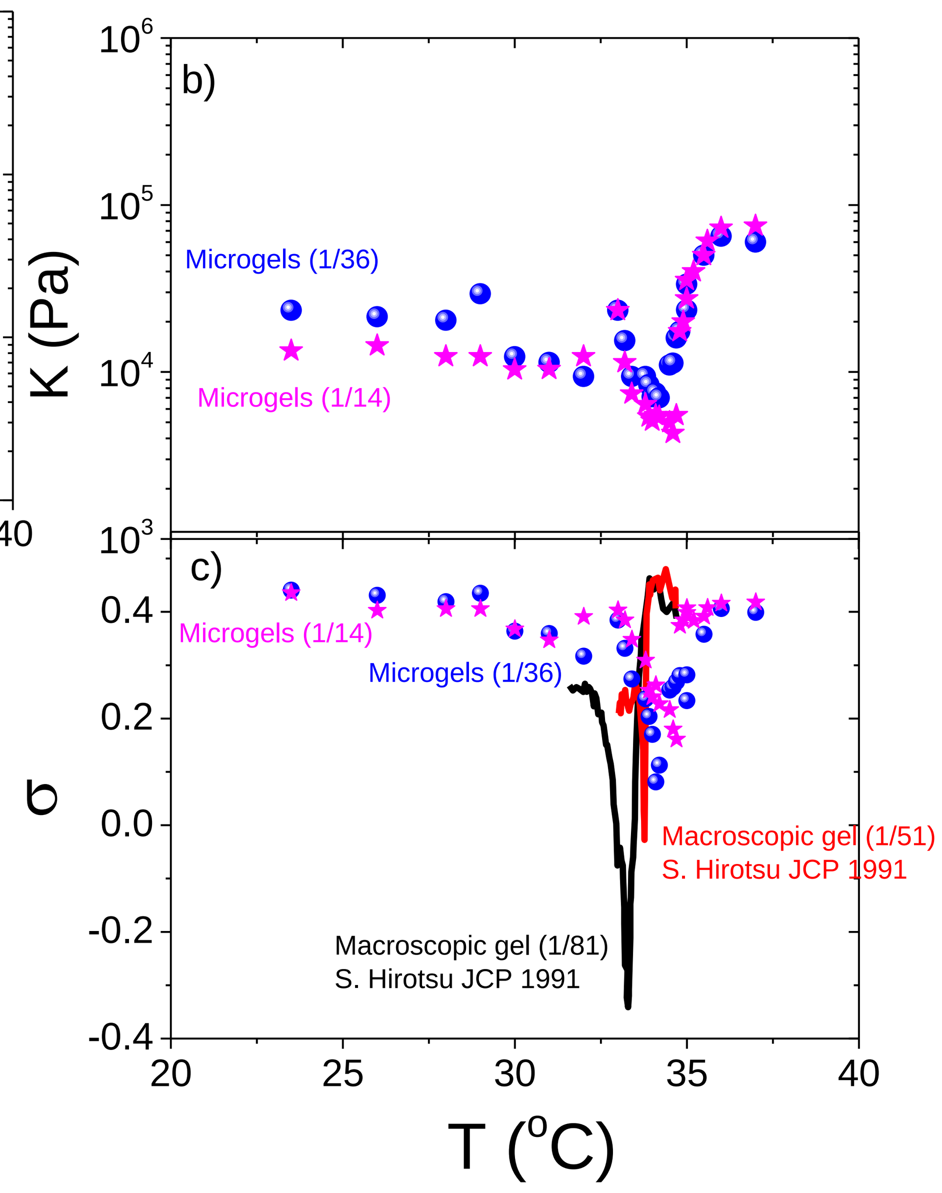


mol cross / mol NIPAM	<R> (μm)
■ 1 : 36	155
● 1 : 14	133
▲ 1 : 10	120
▼ 1 : 7	52

Results and Discussion

At the following figures an overview of our experimental results is presented





We observe that ***G*** constantly increases with increasing T while for ***K*** we observe a sharp minimum close to LCST. Thus we can conclude that close LCST, the particles change easier their volume than their shape! This can be quantified through the so called Poisson ratio (σ - negative ratio of transverse to axial strain) which is presented at fig. C along with the comparison of available data in the literature [2] for a macroscopic gel.

References

[1] H. M. Wyss, T. Franke, E. Mele, and D. A. Weitz *Soft Matter* 4550-4555 (2010)
[2] S. Hirotsu 3949-3957 *JCP* (1991)