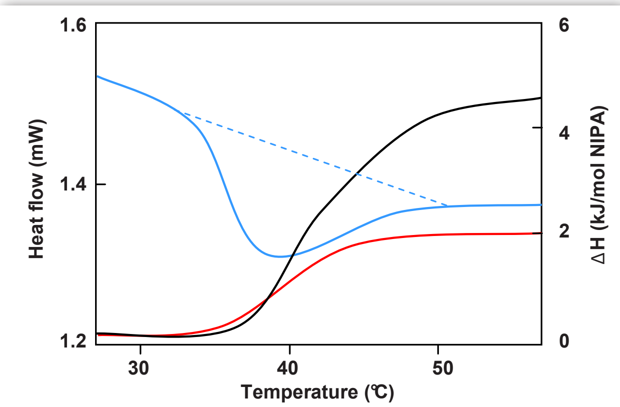
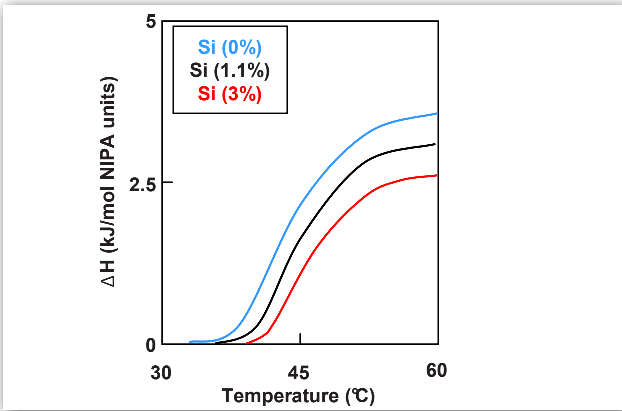
Phase transition of a solution of amphiphilic polymer

INTRODUCTION

Because of the ever-increasing development of water-based formulations, for both environmental and economic reasons, many investigations are realized on associating water-soluble polymers for the past two decades. According to their environment, some polymers, called LCST* polymers, are able to undergo reversibly a dramatic change of their macroscopic properties like swelling/collapse or thickening/thinning. These proprieties are important outlets in macromolecular transducers, controlled permeation, drug release, etc. Some of these are also known to interact strongly with hydrophilic and hydrophobic surfaces such as silica particles.



Heat flow — and transition enthalpy — of an aqueous solution of PAAgPNIPA**. Transition enthalpy of PNIPA precursor in similar condition—. Heating rate 1°C/min (reference1)***



Endotherms corresponding to the phase transition of PAAgPNIPA in the presence of silica particles (reference2)

EXPERIMENT

MICROCALVET ULTRA was used to study responsive properties involving PNIPA phase transition. Polymer solutions (V = 0.8 mL), were analyzed at a heating and cooling rates of 1°C/min between 10 and 70°C. The reference cell contained the same quantity of solvent. These conditions were used to work close to thermodynamic equilibrium and to avoid any kinetic interference.

RESULTS AND CONCLUSION

An endothermic transition is observed for the PAAgPNIPA solution between 34 and 50°C. The cumulative transition enthalpy versus temperature, obtained by integration of the heatflow signals, is plotted for PAAgPNIPA, PNIPA, and samples including silica particles. Their interactions with PAAgPNIPA could be compared thanks to the microcalorimetry signals.

**** LCST (Lower Critical Solution Temperature) : Temperature from which a polymer is not soluble any more when it is heated.***
***** PAAgPNIPA : Poly(acrylic acid) grafted with PNIPA***
****** PNIPA : poly(N-isopropylacrylamide)***

INSTRUMENT

MICROCALVET ULTRA

-20 to 170°C

HIGHEST HEAT MEASUREMENT ACCURACY
3D sensor based on Peltier elements with Joule effect calibration.

MODIFIABLE TEMPERATURE CONDITIONS
for increased flexibility and replication of real life conditions.

CONVENIENT INTERCHANGEABLE CRUCIBLES AND CELLS
to perform even the most demanding experiments using one instrument :
- high pressure (1000bar) and high vacuum
- pressure measurement and control
- mixing experiment

EXTERNAL COUPLING CAPABILITY
designed to increase your research options including manometry, BET instrumentation, gas analyzers, humidity controllers and gas panels

REFERENCE

1. Thermoreversible behavior of associating polymer solutions : thermothinning versus thermothickening. D. Hourdet, J. Gadgil, K. Podhajecka, M.V. Badiger, A. Brûlet and P.P. Wadgaonkar, Macromolecules, Vol 38, 8512-8521,(2005)
2. Hybrid thickeners in aqueous media. D. Portehault, L. Petit, N. Pantoustier, G. Ducouret, F. Lafuma, D. Hourdet, Colloids and Surfaces A: Physicochem. Eng. Aspects, Vol 278, 26-32, (2006)