STUDY OF MODEL LIPID BIOMEMBRANES WITH HIGH-RESOLUTION ADIABATIC SCANNING CALORIMETRY

INTRODUCTION

Scanning calorimetric techniques allow to obtain continuously the evolution of the heat capacity at constant pressure $C_p(T)$ in terms of the power P and the rate dT/dt.

$$C_p = \frac{dQ}{dT} = \frac{dQ/dt}{dT/dt} = \frac{P}{\dot{T}}$$

In an Adiabatic Scanning Calorimeter (ASC) a constant power P is supplied to the sample and the resulting change in temperature $T(t)$ is measured as a function of time from which the rate dT/dt can be calculated. Combining the rate with the constant power results in $C_p(T)$. Moreover, the enthalpy $H(T)$ is easily obtained from the product of the power P and the time laps between the start of the run at t_0 and the time at which $T(t)$ was reached.

$$H(T) = P\left[t(T) - t(T_0)\right]$$

SAMPLES USED

Lipids are the main constituents of cell membranes. Many of these lipids exhibit phase transitions near typical body temperatures, making these transitions biologically relevant.

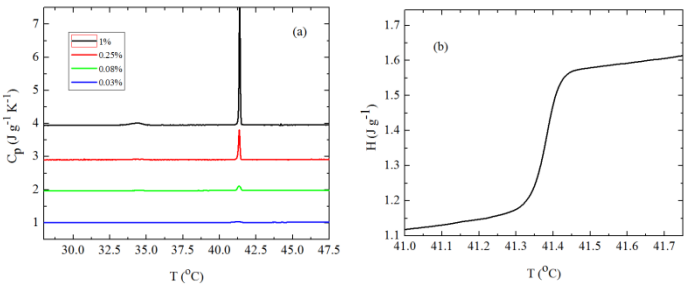
Here, dilute solutions of a model lipid, 1,2-dipalmitoyl-sn-glycerol-3-phosphocholine (DPPC), were measured at increasing dilution level. Four concentrations were prepared by diluting the same initial stock solution. From the respective solutions, an amount was placed in a commercial high-pressure DSC cell. A Peltier-based ASC was used, and an average heating rate of 1 K/min was achieved. The following samples were studied:

Concentration DPPC	Amount of solution in the cell	Effective amount of lipid in the cell
1%	63.2 mg	632 µg
0.25%	63.7 mg	159 µg
0.08%	71.6 mg	57 µg
0.03%	65.4 mg	20 µg

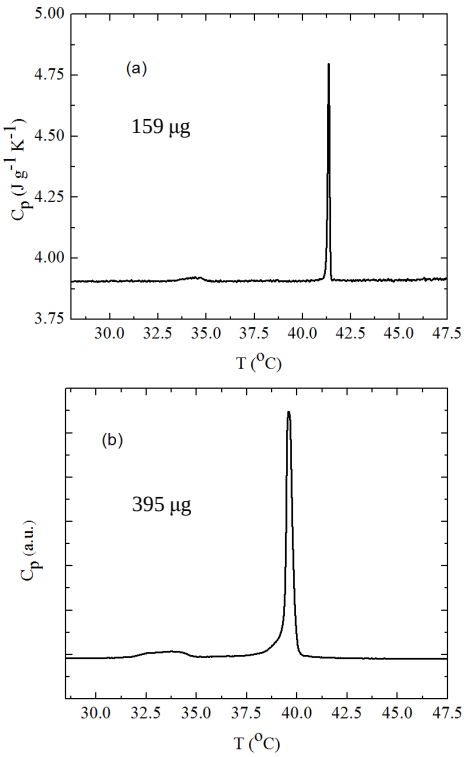
RESULTS

Two phase transitions were detected for all concentrations, although the smaller transition becomes very faint at the lowest concentrations. The phase transitions separate, with increasing temperature, the gel phase L_β', the ripple phase P_β' and the liquid crystalline phase L_α [1].

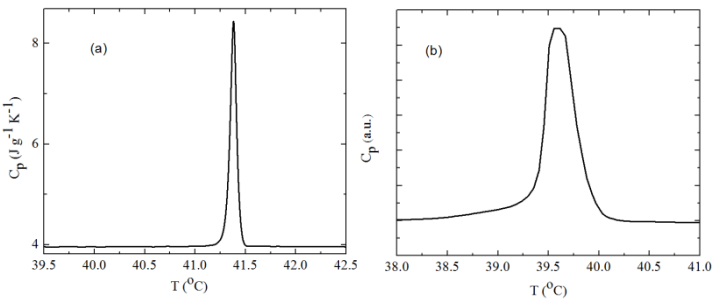
The results are better than those [1] of a Privalov-type DSC calorimeter [2], the standard calorimeter type used in the study of solutions of biological systems. In this case, a sample similar to our second concentration (with 159 µg DPPC) was measured, but with a total sample of 500 mg and effective mass of DPPC of 395 µg. ASC shows the transition to be sharper and more symmetric than the DSC.



(a) Concentration dependence of C_p profile. (b) Enthalpy of the ripple to liquid crystalline phase transition in sample with 1% DPPC concentration.



C_p profile. (a) This work. (b) Ref. 1.



Detailed C_p profile. of the ripple to liquid crystalline phase transition. (a) This work. (b) Ref. 1.

REFERENCES

[1] Pfeiffer, H., Klose, G., Heremans, K., & Glorieux, C. (2006), Thermotropic phase behaviour of the pseudobinary mixtures of DPPC/$C_{12}E_5$ and DMPC/$C_{12}E_5$ determined by differential scanning calorimetry and ultrasonic velocimetry. Chemistry and Physics of Lipids, 139(1), 54–67.

[2] Privalov, P. L. (1980). Scanning microcalorimeters for studying macromolecules. Pure and Applied Chemistry, 52(2), 479–497.