Influence of carbon nanostructures on the structural and thermal properties of lipid membranes

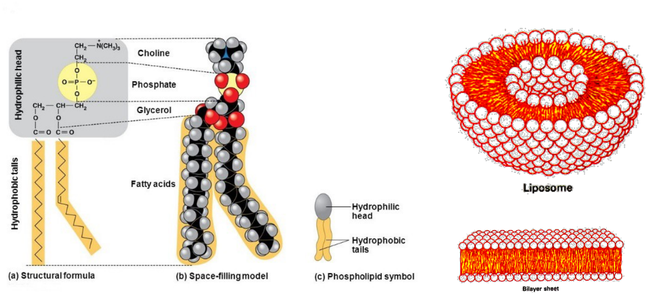
J. Genova, N. Drinova, H. Chamati, M. Petrov, Z. Slavkova
Institute of Solid State Physics, Bulgarian Academy of Sciences, Sofia, Bulgaria
Tel: +359 9795725, e-mail: n_drinova@issp.bas.bg

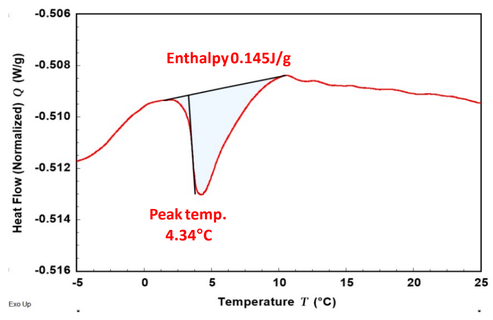
Abstract

Studies of carbon nanostuctures, incorporated in phospholipid bilayers show an effect of these admixtures on the local structure and dynamic properties of biomembranes, as well as on their toxicity and ability to promote trans-membrane channel formation depending on their size, shape, and surface modification. However, the dominant forces of the influence of these structures on the conformational states and functions of biomembranes remain not clarified.

The main goal of our study is the investigation of the thermal and conformational structure characteristics of 1-stearoyl-2-oleoyl-sn-glycero-3-phosphocholine (SOPC) phospholipid at variation of carbon nanostructures in various types and concentrations. For that purpose, we use the differential calorimetric analysis. In the present work we study the influence of incorporated in the membrane graphene nanoparticles (flakes) on the phase transition temperatures and enthalpies of SOPC phospholipid, discuss the possible physical mechanism driving the energetic and structural states of the bio-nano-composites and compare the results to those with pristine or amide functionalized single wall nanotubes.

Materials



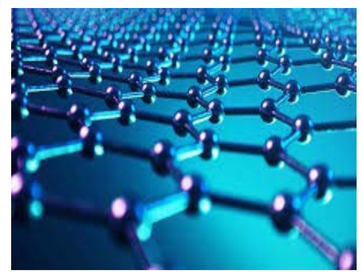


Exo up

(б)

Carbon nanoflakes:
Thickness: <3 layers
Lateral size : 0.5-5 µm

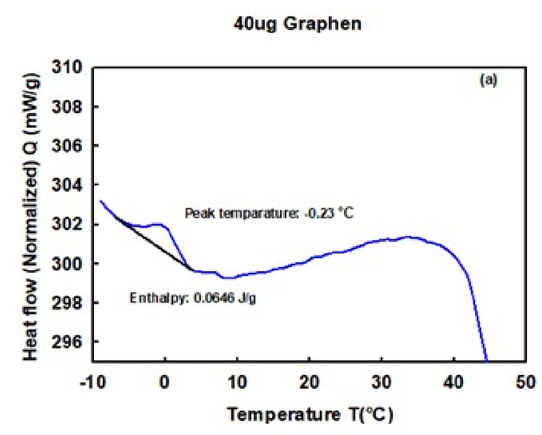
Thermogram of pure SOPC

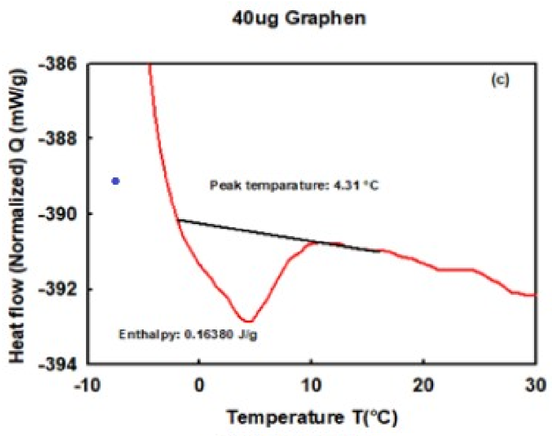


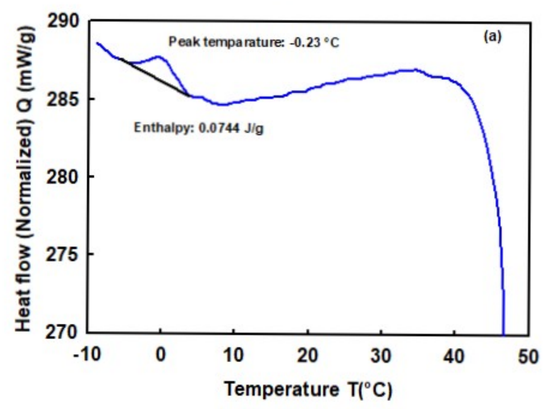
Differential Scanning Calorimetry

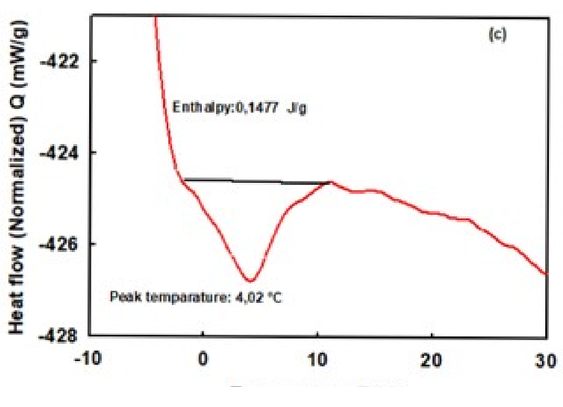
Methods and Results

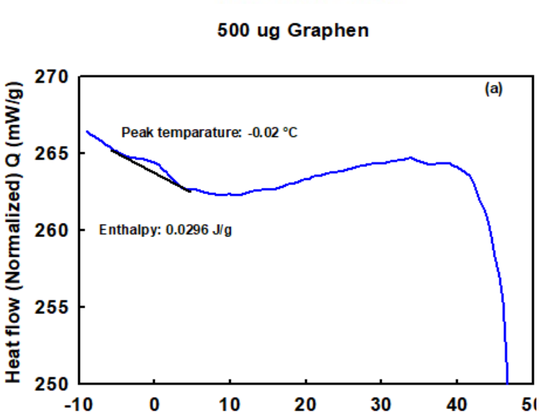
Thermograms of SOPC lipid systems in presence of various concentrations of graphene nanoflakes at cooling (blue curve EXO) and heating (red curve ENDO) and corresponding phase transition temperature and enthalpy

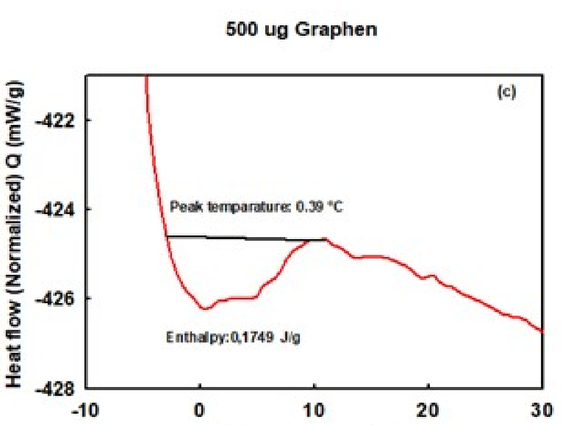




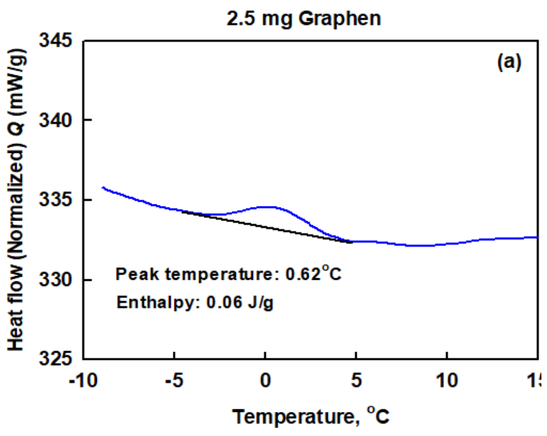


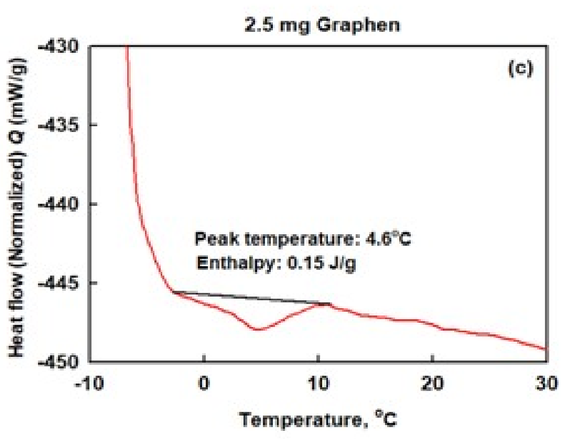


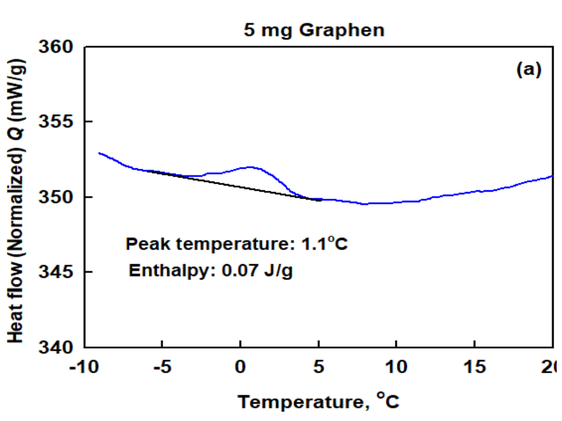


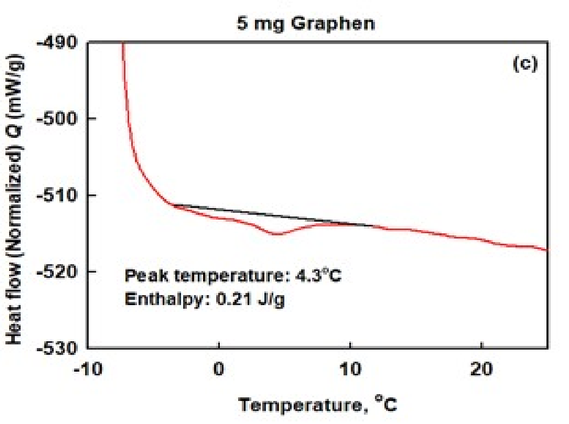


Sample: 1 mg SOPC + 20 w. % dd water	EXO T_m , °C	EXO ΔH, J/g	ENDO T_m , °C	ENDO ΔH, J/g
Pure SOPC	---	---	4.34	0.145
40 µg Graphene Flakes	-0.23	0.06	4.31	0.164
250 µg Graphene Flakes	-0.23	0.07	4.02	0.148
500 µg Graphene Flakes	-0.02	0.03	~ 4	0.175
2.5 mg Graphene Flakes	0.62	0.06	4.60	0.150
5 mg Graphene Flakes	1.10	0.07	4.30	0.210









Conclusions:

The addition of pristine graphene flakes into the SOPC lipid system in concentration 0-5mg slightly influences it's phase behavior;

The phase transition temperature, obtained during heating (endo) as well as the transition enthalpies at both heating and cooling remain practically unchanged for all the studied concentrations of graphene flakes into the lipid system;

The phase transition temperature, obtained during cooling (exo) slightly and gradually increases with the concentration of graphene flakes in the lipid matrix;

Comparing the presented results with previous studies of pristine and amide functionalized carbon nanotubes, we can conclude that functionalization is of crucial importance for incorporation of graphene into the lipid membrane.

The authors acknowledge support from the Ministry of Education and Research, Bulgaria (National Science Fund, Grant DN 08-02/2016).