Insight on the Lateral Organization and the Size Distribution of the Gel and Fluid Clusters in DMPC/DSPC Lipid Bilayers

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1 Introduction

The organization and compartmentalization of lipid membranes are exciting key phenomena demonstrating that the lipid bilayer is not just a structureless solvent [5]. This is suggested to be of critical importance for many of their functions. Both theoretical findings and experimental data provide evidence that the lateral composition of a membrane consists of micrometer-scale lipid domains [1,8]. But there is only indirect evidence for existence of domain formation on a smaller, less well defined scale in erythrocyte [3,4] and mitochondrial membranes [6]. It has been argued [5] that lipid domains should also exist on nanometer scale. The last argument was not supported by experimental evidence until a recent report on atomic force microscopy detection of such domains [2]. The last work investigated the same system, which is in the focus of our interest. The size distribution of nanometer-scale domains in the fluid-gel coexistence region depends on the lipid composition and on the temperature. The lipids, subject of our study, dimyristoylphosphatidylcholine (DMPC) and distearoylphosphatidylcholine (DSPC), belong to the class of the phospolipids, the major components of biological membranes, and therefore the most important among the membrane lipids.

2 Method and results

In order to understand the formation of lipid domains, a two-state two-component model, proposed by Sugar *et al.* [7], of DMPC/DSPC membranes is studied by employing Monte Carlo method in canonical ensemble. This simple model calculates excess heat capacity curves in agreement with the experimental data generated by differential scanning calorimetry (DSC), a powerful and very sensitive technique for investigating the thermodynamic properties of lipid membranes. As a result of such simulations the size distributions of both gel and fluid clusters, composed of DMPC and DSPC molecules have been obtained in a interval of temperatures corresponding to the coexistence region of their phase diagram. Here the model is modified to calculate the size distributions of the gel and fluid clusters at different temperatures and mole fractions as well as the properties related to these distributions. The simulated average size of the non-percolated gel clusters in the gel-fluid coexistence region is found to be 9.6 $\pm$1.8 nanometers, which is in excellent agreement with the data, resulting from two direct and independent methods, neutron diffraction and atomic force microscopy predicting value below 10 nanometers [1].

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