Thermal behavior and stability of dialkyldimethylammonium bromide cationic vesicles studied by differential scanning calorimetry

E. Feitosa

Department of Physics, Sao Paulo State University – Rua Cristovao Colombo, 2265, CEP 15054-000 – Sao Jose do Rio Preto – SP, Brazil
e-mail: eloi@ibilce.unesp.br

Cationic lipid vesicles have had increasing interest in academic and industrial research because of their potential use in nonviral DNA transfection to target cells in gene therapy [1]. In principle, any cationic lipid may be used for this purpose. Special interest, however, has been devoted to the vesicle-forming cationic lipids, which include those from the series dialkyldimethylammonium bromide (DiDAB, n = 12-18), since they self-assemble spontaneously as large unilamellar vesicles when mixed with water at a temperature safely above their melting temperature (Tm). From these lipids, Di12DAB and Di18DAB are by far the most investigated ones, probably because they form more stabilized vesicles. In the present work, DiDAB dispersions were prepared by simple dilution of the lipids in water at 25 °C (n = 10 and 12), 40 °C (n = 14 and 16 °C) or 60 °C (n = 18).

Herein we have investigated by differential scanning calorimetry (DSC) aqueous dispersions of 0.1 and 1.0 mM DiDAB (n = 10-18). The data mainly show that the heating and cooling thermograms can be flat, single- or double-peak depending on the surfactant concentration and dispersion ageing time. The thermograms revealed that up to 1.0 mM the shortest Di10DAB forms no vesicle; Di12DAB presents a single melting transition at around 16 °C and no cooling transition; Di14DAB displays a main endotherm close to that for Di16DAB at around 28 °C; for n = 16 the melting endotherm is an overlap of two peaks at around 27.5-28.5 °C, and there are two exotherms at 23.0-24.5 and 12.5-16.0 °C in the cooling mode, characteristic of the reverse of the overlapped melting peaks, indicating thermal hysteresis. Di16DAB also presents an endotherm at Td = 41-42 °C we ascribed to the vesicle thermal deflocculation: below Td, the deflocculation rate tends to increase with increasing surfactant concentration and vesicle ageing time, while above Td, the vesicles are stable. At 1.0 mM Di18DAB presents two characteristic endotherms in the heating mode at around 36.0 and 44.5 °C and two cooling exotherms at around 40.0 and 14.9 °C, which correspond to the reverse transitions, but no deflocculation endotherm, indicating Di18DAB vesicle stability. At 0.1 mM both the heating and cooling traces are single-peak with the cooling transition being ca 5 °C smaller than the melting temperature (hysteresis). For n = 12 and 14, the dispersions tend to form hydrated crystals at temperatures below Tm and above 0 °C rather than vesicle flocks.

Based on this investigation, we conclude that a systematic analysis of DiDAB dispersions may be helpful to better understand some vesicle characteristics; for example, that the flocculation phenomenon discerned for Di16DAB vesicles, but not for the other lipids is clearly related to the destabilizing flocculation effects that happens below the thermal deflocculation temperature (Td). Past this temperature, the vesicles are highly stable. The data also reveal that DSC is a powerful technique to investigate vesicle stability yielded either by crystal or flock formation.