

## Phase behavior of didecylpyrrolidinium bromide in aqueous solution

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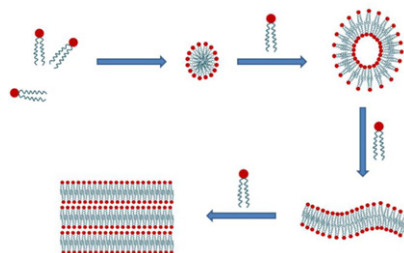
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### HIGHLIGHTS

- ▶ Didecylpyrrolidinium bromide can form bilayers in aqueous solution.
- ▶ The structural parameters of the LLC phase depend on the content of surfactant.
- ▶ The properties of aggregates are influenced by the structure of hydrophobic chain.

### GRAPHICAL ABSTRACT

The phase behavior of double chained didecylpyrrolidinium bromide (DC<sub>10</sub>PB) in aqueous solution was investigated at 25 °C. It was found that DC<sub>10</sub>PB was easy to self-assemble into bilayers including vesicles and lamellar liquid crystals compared with single-chain surfactants.



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### ABSTRACT

The phase behavior of a double chained pyrrolidinium surfactant, didecylpyrrolidinium bromide (DC<sub>10</sub>PB), in aqueous solution was studied. Polarized optical microscopy (POM), cryogenic-transmission electron microscope (cryo-TEM) and small-angle X-ray scattering (SAXS) measurements were employed to investigate the properties of the structures formed. With increasing DC<sub>10</sub>PB concentration, isotropic solution phase, vesicle phase, and lamellar liquid crystal (LLC) phase are presented in aqueous solution. The structural parameters of the LLC phase were calculated from SAXS patterns, which show the change in detail as a function of the amount of DC<sub>10</sub>PB. The rheological measurements reveal that the viscoelasticity increases with DC<sub>10</sub>PB concentration because of the densely packing of the surfactant molecules.

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### 1. Introduction

It is well-known that surfactant molecules can self-assemble to form different aggregates in aqueous solutions such as spherical micelles [1], microemulsions [2], vesicles [3,4], and lyotropic liquid crystals (LLC) [5,6] due to their unique amphiphilic properties. These aggregates have been extensively studied not only for their fundamental interest but also for practical applications including cosmetics, pharmacy, and dispersion technology [7–9].

The self-assembled structures formed by ionic surfactants are mainly influenced by many factors, including the structures of head groups and hydrophobic chains of surfactant molecules, temperature, pressure, and the solvent effect etc. A suitable molecule design to subtly tune the phase behavior of surfactants is convenient and preferable.

The self-assembled aggregates formed by cationic surfactants with different headgroups have been studied extensively over the past decades. The micellization and phase equilibria in aqueous solution of cationic quaternary ammonium bromide surfactants have been investigated as a function of alkyl chain length, electrolyte concentration, and temperature by Buckingham et al. [10]. Liquid crystalline phases in ternary systems

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