Liquid crystal phase formation of monoolein in protic ionic liquids

S. Paporakis\(^1\), C. Darmanin\(^2\), S. Brown\(^1\), P. Adams\(^1\), M. Hassett\(^1\), A. V. Martin\(^1\), T. L. Greaves\(^1\)

\(^1\)School of Science, RMIT University, Melbourne, Victoria 3000, Australia
\(^2\)La Trobe Institute for Molecular Sciences, La Trobe University, Victoria 3086, Australia

s3599678@student.rmit.edu.au

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Monoolein-based liquid crystal phases formed through lipidic self-assembly have an established media for drug delivery and membrane crystallisation\([1,2]\). Only solvents containing specific properties can support lipidic self-assembly, of which ionic liquids are the largest class\([3]\). Protic-ionic liquids are tailorable solvents which can have low melting points, and have emerging applications as solvents for biomolecules, including as protein crystallisation media\([4]\). While separately the roles of protic ionic liquids, lipids and liquid crystal phases have proven benefits in biological fields\([5], [6]\), foundational knowledge of liquids crystal phases present for lipid:protic-liquid systems is lacking. In this study, the liquids crystal phase behaviour of the lipid monoolein was investigated in a series of 6 protic ionic liquids known to support amphiphile self-assembly, namely ethylammonium nitrate, ethanolammonium nitrate, ethylammonium formate, ethanolammonium formate, ethylammonium acetate, and ethanolammonium acetate. The effect on monoolein self-assembly of systematic changes to the protic ionic liquid structure was conducted, including increasing alkyl chain length, presence of a hydroxyl group on the cation, and changing the anion. The liquid crystal phases were studied using synchrotron small angle x-ray scattering, paired with cross polarized optical microscopy. Utilisation of a high throughput phase identification procedure aided in discovery of hexagonal, bicontinuous cubic and lamellar liquid crystal phases in all 6 protic ionic liquid solvents, leading to the production of intricate phase diagrams for 20-80wt% monoolein in the temperature range of 25 °C-70 °C.

Figure 1. Example small angle x-ray scattering and 1D scattering profile, leading to MO:EAF phase diagram .