QUATERNARY AMMONIUM SALT HYDRATES: A NEW IONIC FORMER FOR STRUCTURE-H CLATHRATE HYDRATE

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ABSTRACT

Ionic clathrate hydrates are known to form numerous clathrate structures by the enclathration of either the cations or anions in cages and the incorporation of the counterions into the water framework. Due to the ionic species included in the hydrate phase, ionic clathrate hydrates not only show many peculiar features such as metal ion encagement and superoxide ion generation but also exhibit notable physicochemical properties such as outstanding ionic conductivity and thermal stability. Thus, the ionic clathrate hydrates are considered for their potential applicability in various fields, including those that involve solid electrolytes, gas sensors, and energy storage. In this study, we report a new ionic former of structure-H (sH) hydrate. Diethyldimethylammonium hydroxide (Et₂Me₂NOH) + CH₄ hydrate was synthesized and its crystal structure was identified. From Raman spectroscopy, it was found that the material synthesized contained at least one or more phases besides pure CH₄ structure-I (sI) hydrate. Solid-state high-power ¹H decoupled ¹³C NMR spectroscopy indicated the presence of sH and sI hydrates and this was verified by powder X-ray diffraction analysis. The sH hydrates are commonly more stable than other structures thus, the present findings on the ionic sH clathrate hydrate might suggest a new important approach for improving the stability of ionic clathrate hydrates for their practical applications.

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