

### Spectroscopic Observation of Metastable Structure Formation in Gas Hydrate System

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Clathrate hydrates have been steadily receiving much attention because of their various applications such as natural gas hydrate production, energy gas storage, carbon capture and sequestration, and synthesis and fabrication of versatile energy devices. The sH hydrate is important in the oil industry because its large cage(5<sup>12</sup>6<sup>8</sup>) can accommodate larger molecules found in crude oil regions that cannot occupy the large cages of sI (5<sup>12</sup>6<sup>2</sup>) and sII (5<sup>12</sup>6<sup>4</sup>). However, there is only limited research of sH hydrate, contrary to sI and sII. The major difficulties of understanding of sH hydrate are that 1) sH can be formed only in the presence of large guest molecules (LGMs) and 2) most of the LGMs are insoluble or sparingly soluble in water. Also, there have been no reports on sI-sII-sH whole-phase behavior. The aforementioned barriers can be overcome by exploiting hydrophilic LGMs such as hexamethyleneimine(HMI). These highly water-soluble LGMs can create a homogeneous solution, which guarantees uniform hydrate phases. Therefore, the kinetic behavior of gas hydrate phases can be compared using HMI at a laboratory scale.