

## Encapsulation of Methacrolein and Gaseous Guests in Clathrate Hydrates and Their Spectroscopic Investigations

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Here, new structure II (sII) clathrate hydrates with methacrolein in the presence of gaseous guest (CH<sub>4</sub>, N<sub>2</sub>, O<sub>2</sub> or CO<sub>2</sub>) were characterized. The crystal structure and guest distributions of binary (methacrolein + gaseous guests) clathrate hydrates were identified through spectroscopic tools. The crystal structure of binary (methacrolein + gaseous guests) clathrate hydrates was identified as cubic Fd3m structure through powder X-ray diffraction patterns. We revealed that the inclusion of methacrolein and gaseous guests including CH<sub>4</sub>, N<sub>2</sub>, O<sub>2</sub> or CO<sub>2</sub> could be monitored in the large and the small cages of sII hydrates through Raman spectroscopy. The conformation of methacrolein in the large cages of sII hydrates was also analyzed via Raman spectroscopy, revealing s-trans conformer of methacrolein in the large cages of sII hydrates. We also checked the thermodynamic stability of binary (methacrolein + gaseous guest) clathrate hydrates.

KEYWORDS clathrate hydrate, methacrolein, guest, spectroscopic investigation