

## Spectroscopic Analysis of Hydrogen Atomic Radical Stabilized in Hydrogen Clathrate Hydrate

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Atomic hydrogens can be generated and stabilized at very low temperatures (4K) experimentally, and they possess unique quantum mechanical properties. We, in this paper, stabilized the atomic hydrogen radicals in icy hydrogen clathrate hydrate at 173K using 15kGy  $\gamma$ -irradiation, and spectroscopically observed with ESR and NMR. In icy hydrogen hydrate, organic molecules (Tetrahydrofuran) occupy the large cages and hydrogen molecules occupy the small cages. Using ESR and solid-state MAS  $^1\text{H}$  NMR, we confirmed that atomic hydrogen radicals exist in the hydrate channels without any collapse of the host framework. We discuss the confined icy hydrate channels, which can act as potential storage sites for simultaneously imprisoning both molecular and ionized hydrogen and further as icy nanoreactors.