

Spectroscopic identification of multiple hydrogen occupancy in binary clathrate hydrate

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Hydrogen clathrate hydrates receive attention due to their advantages of environmentally friendly feature, low cost and comparatively high storage efficiency. To form pure hydrogen hydrates typically requires very high pressure (~2000 bar) and low temperature conditions. The loading of multiple H₂ molecules into both small and large cage under mild conditions is the key factor to utilize clathrate hydrates for hydrogen storage media. To explore the potential realization of H₂ multiple cage occupancy under moderate conditions, reaction product of binary (LGM+ N₂) hydrates with H₂ molecules was synthesized and a series of microscopic analyses (Raman spectroscopy and high resolution powder diffraction) was conducted. Reaction product suggests possibility of multiple H₂ occupancy in each cage at relatively low pressure. The idea was to substitute the large N₂ molecule in N₂ hydrate with the smaller H₂ molecule. We acquired microscopic spectrum showing cage occupancy according to increase of H₂ pressure, as well as cage occupancy comparison between reaction product and non-reaction product. Also, we obtained their lattice parameter for each sample to analyze correlation of lattice constant with cage occupancy.