# Structure Transition of Gas Hydrates in the $CO_2$ + $N_2$ + Methylcyclopentane + Water Systems

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Recently, there were many studies about structures of gas hydrate because gas hydrates have generated considerable interests on the feasibility for the industrial application and attempts are being made to solve the global warming problem, especially $CO_2$. There were also several studies to investigate guest molecules of structure H hydrates including $CH_4$, $N_2$, and $CO_2$. There is controversy on the fact that $CO_2$ functions as a co-guest molecule to form a structure H hydrate. In this study, we examined the $CO_2$ + $N_2$ + Methylcyclopentane (MCP) hydrate systems in terms of two perspectives: the function of $CO_2$ as a co-guest in sH hydrates, and the influence of enclathrated $CO_2$ on structural transition. To investigate the effect of sH hydrate formation on the four-phase (Gas hydrate - Liquid water - Liquid MCP - Vapor) equilibria of the $CO_2$ + $N_2$ + MCP hydrates were compare with three-phase equilibria of $CO_2$ + $N_2$ hydrate. The structural transition were verified using Raman spectroscopy, X-ray diffractometry (XRD), and differential scanning calorimetry (DSC). From these results, it can be explained that $CO_2$ functions as a co-guest of sH hydrate and structural transition of sH to sI occurs.