Study on Thermal Conductivity of Semiclathrate Hydrate by the Transient Hot-Wire Method

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Semiclathrate hydrate is a crystalline solid which has a structure with ionic substances (called guest molecules) encapsulated in a cage formed by water molecules. Semiclathrate hydrates can be applied for various engineering applications related to the environment and energy, such as latent heat storage materials for air conditioning equipment and the gas storages of CO_2. For their thermal design, thermal conductivity is an important thermophysical property, however, there are very little data on thermal conductivity of semiclathrate hydrates. Here, in this study, the thermal conductivities of several semiclatrate hydrates are measured by using our transient hot wire method. In our method, a step current is supplied to a thin metal wire, and the transient temperature change is measured. The diameter of the wire is 30μm, and the metal wire is coated with parylene for electrical insulation. Since the wire is very thin and the measurement time is very short, our method achieves high measurement accuracy of ±0.7%. During the measurement, the crystal growth of semiclathrate hydrates is observed via a CMOS camera to estimate the crystal structures and their change with temperature. Furthermore, the crystal growth protocol of semiclathrate hydrates is confirmed by monitoring the density distribution of samples using the X-ray CT scan. In the presentation, a guest anion dependence of carboxylic acid TBA (tetrabutylammonium) hydrates are discussed based on the thermal conductivities measured by the transient hot wire method.