NMR study on motional state of helium film adsorbed in nanochannels of FSM silicate

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Nondegenerate ^{4}He and ^{3}He films adsorbed on disordered surface such as in nanoporous materials have shown quite similar heat capacities, up to coverages a little above the first-layer completion n_1, where the quantum-fluid layer appears. Those heat capacities show a steep decrease below a temperature $T_{\rm L}$, where mobile adatoms on the wall are considered to be localized.
In this study, we have studied the motional state of ^{3}He film adsorbed in 2.4 nm channels of FSM silicate. Using pulsed-NMR at 3.3 MHz, the spin-lattice and spin-spin relaxation times T_1, T_2 of ^{3}He film were systematically measured down to 0.54 K, lower than those in the previously reported experiment[1]. Temperature dependences of relaxation times are attempted to be analyzed in terms of the dipolar relaxation such as Bloembergen-Purcell-Pound (BPP) model, and compared with the phase diagram determined by the heat-capacity measurement. In submonolayer films, the temperature of T_1-minimum, which implies the dipolar correlation time $\tau_{\rm c}$ nearly equals to the NMR period, lowers almost linearly to the film coverage, indicating that adatoms become more mobile in thicker film. In addition, at the temperature a little below the T_1-minimum, an inflection was always found in the T dependence of T_2. This feature is probably characteristic of film in 1D nanochannels, which has not been observed in films adsorbed on flat substrates or 3D nanopores. Below 2 K, steep increase of T_1 dependent on coverage was observed, which agrees with localization of adatoms below $T_{\rm L}$, suggested by the heat capacities.

1. T. Matsushita, A. Kuze, R. Kawai, M. Hieda, and N. Wada, J. Low Temp. Phys. **171**, 657 (2013).

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