RELAXATION TIMES OF ^1H NMR OF H_2 IN VYCOR GLASS†

S. H. Choh‡, G. M. Seidel, and H. J. Maris
Department of Physics, Brown University, Providence, RI 02912 U. S. A.
‡On leave from Department of Physics, Korea University, Seoul 136-701, Korea

Presented at the ISMAR 10th Meeting, July 16-21, 1989, Morzine, France

INTRODUCTION

In the hope of realizing superfluidity of liquid hydrogen in the restricted geometry of the Vycor pore, the spin-lattice relaxation time (T_1) and spin-spin relaxation time (T_2) of ^1H have been investigated with the 40~50 MHz pulsed nuclear magnetic resonance technique. Measurements were made in the temperature range from 4 to 15 K for a wide variety of H_2 loads in the pore. The Vycor glass specimen employed has a demension of 1.7 mm thick, 12.3 mm diameter, and 50 Å diameter pore, so that 2.3 m mole of H_2 makes the full pore.

MEASUREMENTS

The T_1 measurements were made by applying the $\pi/2$ pulse sequences with the repetition time τ in the range of 5 ms to 5 s using the following equation :

$$M(\tau) = M_0 [1 - \exp(-\tau/T_1)],$$

where M denotes the magnetization. The T_2 was measured with the free induction decay of the NMR signal produced by the $\pi/2$ pulse.

RESULTS AND ANALYSIS

Two components spin-lattice relaxation is observed at a various amount of H_2 in the pore, like a recent report[1], instead of the well-established one component for the bulk H_2. Two components of T_1, the faster component T_1^f and the slower one T_1^s, are significantly dependent on the temperature and the amount of H_2 in the pore. From the measurements with 4 different hydrogen amounts such as the full pore, 1/3 of the full pore, 1/6th of it, and 1/12th, T_1^f is found to be in the range of 5×10^{-3} ~ 1×10^{-1} s, whereas T_1^s is approximately one order of magnitude longer. Moreover, the variation of amplitudes enables us to propose that T_1^f is related with a relaxation of the H-H interation, whereas T_1^s is originated with the H-wall interaction.

When the pore is full, T_2 is decreased first and stayed nearly constant as the temperature is lowered. It is proposed that the hydrogen in the pore is possibly in the solid phase for the temperature T $<8 \pm 1$ K. When the amount of hydrogen in the pore is reduced to 1/3 of the full pore or less, T_2 is found to be independent of temperature but depending on the amount of hydrogen. It is observed that T_2 is roughly inversely proportional to the square root of the hydrogen amount, implying that T_2 is inversely proportional to the intermolecular distance.

Details of the experimental results will be published elsewhere.

REFERENCE

1. C. S. Lin, K. Luszczynski, and R. E. Norberg, Bull. Am. Phys. Soc. 32, 575 (1987).

† Supported by the National Science Foundation of U. S. A. through Grants No. DMR 8501858 and in part by the Basic Research Institute Program, Ministry of Education, Korea.