

Observation of Hydrogen Tunneling in Pd nanoparticles by Low-temperature Neutron Scattering Measurement

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^2H NMR spin-lattice relaxation times (T_1) for deuteron atoms in the Pd nanoparticles showed a particular minimum below 30 K while T_1 for the bulk sample increase monotonously with decreasing temperature. In order to clarify the origins of the unusual T_1 minima, neutron scattering experiments were carried out for the bulk and nanoparticle of Pd with AGNES spectrometer installed at JRR-3 (JAEA, Japan). Pd nanoparticles, that are homogeneous in size, were synthesized by a chemical reduction method with water-soluble polymer, poly[N-vinyl-2-pyrrolidone] abbreviated as PVP. By TEM measurements, homogeneity in size of Pd nanoparticles was confirmed and the mean diameter was estimated to be 6.3 ± 1.0 nm. 800 mg of Pd nanoparticles were loaded into the sample tube that was connected to a vacuum line and a hydrogen gasbag. In this system, pressure inside the sample tube can be monitored and hydrogen gas provided. Measurements for bulk Pd and Pd nanoparticles with and without hydrogen gas were performed at 7, 14 and 28 K. The data were accumulated for 32 hours. Scattering intensity from absorbed hydrogen atoms was evaluated from the intensity difference between the samples with and without hydrogen atoms. Difference scattering intensities for the Pd nanoparticle are shown in Fig. 1. Although, in general, scattering intensity is increased due to thermal vibration, that is, the intensity at high temperature is larger than that at low temperature, the scattering intensity at 7 K of hydrogen absorbed in Pd nanoparticles seems to be slightly larger than that at 28 K under magnification in the energy region below 3 meV. This unusual tendency of the scattering intensity is attributed to the same origin of the NMR T_1 minima ob-

served below 30 K.

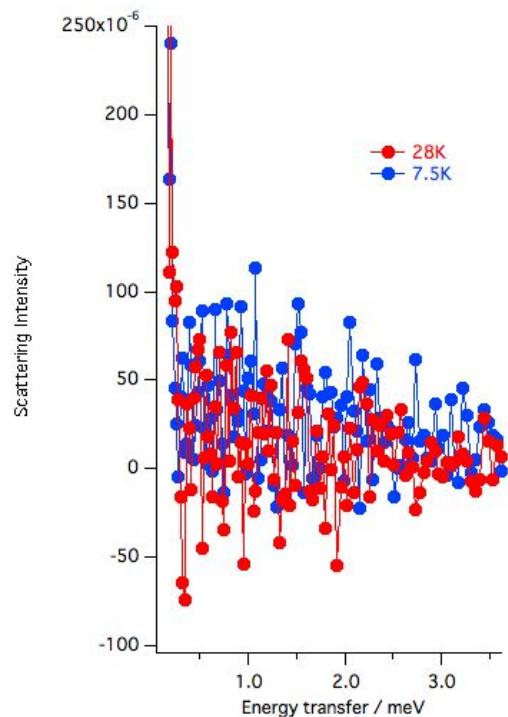


Fig. 1. Scattering intensity of hydrogen absorbed Pd nanoparticles.