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Operando μSR Experiments on Palladium Hydride

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Palladium metal is known to be formed as palladium hydride PdH x by the penetration of dissociated hydrogen atoms into the crystal lattice in a hydrogen gas atmosphere, and has been studied extensively from the viewpoint of industrial applications as a hydrogen storage material. On the other hand, it is also known to exhibit superconductivity at high hydrogen concentrations at low temperatures as low as 9K. In particular, experimental results comparing hydrogen and deuterium absorption show that deuterium-absorbed samples exhibit a higher superconducting transition temperature, which is the opposite tendency of the so-called isotope effect that has long been known and has attracted much attention [1].
We have constructed a cryostat and gas handling system for in-situ observation of hydrogen absorption by the operando μSR technique and observed hydrogen in palladium at low temperatures. A hydrogen concentration of x=0.87 can be achieved by absorption at 150 K. The zero-field μSR time spectrum is well fitted by the Kubo-Toyabe function, and the muon spin relaxation rate is in good agreement with the theoretical prediction when hydrogen occupies the octahedral O-site. Furthermore, a comparison with the experimental results for x=0.7 shows that the muon spin relaxation rate increases with increasing the hydrogen concentration.

1. T. Kawae *et al.*, J. Phys. Soc. Jpn. **89**, 051004 (2020).

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