Development and demonstration of a ^{3}He nuclear spin flip system for the in-situ SEOP ^{3}He neutron spin filter

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We have developed a ^{3}He neutron spin filter (NSF) using a spin exchange optical pumping (SEOP) technique. The SEOP technique enables us to use a ^{3}He NSF with in-situ pumping of ^{3}He gas, which has a huge advantage of maintaining a stable ^{3}He gas polarization over long neutron measurement times.

In this study, we tried to install a ^{3}He nuclear spin flip system, which works as a π-flipper for polarized neutrons, in the in-situ SEOP. In the system the ^{3}He nuclear spins can be flipped by nuclear magnetic resonance (NMR) technique, which have already been installed in our SEOP system. And a polarity of circularly-polarized laser beam also has to be reversed simultaneously because non-reversed laser beam reduces the polarization of the spin-flipped ^{3}He. For the change in polarity of laser beam, a half-wavelength plate was installed. A rotational angle of the half-wavelength plate was optimized, and a polarization of circularly-polarized laser beam was 98 %. The ^{3}He polarization reached 70 % and it was stable over one week. This spin flip system on the in-situ SEOP was demonstrated at the neutron reflectometer SHARAKU. A Fe/Cr multilayered thin film was used as a sample [1]. The neutron spin was controlled by the spin flip system after the sample, and then four patterns of neutron spin combinations before and after the sample (↑ , ↑), (↓ , ↓), (↑ , ↓) and (↓ , ↑) could be measured. Consistent results with that of a previous experiment [1] were obtained and the demonstration of the developed spin flip system on the in-situ SEOP was successfully performed.

References

[1] M. Takeda, et al., Physica B **213&214**, 248 (1995).