Polarized Solid Proton Target for RI Beam Experiments

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Reactions induced by polarized protons are rich sources of information on nuclear structure. Application of the $\vec{p}$ scattering to radioisotope (RI) beam experiments is a quite promising way to understand the role of spin degrees of freedom in nuclei far from the stability line. In experimental point view, $\vec{p}$ -RI beam experiments will be carried under the so-called inverse kinematics condition. Here, detections of low-energy, typically ~10 MeV, particles are of critical importance in discriminating background events and in achieving high angular resolution. Conventional polarized proton target systems are not suited for such experiments, because a high magnetic field (2.5 T) and a very low temperature (≤IK) required there would prevent the recoiled particles from escaping from the target system. In order to resolve the difficulty, we are developing a polarized proton target system based on a pulsed dynamic nuclear polarization, which can polarize protons in a lower magnetic field (≤0.3 T) and at a higher temperature (≥77 K) [1,2].

A prototype of a proton polarizing system has been constructed [3] and used to study the effectiveness of Ar-ion laser as light source for optical pumping. The power of the Ar-ion laser used in this study is 4.2 W and the laser beam is mechanically pulsed by an optical chopper. With the pulsed laser beam, we have successfully obtained proton polarization up to 18.4 ± 3.9% in 0.3 T and at 100 K [4]. We have also examined that proton polarization increases almost linearly with increasing laser power below 4.2 W. On the basis of the results, we have decided to increase the laser power by introducing an Ar-ion laser with the power of 25 W with which proton polarization of higher than 40% is expected, according to our calculation taking into account an increase of a relaxation time.

In the new system that will be used in a beam irradiation experiment, a copper-film loop-gap resonator (LGR) [5] is introduced instead of a microwave cavity in the prototype. The LGR is well suited for scattering experiments, because it has a form of the cylinder and there is no wall in the path of the beam. Moreover, the material of that is made from 25 μm thick Teflon coated on both sides with 4.4 μm thick copper metal; recoiled protons can pass through the resonator to detectors. The measurement of proton polarization using the LGR is in progress.

The test run with a 80-MeV/A ^{4}He beam bombarding on the target is scheduled in 2002, where sublimation of crystal and the depolarization due to the beam irradiation will be studied. In 2003, the first physics run, the measurement of a vector analyzing power in the elastic scattering of $\vec{p}$ + ^{6}He at 71 MeV/A will be carried out with the new target system and a ^{6}He beam from the projectile fragment separator RIPS. Design of the target system and preliminary results of proton polarization will be reported.

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