Elastic Recoil Detection method using DT neutrons for fusion material analysis

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Hydrogen isotopes show complicated behavior on the surface of plasma facing components in fusion devices, and the study is important for the design of the fuel recycling, the plasma control *etc*. The Fusion Neutronics Source (FNS) of Japan Atomic Energy Research Institute (JAERI) has started the study on the hydrogen isotope analysis for fusion components since 2002 on the basis of the techniques such as the nuclear activation analysis, the ion beam analysis and the imaging plate method. So far, deuterium and tritium distributions as regards the depth from the surface of the JT-60U plasma facing components up to the range of a few micrometers were obtained by means of the deuteron induced nuclear reaction analysis. However, the methods cannot be applied to the analysis beyond the range. In this study, we propose the elastic recoil detection analysis method using the pencil neutron beam to extend the depth of hydrogen isotopes analysis up to several hundreds micrometers.

We constructed an experimental setup for the neutron elastic recoil detection analysis. The 14 MeV-neutrons produced by DT reactions at the target of the 0° beam line of FNS were collimated with a hole of 20mm in diameter. The collimated neutrons, *i.e*. the pencil neutron beam, were incident on the sample from the direction at an angle of 0°. Emitted particles from the sample were measured using a ΔE-E telescope system. A pair of solid state detectors (SSDs) with the depletion layer thickness of 75 and 1500 micrometers was positioned in the direction at 25° with respect to the neutron beam for detection of ΔE and E values, respectively. Output signals from each SSD were analyzed with a multi-parameter analyzer to estimate the particle mass and its energy. The energy calibration of SSDs was corrected based on an ^{241}Am alpha source (5.486MeV). The neutron flux was monitored with a fission chamber located behind the target chamber.

A proof-of-principle experiment was made using the pencil beam of 14 MeV neutrons and a standard sample of deuterated polyethylene film containing a known concentration of deuterium. The deuterated polyethylene film was fabricated using a solvent-cast method. In the result of the experiment, we have obtained recoil deuteron and proton spectra separately on the contour map. The depth distribution and its depth resolution estimated with the deuteron spectrum are discussed.