Development of activation detector for quantity of long-term D-T neutron irradiation

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Abstract

We are developing an activation detector to monitor the total irradiation amount for a long-term. In this study, we considered beta-ray and investigated optimal material for the detector in case of 1 year and 20 years of irradiation. As a result, ^{158}Tb with a half-life of 180 years was selected. In the conference, we will report the details of the selection process and the D-T beam irradiation experimental result of ^{158}Tb.

Keywords: Activation detector, 14MeV neutron, Activation foil method, Nuclear fusion

Introduction

Nuclear fusion is expected to serve as a major energy source in the future[1], and much research has been performed. Among these studies are neutron irradiation experiments for fusion reactors to develop materials for nuclear fusion reactors. In neutron irradiation experiments, it is necessary to measure the fluence of neutrons to evaluate the damage brought on to materials of the fusion reactor caused by neutrons[2].

For this purpose, the Activation foil method using Nb has been adopted. However, Nb has a short half-life of 10 days; hence, unsuitable for long-term irradiation measurements such as International Thermonuclear Experimental Reactor (ITER) research, which can take years.

Therefore, developing an activation detector for long-term irradiation has become necessary. The author's team is developing an activation detector to monitor the total irradiation amount in the long-term, and we searched for gamma-ray emissions nuclides in previous studies[3].

In this study, we assessed beta-ray to examine any improvements in detection efficiency and explored optimal materials for the detector in the case of 1 year and 20 years of irradiation, similar to previous studies.

Conclusion

As a result, ^{103}Rb was apt for 1-year irradiation and ^{158}Tb appeared suitable for irradiation longer than one year.

In the following experiment, we made a model of an activation detector using ^{158}Tb to confirm its measurability of beta-ray and effectiveness.

In conclusion, this study proved that developing a novel, more effective activation detector is feasible.

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