Radiation Measurement by Compensation Method Using Optic Fiber Scintillator With Passive Fiber Cable

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1. Introduction

The optical fiber scintillator(OFS) of Ce^{+3} (cerium) activator detects radiation by converting the radiation energy into visible light. In the case of gamma rays, photoelectrons are generated by the interaction with glass materials (photoelectric effect, calculation effect, electron pair generation) in OFS, and this photoelectron loses energy and generates light. The neutrons detect charged particles from the (n, α) nuclear reaction of 6Li and neutrons in OFS.

If a system for transmitting light from an OFS through a passive fiber cable(PFS) is developed, it is not necessary to attach electronic equipment for signal detection in a high radiation zone, thus preventing equipment damage due to radiation exposure. However, since PFC also generates light due to interaction with radiation, a method of detecting only the OFS signal is necessary.

2. Radiation detection by Subtraction Method

2.1 Hardware Configuration

Although it is possible to consider how optical filters can be used to block light emitted from PFCs, this method is known to have a removal rate of about 87%. Therefore, we want to develop a subtraction system that completely removes the influence of PFC and uses only the signal detected by OFS. As shown in Fig. 1, the system installs a PFC2 to compensate for the signals of PFC1, and the signals from these are configured to be compensated by a computer program. If the values of these two signals are the same under the same radiation dose conditions, only the signal generated by the OFS will be measured by the compensation method.

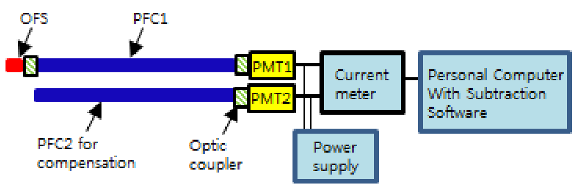

Fig. 1. Radiation Measurement System by Compensation.

2.2 Compensation Experiments

To investigate the radiation sensitivity from PFC, two PFCs of the same length without OFS were irradiated from 100 rad/h to 4,000ra / h of Co-60. As shown in Figure 2, these PFCs showed almost the same sensitivity. The software program for this sensitivity was almost subtracted and showed 0.5% difference at over 3,000 rad/h. These results suggest that the compensation method sufficiently removes the influence of PFC signals on measured values.

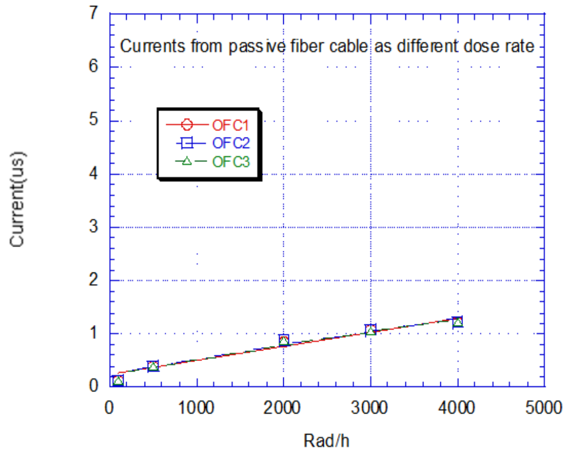

Fig. 2. Radiation Response of PFC.

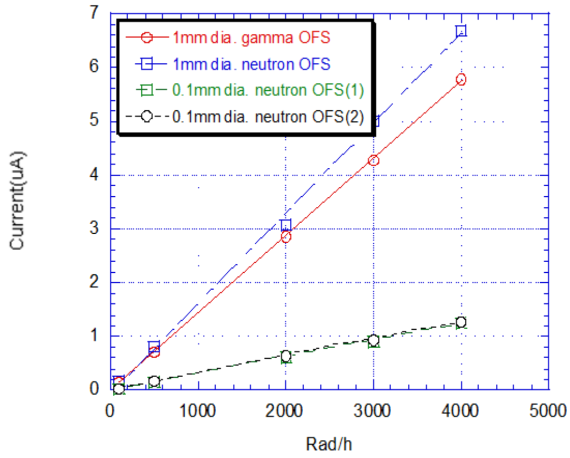

Fig. 3. Measured Linearity by Subtraction.

The OFS for neutron measurement used in the experiment is 0.1 mm and 1 mm in diameter, respectively, and the length is 10 cm. the OFS for gamma ray measurement is also 0.1 mm and 1 mm in diameter and 10 cm in length. The PFC is 1 mm in diameter and 15 m in length. These OFSs are shown in Fig. 3 as a result of subtracting the radiation dose from 100 rad/h to 4000 rad/h. The 0.1 mm diameter OFS was measured at almost the same value and the 1 mm OFS was larger than the OFS for gamma and OFS for neutron.

Therefore, in the case of measuring neutrons in areas with high gamma - ray intensity such as spent nuclear fuel, it is found through this experiment that a system development or a method for selecting neutron signals is necessary. The measured values for dose changes showed excellent linearity within 5% for all four OFSs. Therefore, the compensation method can be used for the measurement of high radiation.

3. Conclusion

In this paper, a study was made using PFC as a transmission medium of light when using OFS for radiation measurement. The compensation method showed that 99% or more of the effects of PFC were eliminated, and linearity for 4 different OFSs was excellent within 5%. Therefore, the OFS can be used for measurement of high-radiation at a very small point, because it can utilize various detection sensing areas by simple manufacturing and does not need electronic equipment for transmitting OFS signals.

REFERENCES

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