Feasibility Study on the Development of Position Sensitive System Based on Plastic Scintillating Fiber for Detecting the Leak Position of Radioactive Waste Drum

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1. Introduction

A low and intermediate level radioactive waste has been produced from commercial nuclear power plants, research institutes and nuclear fuel manufacturing facilities [1]. This radioactive waste is stored in a drum and moved to a storage. As this radioactive waste is increasing, it is important to manage this radioactive waste. In order to handle safely this radioactive waste in the storage and efficiently reduce risks of contamination due to the radioactive materials, a monitoring system to detect a leak position of radioactive waste drum is needed [2].

In this study, we fabricated a position sensitive system (PSS) to detect the leak position of radioactive waste drum using a plastic scintillating fiber (PSF), which was cracked at regular intervals by using the blades of fiber-optic stripper.

2. Materials and Methods

2.1 Sensing material

As a sensing material to detect the leak position of the radioactive waste drum, the plastic scintillating fiber (PSF; BCF-12, Saint-Gobain Ceramic & Plastics) was used. The PSF is a cylindrical shape and composed of core and cladding, similar to a commercially optical fiber. The material of the core is polystyrene (PS) synthesized with fluorescent dopants and the cladding material is polymethylmethacrylate (PMMA). The refractive indices of the core and cladding are 1.60 and 1.49, respectively. Thus, the numerical aperture (NA) is about 0.58 by the refractive index of materials. The other physical properties of PSF are listed in Table 1.

Table 1. Physical properties of PSF

Physical properties	BCF-12
Emission color	Blue
Emission peak (nm)	435
Decay time (ns)	3.2
1/e length (m)	2.7
# of photons per Mev	~8000

2.2 Experimental setup

Fig. 1 shows the experimental setup to detect a position of radioisotope using the PSF. In order to measure the scintillating lights generated in the PSF, a photon counter system which was composed of a photon counting head (H12525-01, Hamamatsu Photonics) and a photon counting unit (C8855-01, Hamamatsu Photonics) was used. Also, we used plastic optical fiber (POF; GH-4001, Mitsubishi Rayon) for transmitting the scintillating lights produced the PSF to the light-measuring device. The diameter and length of this POF are 1 mm and 1 m, respectively.

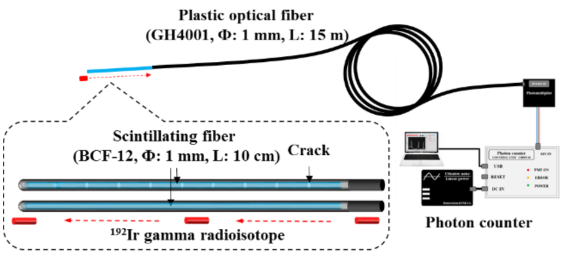


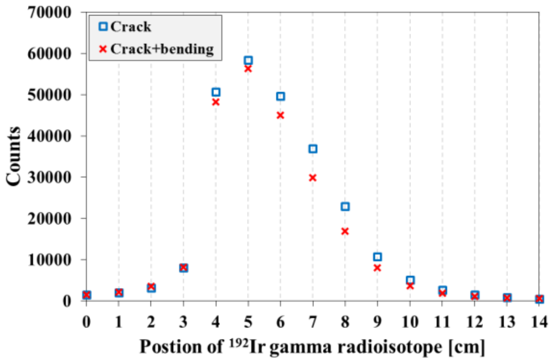
Fig. 1. Experimental setup to detect the position of the radioisotope.

To evaluate the performance of the PSF, ^{192}Ir gamma radioisotope was moved at intervals of 10 mm and measure the scintillation lights according to the location of ^{192}Ir gamma radioisotope.

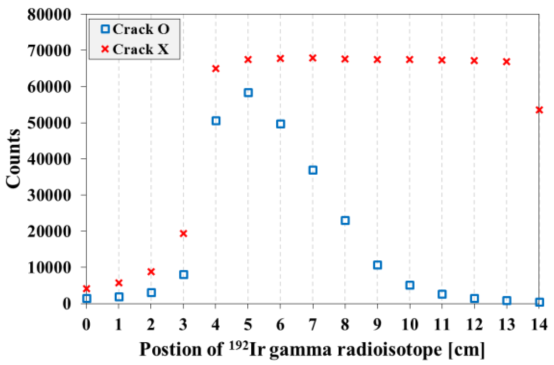
3. Results

Fig. 2 shows the counts of the scintillating lights generated on the PSF according to the position of ^{192}Ir gamma radioisotope. In Fig. 2 (a), as the position of ^{192}Ir gamma radioisotope is changed, the amount of scintillating lights was measured differently because of the increasing the number of crack. On the other hand, in the case of the PSF which doesn't have the cracks, the scintillating lights was not changed. In Fig. 2 (b), when the PSF wasn't bent, the scintillating lights were changed smaller than the bent PSF.

From the experimental results, we can detect the leak position of radioactive waste drum through the scintillating lights generated in the PSF.



(a)



(b)

Fig. 2. Counts of the PSF according to the position of the ^{192}Ir gamma radioisotope. ((a) With the existence of crack, (b) With the existence of bending)

4. Conclusion

In this study, we developed the PSS, which is composed of the PSF and the photon counter system, to detect the leak of radioactive wastes. The experimental results show that the proposed PSS measured the different scintillating lights according to the position of ^{192}Ir gamma radioisotope. Thus, the PSS can detect the leak position of radioactive wastes by measuring the intensity of scintillating lights. It is expected that the PSS can be used as a useful monitoring system to detect a leak position of radioactive waste drum.

Further studies are planned to fabricate a PSF with the different intervals and deep of cracks for optimization of PSS. Then, we will measure the scintillating lights using the fabricated PSF and select the best PSF.

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