Development of the Small Size ZnS(Ag) Scintillator Sensor for Detection of Alpha Particles

Chan-Hee Park, Bum-Kyoung Seo, Dong-Gyu Lee, Kune-Woo Lee
Korea Atomic Energy Research Institute, 150 Deokjin-dong, Yuseong-gu, Daejeon 305-353, Korea
**Corresponding author: teras45@hanmail.net*

1. Introduction

Some facilities such as hot-cell are very high radiation level, so it is difficult to approach for radiation monitoring. In this case the detector system is preferable to separate the sensor and electronics, which have to locate in the facility outside to avoid the electric noise and worker's exposure [1,2].

In this study the detector system applicable to the high-level radioactive contamination of the narrow gap of the installations in the nuclear facilities was developed. The radiation sensor was prepared using a transparent epoxy resin and an inorganic scintillator. The epoxy resin has been used in a wide application field by advantages such as reaction-constriction is very small and no volatility during the hardening process, easiness to manufacture and a high transparency. For signal transmission of the scintillation the optical fiber was used and the epoxy resin easily combined with an optical fiber.

2. Methods and Results

2.1 Fabrication of the detection sensor

We used YD-128(Kukdo co. Korea) as the epoxy resin. YD-128 is a liquid type standard epoxy resin derived from bisphenol-A. It has excellent adhesion, chemical resistance, heat resistance, etc [3,4].

To detect α-ray, we fabricated an inorganic scintillator sensor as the detection part [5]. The inorganic scintillator sensor was made of an epoxy resin, hardener and ZnS(Ag) of powder type. After they are solidified, besides that, we combined the inorganic scintillator sensor part with an epoxy supporter. To make the supporter as a light guide role, we mixed YD-128 with D-230(Kukdo co. Korea) of hardening-hastened role as mixture rate 5:1. Before the epoxy supporter was solidified, an optical fiber must embed in it. In order to decrease the light loss of an incomplete connection between an optical fiber and a scintillator, for that reason, the optical fiber was inserted into the scintillator during the fabrication process. Fig. 1 shows procedure of sensor fabrication for a remote monitoring system of a radiation contamination.

In this study, we have used commercially available plastic optical fiber of Edmund model. The core is made of acrylic polymer PMMA (polymethyl-methacrylate) and the clad is made of fluorine polymer which has a lower refractive index than the fiber core. This fiber was designed to provide higher transmission in the visible region of the spectrum.

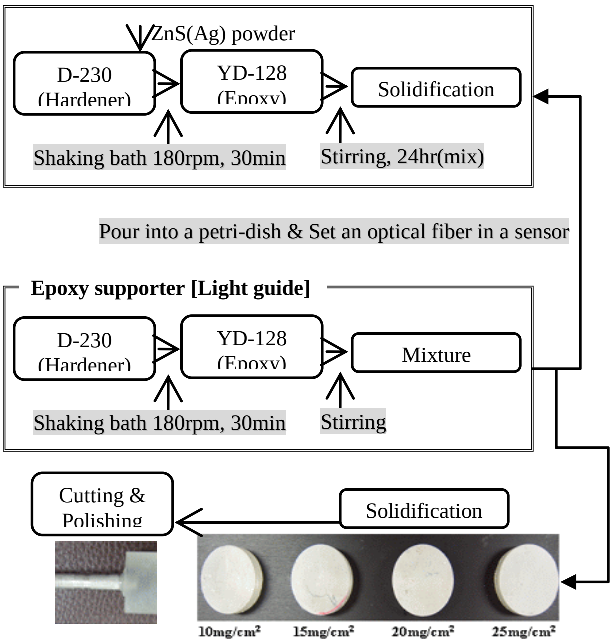

Fig. 1. Preparation procedure of the inorganic scintillator sensor based on epoxy.

2.2 Experiment

The optical signals generated inside the inorganic scintillator sensor were converted into electrical pluses by a photomultiplier tube (PMT) through an optical fiber. We measured the pulse height spectra from the electrical pulse signal using an MCA, and analyzed. Fig. 2 shows experimental setup for remote detection of radiation contamination.

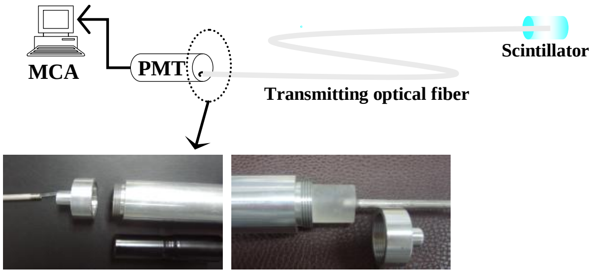

Fig. 2. Experimental setup

To evaluated α-ray detection efficiency according to planar density (mg/cm^2) of ZnS(Ag) scintillator, we manufactured a sensor that planar density of ZnS(Ag) scintillator is 10, 15, 20 and 25mg/cm^2. The senor was estimated for its detection efficiency by an optic fiber's geometric factor. Fig. 3 shows that detection efficiency of the sensor as planar density of a ZnS(Ag) scintillator. Planar density of 15mg/cm^2 was measured excellently about 2-4 times than the other three. Then it has been decided that planar density of the sensor has selected 15mg/cm^2.

Also, detection efficiency of the sensor has analyzed and evaluated according to a diameter change (5-10mm) of the sensor and a length (1, 3, 5 and 10m) of an optical fiber.

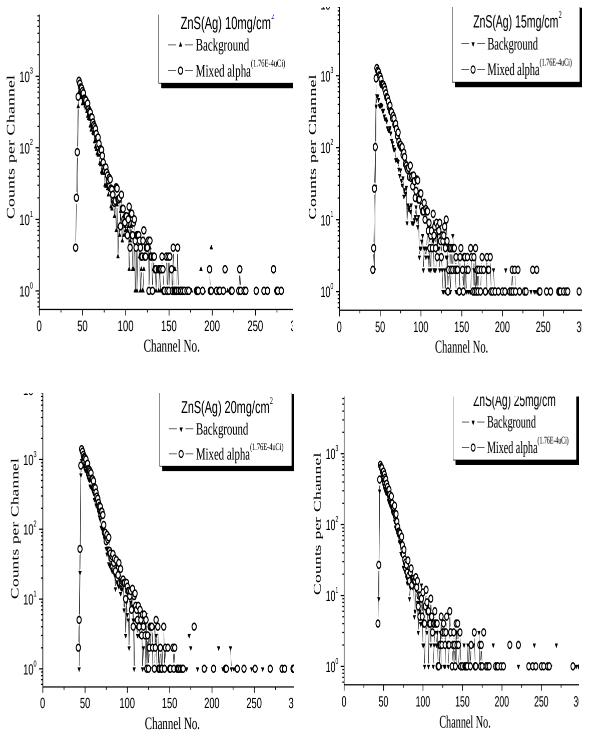

Fig. 3. Pulse height spectrum of planar density (mg/cm^2) of the sensor.

3. Conclusions

We found that possibility of remote monitoring for a radiation though development of the sensor using an inorganic scintillator, epoxy resin and an optical fiber.

The sensor of one-body type will be very useful to measure radiation in various applications as well as in a strong radiation field by remotely handling of the sensor.

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