Development of Radiation Resistant In-water Transmission System

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In June 2011, the Japanese government referred to the lesson of the accident at the Fukushima Dai-ichi (1F) Nuclear Power Plant, in the report of Japanese government to the IAEA ministerial conference. In accordance with such situation, we started from 2012 a research and development which corresponds to the provisions so as to monitor the NPPs situations during a severe accident. Considering that reactor buildings could be filled with water under severe accidents, a development of the wireless transmission system in water is necessary. A transmission method using visible light was adopted because of its relatively lower attenuation rate and higher transmission rate in water. Light-emitting diodes (LEDs) and photo diodes (PDs) were adopted for emission and receiving devices. In this study, gamma irradiation effects on LEDs and PDs were evaluated for the development of a radiation-resistant in-water wireless transmission system using visible light in FY 2013. The three types of LEDs and the two types of PDs were irradiated at the ^{60}Co gamma-ray irradiation facility. The LEDs were encapsulated in a bullet-shaped epoxy resin package and each had 575, 609 and 635 nm of peak emission wavelengths, respectively. One of the PDs had a light window composed of a borosilicate glass and a silicone resin, and the other a quartz glass. The Current-voltage property and total luminous flux of the LEDs and the dark current and light sensitivity of the PDs were measured before and after the irradiation. The shorter wavelength the LEDs emitted, the greater the total luminous flux decreased. The shorter wavelength the PD received, the greater the light sensitivity decreased. For the other one with the quartz glass window, which has good irradiation resistance, the light sensitivity did not changed significantly except for the wavelength of 450 nm. After the irradiation, only the resin window turned oxblood and their coloring became dark with the irradiation dose while the dark currents were at most 10 nA for both the PDs. These results indicated that the decreases of the total luminous flux of the LEDs and the light sensitivity of the PDs were caused by not the degradation of the semiconductor parts but the coloring of the resin parts by the irradiation.

In the presentation, the in-water wireless transmission experiment unit and the results of the experiments will be also introduced.