Development of Gamma-ray Dosimeter Using Radio-Photoluminescence Glass Dosimeter and Gamma-ray Filter in A Neutron/Gamma-ray Mixed Field for BNCT

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Boron neutron capture therapy (BNCT) is a cell selective radiotherapy based on neutron capture reaction with ^{10}B. Recently, accelerator based neutron sources are being developed as the next generation irradiation system for BNCT instead of a nuclear reactor. From the accelerators, various energetic neutrons are emitted, whereby the background radiation of gamma-rays as well as neutrons increases in the irradiation field. Therefore, measurement of gamma-rays to the human body is quite essential to manage the whole-body radiation dose of patients and medical workers. In order to measure gamma-rays in that field, we employed radio-photoluminescence glass dosimeter (RPLGD) because it has excellent features. Generally, RPLGD is used for environmental monitoring. However, it is difficult to measure gamma-ray dose accurately in an intense neutron field, because gamma-rays are produced by neutron interaction to become a mixed field and RPLGD has sensitivity to neutron and gamma-ray. To evaluate gamma-ray dose in a neutron/gamma-ray mixed field, we have devised a method by using two RPLGDs covered with shielding material filters. If the filters are enough thin, neutron interaction is suppressed, and the neutron attenuation can be kept negligible. Thus the effect of neutron can be removed by making difference of the two RPLGDs' absorbed doses. Furthermore, by appropriately controlling two RPLGDs' energy response for gamma-rays, the true gamma ray dose can be estimated also from the difference between the absorbed doses of the two RPLGDs, excluding the neutron effect. As the first step, we aimed to realize measurement in an only gamma-ray field the energy spectrum of which is unknown with a single RPLGD and filter, by controlling the energy response to become proportional to the air kerma coefficient. In order to adjust the energy response, we adopted a method of giving a distribution to the thickness of the filter. Initially, we selected lead as a shielding material. However, the results of simulations by Particle and Heavy Ion Transport code System (PHITS) showed that the use of lead was difficult due to insufficient reproducibility of the air kerma by the presence of the K absorption edge of lead and the difficulty of fabrication owing to employment of a too thin lead filter. Therefore, we tried to design a filter using iron, which is a lower-Z material than lead. Using iron as a filter, problems for the lead filter were successfully solved. We thus fabricated the iron filter for a single RPLGD and conducted irradiation experiments in gamma-ray fields with several gamma-ray standard sources and in the nuclear fuel storage room of OKTAVIAN facility of Osaka University. These results showed that the gamma-ray dose can be measured by controlling the energy response of RPLGD by the filter. On the other hand, since the size of the iron filter is relatively large, a further improvement is required for practical use. Currently, we are conducting researches on feasibility of gamma-ray dose measurement using two RPLGDs in a gamma-ray field.