Study on Dose Evaluation of LiF:Mg,Cu,Si in a Wide Dose Range for Inter-laboratory comparison of Retrospective Dosimetry techniques

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One of the most frequent high-dose exposure accidents within a controlled area is an terrible failureoccurs during a non-destructive testing (NDT) work using a high activity radiation isotope. To confirm whether retrospective dosimetry techniques can be applied reasonably when a legal personal dosimeter such as thermoluminescece dosimeter (TLD) is not available or when it is necessary to reconstruct dosesbased on a information of exposure situations, Korean Atiomic Energy Research Institute(KAERI) and Korea Institute of Radiological and Medical Sciences(KIRAMS) conducted an intercomparison experiment using physical human body phantoms in a radiation testing (RT) room. In this experiment, LiF:Mg, Cu, Si TLDs were used as reference dosimeters to compare the accuracy of each retrospective dosimetry technique which uses fortuitous materials such as mobile phones, smart bands, ear buds, and etc.

Two physical human body phantoms realized from a mech type referece computational phantom (MRCP) were develped by a 3D-print technique in KIRAMS and they were exposed by 98.6 Ci Co-60 radioactive source at different distances and times; One was exposed for 15 minutes with the source in left hand (local and heterogeneous exposure), and the other was exposed for 1 hours (4 times of 15 minutes each in different directions) at a distance of about 1.4 m from the source (homogeneous exposure). LiFs were placed on the surface of each phantom and on the fortuitous materials which were attached on the phantom. Therefore, the dose range to be read from LiFs will be very wide. In particular, the expected dose on each position ranges from several tens of mGy to several tens of Gy in the case of heterogeneous exposure.

The luminescences from a LiF were read using a Riso TL/OSL DA-20 reader. All the signals were measured by a built-in PMThaving a neutral density (ND) filter on the detection window. The ND fileter was selected to OD3 density considering a signal saturation at a higher dose and a high uncertainty at a lower dose. As we expected, the tendency of dose response in the low-dose (≤ 1 Gy) and high-dose(> 1 Gy) regions was different. The dose response in low-dose region was linear, whereas the dose response in high-dose region was sub-linear. Therefore, TLDs, which are expected to have low doses less than 1 Gy, were calibrated by a one-point calibration method with a test dose of 10 mGy. TLDs exposed to high doses were calibrated using a function obtained based on a dose response acquired from high doses (1, 5, 10, 20, 30, 40, 50 Gy).

Through these measurements, it was found that a dose assessment with LiF:Mg, Cu, Si for very higherdoses needs to be calibrated by different method from the dose assessment for lower doses. Consequently, the reference dosimetry results in this study will be provided for the inter-laboratory comparioson.

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