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Preliminary study for dosimetry of toenail using Optically Stimulated Luminescence (OSL)

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1. Introduction

Optically Stimulated Luminescence(OSL) techniques similar to those used in dating have been adopted for retrospective dose assessment i.e. reconstruction of radiation doses received by the general population after nuclear accidents. Typically, radiation doses are determined using luminescence measurements carried out on quartz and feldspar samples extracted from bricks, tiles, pottery, or porcelain items collected in radiation contamination areas such as Hiroshima and Chernobyl (e.g. Godfrey-Smith and Haskell, 1993; Haskell, 1993; Bailiff, 1995; Bøtter-Jensen, 1995; Bøtter-Jensen, 1996; Bøtter-Jensen et al. 1996) [1].

In the present study, OSL has been examined for its potential in emergency dosimetry using different materials as possible personal dosimeters.

Radiation Health Research Institute has been conducting research on the physical, biological methods for the assessment of treatment and dose for radiation workers work accident. some other materials have been tested for possible use as personal emergency OSL dosimeters. materials examined included human nails (both from fingers and toes), we compare the OSL response of these materials with toenails on the existing tooth and nail for basic research and conduct research.

2. Methods and Results

Toenail clippings were tested as possible biological OSL dosimeters. The total number of samples tested was several hundred, including approximately 50 samples of toenails from 5 different individuals from private collections.

2.1 The experimental equipment

All measurements were made using an automated Riso TL/OSL system (Model TL/OSL-DA-15). the system comprises a precision rotatable wheel, a ^{90}Sr beta irradiator, heater for TL emission and preheating, a blue light emitting diode (LED) array for optical stimulation, and a photomultiplier (EMI type 9635QA) for luminescence measurement. the blue LEDs (type NSPB-500S) produced 50 mW/cm^2 at the sample position with a peak in the emission spectrum at 470 nm (full width at half maximum 40 nm). the troublesome tail of blue light (<400 nm), which can cause cross-talk between luminescence and light from the LEDs, was removed by placing a long pass GG-420 filter (Schott) in front of the blue LED array. Luminescence was detected by the photomultiplier, preceded by a Hoya U340 filter[2].

2.2 Evaluation of the dosimetric signal

OSL curves for some representative samples recorded immediately after samples exposure are shown in Fig. 1 for other people's toenail samples. Fig 1. shows that the OSL signal decays quickly, over the first approximately 3 s, Fig. 1 shown for comparison is the 'OSL signal' from such a sample recorded after sample exposure to 5 Gy of beta irradiation.

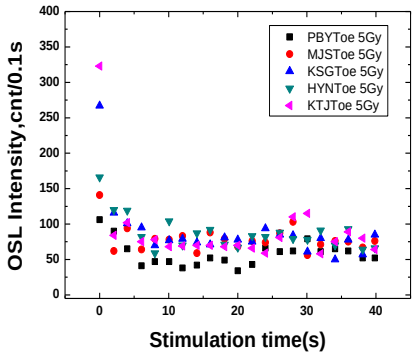

Fig. 1. Examples of OSL curve recorded immediately after 5 Gy laboratory-administrated dose by using a ^{90}Sr/^{90}Y beta source.

2.3 Dose-response curves

Representative examples are shown in Fig. 2. The dose-responses were found to be linear in the tested dose range (below 14 Gy) for all the materials studied. Each material demonstrated significant variability of radiation sensitivity between samples of the same type.

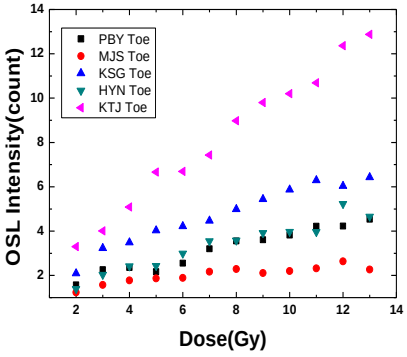

Fig. 2. The representative of OSL SAR growth curve obtained from the samples of toenails.

2.4 Fading

Fig. 3 shows the fading of the dosimetric signal from samples stored in the dark at room temperature. In general, the fading was the fastest for toenails. The reduction of the dosimetric signal was about 94% for corresponding samples of toenails stored in the dark over a period of 2 hours following exposure. The fading was much faster for samples stored under routine laboratory light (white fluorescent light) and the radiation-induced signals almost disappeared after a few hours of such illumination. As expected for OSL, ambient light very quickly destroys the OSL signals in irradiated samples and only samples that have been stored in the dark may be potentially suitable for dose determination with the OSL technique [3].

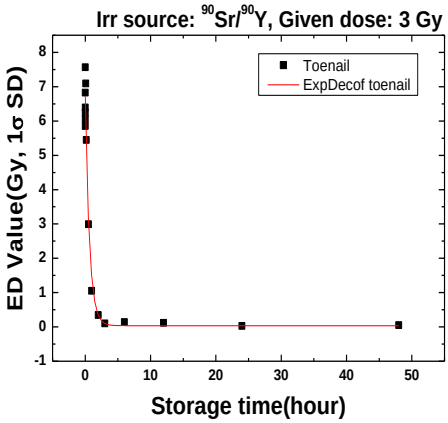

Fig. 3. Fading of PKH Toenail OSL signals from samples stored in the dark at room temperature. (Fading rate 94%)

3. Conclusions

Biological samples (toenails) of the OSL measurements by assuming a radiation accident dose assessment was performed. Could see the result of applying the law to reproduce a single sample in each sample, 2 Gy - 14 Gy of dose-response curves were obtained, appears 2 hours fading measurement results, the fading rate of 94% was measured(Table I).

Table I: The experiment result

Sample	Native Signal	OSL Signal	MMD	Fading	Bleaching
Toe nail	non	small	2 Gy	2h	10 min

The most curious situation was found with toenails detailed experiments revealed that only a few pieces from all the toenail clippings collected contributed to the OSL signal after exposure. If these pieces are removed, the OSL signal was significantly reduced. It was also found that simple mechanical cleaning of these sensitive pieces with paper napkins resulted in the disappearance of the dosimetric OSL signal. It was concluded that the OSL from nail samples is emitted mainly, not by the toenail tissue, but rather by impurities such as small particles of sand, on the nails' surfaces. Also, the OSL signal is affected by workers in sweat (salt). This complicates the possibility of using OSL for dosimetry with toenails.

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