Transactions of the Korean Nuclear Society Spring Meeting
Gyeongju, Korea, May 29-30, 2008

Retrospective Accident Dosimetry using OSL of Electronic Components of Mobile Phones

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1. Introduction

New ICRP recommendations (ICRP-2007) have given due emphasis to measurement of doses for radiation protection in "Emergency exposure situations" that may occur from a malicious acts of terrorism or from any other unexpected situations and recommended efforts for reduction of doses when they approach 100 mSv to any person, whether a member of public or a worker. Measurement of radiation doses in unplanned, unexpected and unforeseen situations is also needed for tracking the sources and the culprits in the case of terrorist activities such as the use of dirty bomb. Such situation cannot be covered by planned radiation dosimeters such as personal dosimeters or area monitors installed at some strategic locations. Dosimetry of nuclear accidents such as Hiroshima & Nagasaki or Chernobyl involving higher doses has been possible by using solid state / luminescence (TL & OSL) by processing common material such as bricks or tiles and measuring the doses cumulated for long periods of time / several years. The procurement of such material and the processing is often a very time consuming process. In cases of the unexpected situations, not only the doses encountered are low to escape the range of remotely installed area monitors but also need the evaluation of doses is shortest possible time by using well defined objects because the delay in communicating the information on risk enhances disruption of normal life because of the apprehensions, it becomes important to be able to measure much smaller doses as quickly as possible and this enhances the search of sensitive and most commonly used items which are always carried by most persons all the time. Some attempts have been made to demonstrate that the optically stimulated luminescence (OSL) in chip-cards (health-care ID card or a phone card) could be used as a dosimeter [1, 2]. These studies clearly proved the superiority of OSL over thermoluminescence (TL) in which samples exhibited large zero dose signal which was absent for OSL. Mobile Phone was considered one such equipment which forms almost a part of an individual person. In the present work electronic components of Mobile Phones were tested and OSL of some components were found to offer an excellent "fortuitous" dosimeters.

2. Methods and Results

A large number of a variety of Mobile phones from different manufacturers was procured and the electronic components were removed. IC chips, resistors (chip type), packaging white and black ceramic of the clock component, quartz crystals of the clock, capacitors, glass on CMOS device of the camera and epoxy resin on circuit board were tested for the OSL. The surface of the IC chips was polished by using a grinder followed by cleaning with propanol. Resistors (chip type) were mechanically picked out from the circuit board one by one using a sharp bar (-) type screw-driver and no additional treatments were applied. It was noted that at least 40 chip resistors could be obtained from one mobile phone. Packaging white and black ceramics for clock components were obtained by pulverizing the component. All measurements were performed using a Risø TL-OSL-DA-15 reader [3] and the samples were irradiated using the integrated 1.48 GBq (40 mCi) $^{90}Sr/^{90}Y$ irradiator. Light beam filtered through GG-420 filter from blue LEDs (50 mW/cm^2 power) were used for optical stimulation and violet/UV emission through an U-340 filter was recorded as a an OSL signal.

3. Results and Discussion

OSL response of IC Chips, packing ceramics and chip resistors was found to increase linearly with dose in the studied range from 10 mGy to 1 Gy. The chip resistors are the most promising components in Mobile Phones Fig. 1 shows the typical dose response of OSL of chip resistors.

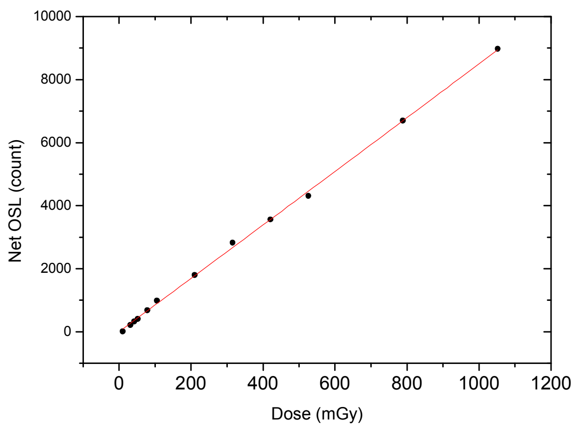

Fig.1 OSL (Net OSL) versus dose for the chip resistors of Mobile Phones.

For testing the practical applicability, mobile phones were exposed by 150 mGy and 500 mGy of ^{137}Cs gamma rays and dose evaluation was attempted by using SAR (single aliquot regenerative) protocol [4]. The results are shown in Tables 1 and 2. It can be seen that estimated average dose is within 15% for an exposure of 150 mGy and within 10 % for 500 mGy exposure.

There is a significant scope to improve the dose measurement. Sample preparation method needs to be improved, especially for the chip resistors.
The beta irradiator has to be recalibrated by using reference samples.

Table-1 Doses estimated by different electronic components from a mobile phone exposed 150 mGy of ^{137}Cs gamma rays.

Sample ID	ED (mGy)
3 (IC chip)	76.8
4 (IC chip)	135.2
5 (IC chip)	95.7
6 (*)	171.5
7 (resistors)	164.1
Average (mGy)	**128.7 ± 18.6**

Table-2 Doses estimated by different electronic components from a mobile phone exposed 500 mGy of ^{137}Cs gamma rays.

Sample ID	ED (mGy)
11 (IC chip)	656.4
12 (IC chip)	362.4
13 (IC chip)	307.2
14 (IC chip)	359.3
15 (IC chip))	424.0
16 (IC chip)	572.8
17 (*)	452.9
18 (resistors)	498.1
Average (mGy)	**454.1 ± 41.6**

4. Conclusions

The use of electronic components of Mobile Phones as "fortuitous" dosimeters following a radiological accident or terrorist event has been evaluated. The chip resistors appear to be the most promising components for the dose reconstruction for retrospective accident dosimetry. This study indicated that the electronic components of all modern type of electronic products have a potential of accident dosimetry. However, much work remains to be done, including further study on fading of OSL signal, sample to sample variation, effect of pre-irradiation on OSL signal and efforts to lower detection limits of this technique.

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