Radiation Thermoluminescence Dosimetry by Sand

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The thermoluminescence (TL) technique was utilized to study sand samples from Romania (Valea Cernei) batches for radiation dosimetry. The sand samples have been studied in relation to the main dosimetric properties, such as: glow curve structure, linear dose response (3÷10^4 Gy), low thermal fading. These features provide a useful means of using the present sand samples as gamma dosimeter.

Keywords: sand, thermoluminescence, glow curve, dosimetry, fading

Thermoluminescence (TL) is known to be the result of the radiative recombination of electrons thermally released by trapping levels with holes and it represents a method for measuring doses of ionizing radiation. Although many phosphors are used for dosimetry purpose, the need to develop even more TL materials has still not lost the interests. The sand might be of importance as dosimetric material and it has been studied by several authors [1 - 9].

Sand is a naturally occurring granular material composed by finely divided rock and mineral particles. The most common constituent of sand is silica (silicon dioxide, SiO_2), usually in the form of quartz and feldspar (aluminosilicate with alkali and/or alkali earth elements). The composition of sand is highly variable, depending on the local rock sources and conditions.

In this paper, TL properties of sand from Valea Cernei (Romania) beaches were studied from dosimetric view point.

Experimental part

The sand samples were first treated with 1M HCl solution to remove carbonated, then were washed with distilled water to remove the HCl and finally were treated with H_2O_2 (30%) to remove organic material. The wet samples were dried 2 h at 50^{0}C in an electric oven.

All samples were sieved to obtain grains with diameter between 100 and 180 mm.

Gamma irradiation of samples encapsulated in plastic ampoules was performed at room temperature by their exposure in GAMMATOR M-38-2 irradiator provided with ^{137}Cs source at a dose rate of 0.4 KGy·h^{-1}.

The thermoluminescence measurements were performed with LTM Fimel apparatus on the samples of 4 mg. The thermoluminescence glow curves of studied samples were obtained on a large temperature range between room temperature and 450^{0}C. The linear heating rate was set up at 5^0/s and all measurements were taken at ambient atmosphere. The TL investigations were carried out soon after the end of each exposure except the measurements for fading characterization.

Results and discussions

The thermominescent glow curve of sand sample irradiated to an absorbed dose of 3 Gy is shown in figure 1.

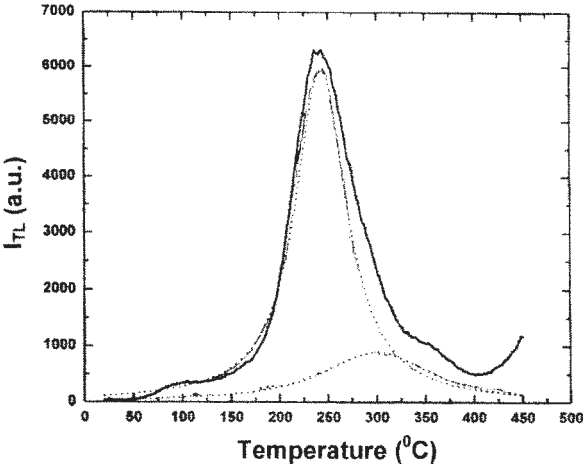

Fig. 1. Thermoluminescence glow curve of sand sample irradiated (^{137}Cs) with 3 Gy

The glow curve shows peaks at ~100, 240 and 300^{0}C. The prominent peak at 240^{0}C is considered the dosimetric peak.

A visual inspection of the thermoluminescence showed (200 Gy) that the majority of the grains emitted a blue light and only a few had a yellow light.

The dosimetric peak response to ^{137}Cs gamma ray exposures ranging from 3 Gy and 10^5 Gy was studied. The response was linear from 3 and 10^4 Gy where saturation occurred (fig. 2).

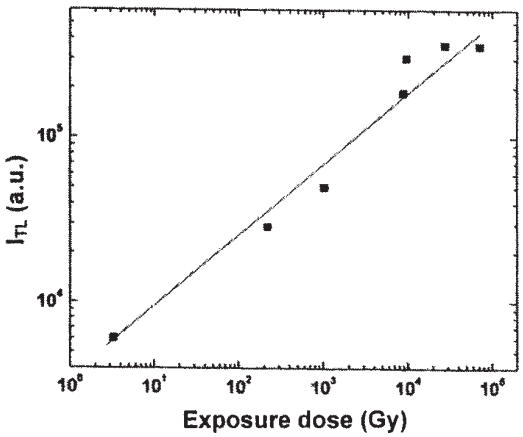

Fig. 2. The dosimetric peak intensity response of sand samples irradiated to ^{137}Cs gamma radiations

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The fading of TL information for gamma irradiated sand samples have been studied. The samples were stored in an opaque box at room temperature. The samples were not allowed any sun shine exposure to avoid the photobleaching effect. The TL signals emitted from gamma irradiated sample were recorded at various intervals to study the fading characteristics (fig. 3).

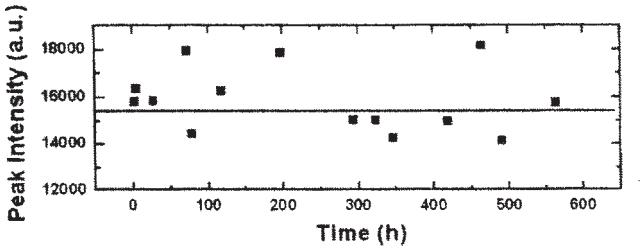

Fig. 3. Fading of sand irradiated to 200 Gy and stored at room temperature in an opaque vial

These results show a good TL dosimetric peak stability at room conditions.

Conclusions

Three glow peaks occurring at 100^0C, 240^0C and 300^0C could be distinguished. Of interest for dosimetry is the 240^0C.

The response of dosimetric peak to ^{137}Cs gamma radiation is linear from 3 Gy to 10^4 Gy where supralinearity began.

The advantages of this material are: low cost, easy handling, abundance of sand etc.

These dosimetric characteristics of the sand show that it would be a useful TL material for further study.

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