THE LASER CREATION OF THIN LUMINESCENT-ACTIVE SENSITIVE LAYERS ON THE CORUNDUM SURFACE*

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Skin dosimetry requires the creation of luminescent detectors with a thin sensitive layer with a mass thickness of 5 mg/cm^2. The linear thickness of such a layer in corundum-based detectors is ~12 μm. To achieve this goal, we proposed in [1] to use laser treatment of specially prepared detectors based on single-crystal corundum. A scanning laser pulse beam with a wavelength of 10.6 μm was used to melt the surface and form a thin sensitive layer in the detectors with a thickness of ~12-15 μm. As a result of this treatment the responses of optically and thermally stimulated luminescence (OSL and TSL) from the thin layers of such detectors became proportional to the radiation dose. However, their OSL and TSL responses (sensitivity) were insufficient. To increase sensitivity of the detectors we have studied the dependences of the OSL and TSL responses (S_{OSL} and S_{TSL}) on the energy (E_{pulse}) delivered by focused laser beam in one pulse, on the pulse frequency (f), on the velocity (v) and the density of scanning (DPI – dots per inch). The change in the structure of the surface layer was monitored microscopically.

Fig. 1 shows micrographs of the surface of samples laser-treated at E_{pulse} = 14 mJ (a) and 38 mJ (b). As can be seen, with increasing E_{pulse}, the surface area with a modified structure increases. At $E_{pulse} \geq 68$ mJ, the entire surface is covered with similar structural elements. Moreover, at $E_{pulse} \geq 102$ mJ cracks is appeared in the volume of the samples and the samples begin to split. Fig. 2 shows the $S_{OSL}(E_{pulse})$ dependency. It can be seen that in the E_{pulse} range from 14 to 68 mJ the value S_{OSL} increases and next at $E_{pulse} > 68$ mJ it reaches saturation. The $S_{TSL}(E_{pulse})$ dependency has a similar form. Further, at E_{pulse} = 68 mJ, the dependences of S_{OSL} and S_{TSL} on v, f and DPI were investigated.

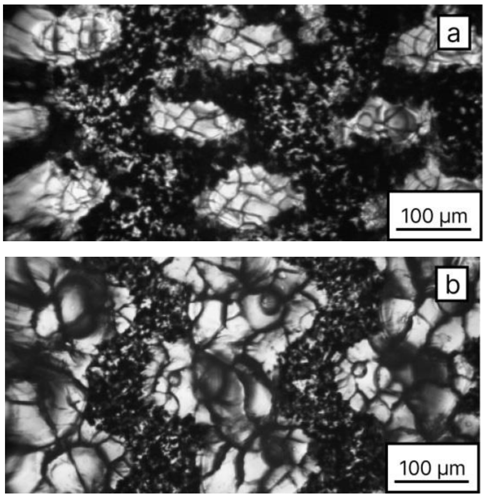

Fig.1. Micrographs of the surface of samples laser-treated at E_{pulse} 14 mJ (a) and 38 mJ (b).

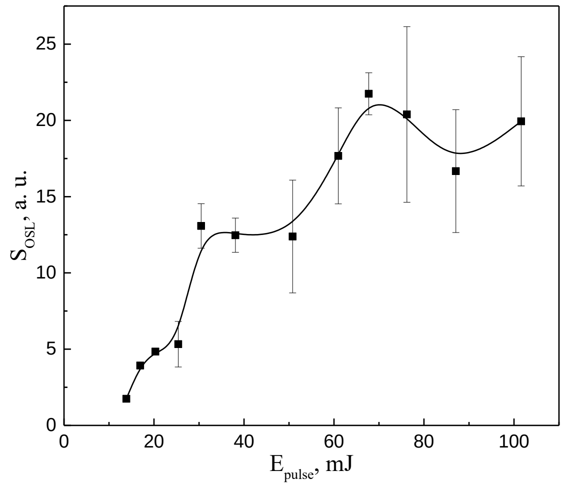

Fig.2. The $S_{OSL}(E_{pulse})$ dependency of samples IR laser treated at 100 pulses per inch, 250 dots per inch and irradiated with 20 mSv β-radiation.

As a result, the optimal laser scanning mode for creating thin sensitive layers of skin detectors based on corundum with maximum OSL and TSL responses was found. The detectors with such a sensitive layer fully meet the requirements of NRB-99/2009 [2] in thickness, energy and dose ranges for photon and β-radiation.

REFERENCES

[1] Milman I.I., Surdo A.I., Abashev R.M. “Method for obtaining thin-layer ionizing radiation detectors for skin and eye dosimetry”, Patent RF, no.2747599.

[2] Radiation Safety Standards (NRB–99/2009). Moscow, 2009.

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