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ANALYSIS OF DOSIMETRIC PROPERTIES AS ENERGY DEPENDENCE IN MATERIALS USING MONTE CARLO SIMULATION

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Introduction: In the area of radiological protection, dosimetry is widely used to monitor workers frequently exposed to radiation; one of the most used ways to record the radiation dose received is the personal dosimeter, which is used by the person to be monitored always close to the body to estimate the dose deposited during the working day as accurately as possible.

Material and method: Relative response curves as a function of photon energy in water and air were obtained for commercially available materials such as $CaSO_4$: Dy, Al_2O_3:C and LiF doped with materials such as Mg, Cu, P, Ti and aggregate with PTFE; promising new materials for use in dosimetry such as crystals varying the concentration of barium oxide, cadmium oxide, dilanthanum trioxide; and crystals composed of pure $BaGd_2ZnO_5$ and doped with Er and Yb.

The relationship was studied by Monte Carlo simulation using the MCNP6.2 code. The simulated environment was a source, a dosimeter located 1m from the source, in air or water. The dimensions of the dosimeters were the same for all, with a thickness of 0.08 cm and a radius of 0.45 cm. The simulated spectrum was from 10 kev to 1000 kev, ranging from low doses, as used in mammography, to high doses, as used in radiotherapy.

Results: The general behavior of all materials was very similar to LiF, showing an increase in response until reaching the peak, then dropping to its stability, both in water and in air; as shown in Figure 1.

In materials with cadmium oxide, the peak was around 45 keV. In dilanthanum trioxide materials, this peak was also around 50 kev.

In materials composed of BaGd, the peak was shifted more to the right and the response was much higher than all the materials presented, reaching a relative response greater than 70, with a peak between 50 and 70 kev.

The materials composed of lanthanum showed the lowest relative responses in relation to all the new materials studied, around 10.

All materials showed a much greater relative response than LiF, none approached the result close to 1 like LiF.

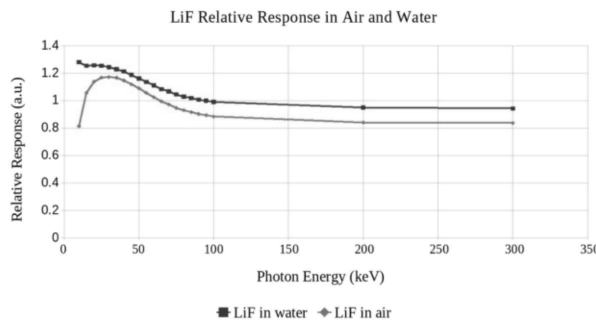

Figure 1: LiF response, as the ratio of mass energy absorption coefficients in relation to air and water.

Conclusions: In the range of doses used, only materials composed of BaGd presented a slightly different behavior from the other materials.

All materials studied did not show linear response behavior as a function of photon energy in water or air. However, the non-linearity presented did not influence the analysis of energy dependence, as the variation in relative sensitivity was the same for irradiation in all beams studied.

As the range of doses studied also comprises doses commonly used in fractional treatments, the results obtained here can serve as a basis for more accurate studies in the practice of radiotherapy centers, whether for measuring doses in patients or for verifying treatments.