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RADIATION DOSIMETER BASED ON A RADIOLYTIC SYNTHESIS OF GOLD NANOPARTICLES

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Introduction: The nanotechnology is a raising field which can impact many areas on humanity demands. One of this demands is a great measurement of absorbed dose on medical procedures, that is necessary for a better control oF radiotherapy, for example, and metal nanoparticles (MNP) can be used for this purpose. Gold nanoparticles (AuNP) have a special property called surface plasmon resonance (SPR), that allow the proper detection of them. As the radiation can be used to synthetize nanoparticles, a signal generated by SPR from AuNPs can be used as a measurement of radiation dose from units to some tens of grays (Gy). In this work, we investigated a radiolytic synthesis of AuNP for dosimetry applications

Material and method: The synthesis of nanoparticles is based on a well-known method for production of AuNP, by reduction of $HAuCl_4$, a precursor gold salt. Cetyltrimethylamonium bromide (CTAB) is employed as a template for the nanoparticle formation and ascorbic acid (AA) is used as reducing agent for gold ions.

An X-ray beam (48 kVp / 0.2 mA) was used to irradiate the samples. Doses between 0.5 and 50 Gy were used, with dose rate equal to 2.054 Gy/min.

The nanoparticles were characterized by UV-visible absorption spectroscopy (ABS) and dynamic light scattering (DLS). The first one was made using an Ultrospec 2100 pro Spectrometer, with light range from 300 to 900 nm. The second one was made on a Zetasizer Pro, with a 10x diluted solution.

Results: Firstly, we investigated if the synthesis is possible with the energy used (generally, the MNP are synthetized by radiation with higher X-ray energies or even with electron beam accelerators). The AuNP solution was made by the referred synthesis route and irradiated with 50 Gy. The result was a dark purple solution exhibiting an absorption peak centered on nearly 550 nm, indicating the successful production of the AuNP.

After that, we studied the effect of synthesis and irradiation parameters on the absorption peak and the size of nanoparticle (measured with DLS). By varying the gold salt concentration, we found an increased absorbance, indicating the formation of more nanoparticles. The DLS analysis indicated that these nanoparticles were smaller upon increasing the gold salt concentration. By varying the dose rate, we found higher absorbance signals for higher dose rates, but a non-linear behaviour of their sizes.

After that we proceded to measure the absorbance with different doses. We found a linear relationship between dose and absorbance on the SPR peak, indicating a promising application of the nanoparticle solution as a dosimeter. On Figure 1, blue line show that linearity, that has a sensibility of 0.14 ± 0.02 Gy/a.u.

Conclusions: We are developing a promising route to produce dosimeters that can be used in low dose and low energy applications. We achieved good sensibility, but further experiments will try to improve that.

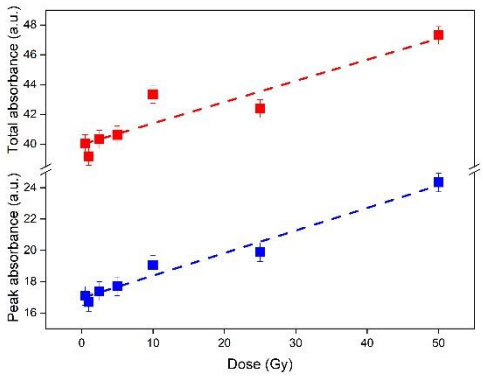

Figure 1: Total absorbance measured on all spectra (red line) and on SPR band (blue line) *versus* absorbed dose

References:

1. K. Pushpavanam et al. *ACS Nano* **Vol. 9, No. 12**, 11540-11550 (2015).