

## Report on the outcomes of a Short-Term Scientific Mission<sup>1</sup>

Action number: CA20129

Grantee name: Telma da Piedade Silva Marques

### **Details of the STSM**

Title: Investigating the Impact of Gamma Rays on Coated Gold Nanoparticles: Formation of Free Radicals and Electrons

Start and end date: 05/06/2023 to 16/06/2023

### **Description of the work carried out during the STSM**

Stock solution of gold nanoparticles (GNP) was prepared as proposed by Slot and Geuze (1981). GNP were synthesized by reducing  $\text{KAuCl}_4$  solutions by a mix of tri-sodium citrate and tannic acid at 60 °C. Washing was performed by repeated ultracentrifugation cycles and replacement of the supernatant by ultra-pure water. With this preparation we have obtained gold nanoparticles with a diameter of 6 nm. Coating was performed by adding different polyethylene glycol (PEG) molecules.

The gold nanoparticles size distribution and shape measurements were performed using absorption techniques and dynamic light scattering (DLS).

All samples were irradiated in a gamma source, at different doses, to determine the influence of gamma rays in the radical production ( $\text{HO}^\bullet$  and  $\text{H}_2\text{O}_2$ ) and the impact of different ligands.

### **Description of the STSM main achievements and planned follow-up activities**

Considering the Working Group 1 goals of the CA20129, it is clear that this project represents high added value to nanoparticles research and their application for radiotherapy. Indeed, we have obtained the gold nanoparticles with the expected size of 6 nm diameter supported by the absorption spectroscopy and DLS measurements. Also coating that is mandatory for biological application was done with increasing sizes of polyethylene glycol and fully characterised with complementary analytical techniques.

Sample irradiation showed that hydroxyl radical production varies according to the coating added to the gold nanoparticles. Longer coating induced higher decrease of radical production as was assessed by

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<sup>1</sup> This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

coumarin hydroxylation quantification. In addition, we were able to determine the hydrogen peroxide quantity as a function of a dose and gold nanoparticle concentration with different ligands. We also could evidence the modification of the  $H_2O_2$  quantity as a function of the ligand size.

We intend to more precisely characterize our nano objects with complementary techniques such as thermogravimetric analysis (TGA) and transmission electron microscopy (TEM). In additions to oxidative species, solvated electrons that were shown to induce important biological damages (e.g. cell death induced by DNA modification) could also be measured in the future.

All the experiments were performed with a gamma source (1 MeV photons), but considering all the different apparatus used in radiotherapy, other beams should be considered in the next future.

These results can be the base for theoretical calculations that should be performed by other groups already involved in the Cost Action 20129. Agreement between experimental and theoretical approaches will provide new insights on the nanoparticle efficiency to produce deleterious species necessary for effective radiotherapy.

Regarding the medical applications of nanoparticles, this study is very important and should help the design of more efficient nanoparticles that could be provided to other partners of this Cost Action.