

Magnetic Nanoparticle transformations and the effect on their heating properties

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In the Magnetic Hyperthermia (MH) and Photothermal Therapy (PTT) applications, magnetic nanoparticles (MNPs) are used as an “antennae” able to capture energy (either from an alternating magnetic field (AMF) or a near infrared (NIR) light) and transform it into local heat. In the frame of this therapy design, it is fundamental to know how possible particle transformation would affect its performance over time.

In this work, we used MNPs with two different coatings (dimercaptosuccinic acid - DMSA-NPs) and poly(maleic anhydride-alt-1-octadecene) - PMAO-NPs) but with same magnetic core (≈ 13.5 nm) (Figure 1A). We evaluated how the MNP coating affects their degradation profile using a medium that simulates the lysosomal conditions and how this degradation affects their heating performance in the frame of both magnetic hyperthermia and photothermal treatments. The faster degradation of DMSA-NPs in comparison with PMAO-NPs was verified by transmission electron microscopy (TEM), magnetic and colorimetric measurements (Figure 1B).

To track how the transformations suffered by the particles along their degradation process affected their heating properties, magnetic hyperthermia and photothermal measurements were performed (Figure 1C). In both cases, the degradation process resulted in a decrease of the heating capacity of both types of materials. As a result of the faster degradation of DMSA-NPs, the reduction of the heating properties along time was increased for this material when compared to PMAO-NPs.

Thus, the less prone to degradation nanoparticles (PMAO-NPs) were selected for the *in vivo* analysis, to evaluate the degradation speed of this material in tumor tissues. In this study, although the number of particles decreased in the tumors along time after their administration, no transformations in the average particle size of particles occurred (Figure 1D).

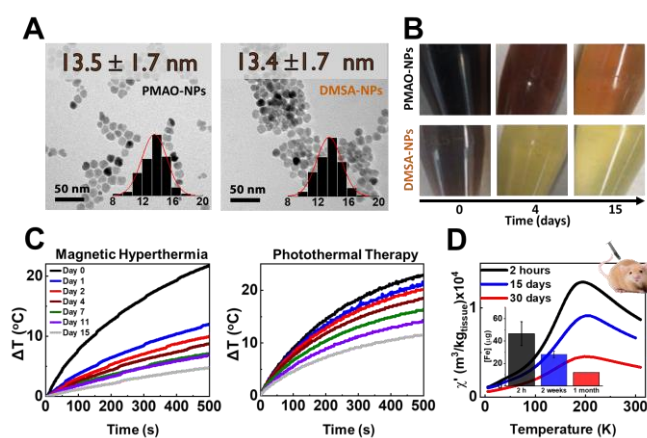


Figure 1. A) TEM images and particle size distribution of the nanoparticles used. B) Photos of the nanoparticle suspensions at different times during the degradation process. C) Magnetic Hyperthermia and Photothermal measurements of PMAO-NPs at different times of the degradation process. D) Temperature dependence of the AC magnetic susceptibility profiles of tumor tissues collected at different time points and iron concentration in the form of particles in the tumor calculated from the out-of-phase susceptibility data.