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Assessment of Different Synthesis Routes of Iron Oxide Magnetic Nanoparticles for Magnetic Hyperthermia Applications

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Extended Abstract

Magnetic hyperthermia (MH) is a promising therapeutic modality for cancer treatment. MH is established on the concept that magnetic nanoparticles (MNPs) delivered to tumors can generate heat after exposure to a noninvasive external alternating magnetic field (AMF), inducing cell death. Cancerous cells heated to temperatures between 42 °C and 46 °C for 30 min or longer undergo apoptosis (cell suicide) [1]. The heating efficiency of the MNPs is a key parameter for the success of therapeutic applications of MH. Superparamagnetism is a form of magnetism which appears in ferromagnetic or ferrimagnetic nanoparticles with single domains. From certain nanoparticle sizes, magnetization can randomly flip direction under the influence of an AMF [2]. The heating efficiency relies on a compromise between the intrinsic time-dependent relaxation processes of the magnetic moments and hysteresis losses of the MNPs, which heavily depends on the MNPs design (size, shape and surface) [3]. Moreover, the surface of the nanoparticles must be functionalized with organic molecules to guarantee their biocompatibility. In this study, we compare the heating efficiency of iron oxide MNPs produced by two different processes, thermal decomposition synthesis and green synthesis. Thermal decomposition synthesis allows MNPs design but relies on the use of toxic chemical reagents [4]. Instead, the green synthesis uses biocompatible natural plant extracts as reducing agents but it has poor design capabilities [5]. In this work we performed the proof of concept of MH with both types of MNPs using a commercial MH applicator having an AMF with a frequency of 437 kHz and a maximum magnetic field strength of 200 Gauss. We report our findings in terms of heating efficiency by means of the Specific Power Absorption (SPA). The MNPs produced by green synthesis presented inhomogeneous size and shape due to the use of the phytochemicals which can play the role of reduction a capping agent in the synthesis but can be less effective compare with the reactants used in the thermal decomposition synthesis, in addition they offer higher probability of nanoparticle agglomeration. This is correlated with the observed reduced heating efficiency of the green synthesis MNPs that were approximately 4 times less efficient than the thermal decomposition MNPs. Furthermore, we studied the biocompatibility of MNPs through toxicity and bioaccumulation using the model organism Caenorhabditis Elegans. The variables used to estimate the toxicity were: lethality, growth, locomotion and reproduction. On the other hand, the bioaccumulation was studied using atomic spectroscopy. In our preliminary results, we observed that the MNPs of green synthesis presented less toxicity in comparison with the MNPs synthesized with the thermal decomposition. We hypothesize that the better biocompatibility of the green

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