Title: Biomaterials with magnetic nanoparticles

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ABSTRACT

The purpose of this PhD thesis is to obtain and characterize new biomaterials with magnetic nanoparticles. An important part of the thesis deals with the characterization of the new biomaterials obtained by determining their physical, mechanical and biological properties in vitro. For this, it were used the techniques and methods commonly encountered in the determination of basic properties, such as the organization in atomic structure, composition, mechanical properties, morphology, micro and nanostructures, micro and nanocomposite materials, in vitro testing of the biomaterials.

The interdependence between the micro- and nanostructure of materials and their properties was the idea on which the new biomaterials with magnetic nanoparticles with a planned structure were obtained, necessary for the potential applications in tissue engineering.

In recent years, magnetic materials are increasingly used in different biomedical applications, primarily because of their considerable performance. With unique characteristic properties, magnetic nanoparticles play an important role in these applications; Iron oxide nanoparticles such as hematite (α-Fe_2O_3), maghemite (γ-Fe_2O_3) and magnetite (Fe_3O_4) are the most commonly used. Although all these forms of iron oxide have similar properties (reduced toxicity in the human body), through superparamagnetic properties, when the dimensions are nanometric, as well as due to the synthesis process (presented in Chapter 2) which flows relatively easily, the magnetite nanoparticles are those more often used.

Tissue engineering is a field that increasingly uses composite biomaterials with magnetic nanoparticles. Of these, nanocomposites based on magnetite and natural polymers (eg natural silk proteins) play an important role, primarily due to the lack of toxicity (Chapter 3).

The mechanical properties of biomaterials are of particular importance in tissue engineering. These properties can be improved by using synthetic polymers, but, as shown in Chapter 4, and by using a new concept of fortifying the nanocomposite structure by properly functionalizing the magnetite nanoparticles.

Following the synthesis of magnetite nanoparticles, for different bioapplications, they can be coated (silica, polymers, $BaTiO_3$), to prevent the formation of large aggregates, but also to prevent rapid biodegradation when directly exposed to the biological system. In this respect, core-shell composite nanoparticles (Fe_3O_4 @ $BaTiO_3$) were prepared (Chapter 5).

During the processing of the biomaterials that are the subject of this doctoral thesis, a large part of the characterization methods was used iteratively to track and ensure the reproducibility of some of the properties, such as the phase composition, micro- and nanostructure of the obtained materials.