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Iron oxide-based nanostructures with applications in oncology

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- Summary –

The purpose of the following thesis is to emphasise the value of iron oxide nanostructures as potential vehicles for anticancer therapy. Moreover, it highlights the importance of the manufacturing technique used for the synthesis of the above-mentioned structures, and provides an alternative over conventional methods, namely laser pyrolysis. The thesis is structured around two main parts: theoretical background and original contributions.

The theoretical background consists of three main chapters. The first chapter is a succinct introduction in the world of magnetism. It presents and explains the main classes of magnetism, as well as the important terms and parameters used to characterize magnetic materials. The second chapter is based on synthesis methods. Chemical, physical, and biological methods are presented along with their advantages and disadvantages. However, attaining high-purity, functionalized, and precisely regulated synthesis of iron oxide nanoparticles still remains a challenge. A promising alternative for the synthesis of uniform nanoparticles is CO_2 laser pyrolysis of the reactants in a vapour/gaseous phase. This technique comes with several advantages that can overcome the drawbacks of conventional methods, including, but not limited to, eliminating the contamination risk because there is no interaction between the rection chamber walls and the fine particles obtained, high yield, and control over the synthesis parameters. Lastly, the third chapter concentrates on the essential properties required for magnetic nanoparticles to be successfully used in clinics, as well as the biological barriers that they need to overcome. Barriers such as abnormal vasculature of the tumour and its dense extracellular matrix are presented, as well as various strategies for nanoparticles tumour uptake.

The original contributions include eight chapters. Amongst these chapters, two review papers and two book chapters emphasise the superiority of nanoscale materials in cancer therapy, including their properties and numerous examples in the field that back up this hypothesis. The remaining chapters are focused on the synthesis of iron oxide nanoparticles by laser pyrolysis. However, these chapters cover several aspects demonstrating the advantages of iron oxide nanoparticles synthesised by laser pyrolysis, ranging from parametric studies regarding the versatility and ease of fabricating finely tuned nanoparticles through laser pyrolysis, to the use of these nanoparticles in *in vitro* studies on human cancer cells with promising results.

Keywords: iron oxide nanoparticles, laser pyrolysis, cancer therapy

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