

Chemical Engineering Master's Defense

Synthesis and Characterization of Polymer-Templated Magnetic Nanoparticles

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abstract

This research reports on the investigation into the synthesis and stabilization of iron oxide nanoparticles for theranostic applications using amine-epoxide polymers. Although theranostic agents such as magnetic nanoparticles have been designed and developed for a few decades, there is still more work that needs to be done with the type of materials that can be used to stabilize or functionalize these particles if they are to be used for applications such as drug delivery, imaging and hyperthermia. For in-vivo applications, it is crucial that organic coatings enclose the nanoparticles in order to prevent aggregation and facilitate efficient removal from the body as well as protect the body from toxic material.

The objective of this thesis is to design polymer coated magnetite nanoparticles with polymers that are biocompatible and can stabilize the iron oxide nanoparticle to help create mono-dispersed particles in solution. It is desirable to also have these nanoparticles possess high magnetic susceptibility in response to an applied magnetic field. The co-precipitation method was selected because it is probably the simplest and most efficient chemical pathway to obtain magnetic nanoparticles.

In literature, cationic polymers such as Polyethylenimine (PEI), which is the industry standard, have been used to stabilize IONPs because they can be used in magnetofections to deliver DNA or RNA. PEI however is known to interact very strongly with proteins and is cytotoxic, so as mentioned previously the Iron Oxide nanoparticles (IONPs) synthesized in this study were stabilized with amine-epoxide polymers because of the limitations of PEI.

Four different amine-epoxide polymers which have good water solubility, biodegradability and less toxic than PEI were synthesized and used in the synthesis and stabilization of the magnetic nanoparticles and compared to PEI templated IONPs. These polymer-templated magnetic nanoparticles were also characterized by size, surface charge, Iron oxide content (ICP analysis) and superconducting quantum interference devices (SQUID) analysis to determine the magnetization values. TEM images were also used to determine the shape and size of the nanoparticles. All this was done in an effort to choose two or three leads that could be used in future work for magnetofections or drug delivery research.

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