Development of highly hydrophilic yolk-shell Fe3O4@C magnetic nanoparticles for cancer theranostics

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SUMMARY:

Due to their remarkable physicochemical properties acquired at the nanoscale, magnetic nanoparticles (MNPs) are of interest in several disciplines, such as data storage, water purification, biochips and biomedicine (1). In order to prevent the oxidation of the MNPs, and their aggregation, several procedures have been developed to encapsulate them as a magnetic core (2). In particular, carbon-coated nanoparticles have several advantages in comparison to polymer or silica coatings, since they usually offer higher chemical and thermal stability, large surface area, biocompatibility and easier functionalization (1, 3). These properties are especially important for biomedical applications, where MNPs should be chemically-functionalized with specific biocompatible targeting molecules to allow their selective attachment to cells or tissues. In this work, carbon-coated yolk-shell magnetic nanoparticles (CYSMNPs), with the potential to be used in cancer theranostics (i.e., simultaneous diagnosis and treatment), namely (i) *Hyperthermia*; (ii) *Drug delivery*; and (iii) *Contrast enhancement for MRI*, were successfully synthesized. To ensure the colloidal stabilization of these MNPs in aqueous solutions, a two-step procedure was investigated and optimized. As a result, the graphitic shells were firstly activated with the incorporation of carboxylic acid groups using an acid treatment (nitric acid at mild conditions), without compromising the magnetic core. Secondly, the activated CYSMNPs were chemically-functionalized, via amidation with 11-aminoundecanoic acid (11-AUA). Overall, the optimized procedure resulted in the generation of highly hydrophilic nanoparticles with available terminal carboxylic acid groups. As represented in Figure 1, this strategy allows for further conjugation of the particles to other biomolecules containing amino groups, making these nanoparticles even more attractive for biomedical applications.

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References

1.
Taylor A. et al., J Nanopart Res (2010) 12:513-519

2.
Liu, W., Liu, Y., Yan, X., Yong, G., Xu, Y., Liu, S., J Mater Chem A (2014) 2:9600-9606

3.
Mohapatra, S., Rout, S.R., Das, R.K., Nayak, S., Ghosh, S.K., Langmuir (2016) 32:1611-1620

Attachement 1