Innovative, sustainable, fast one-step synthesis to produce iron oxide nanoparticles for the biomedical field

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Iron oxides nanoparticles, mostly in form of magnetite (Fe_3O_4), present a peculiar magnetic behaviour, called superparamagnetism, that allows the creation of non-toxic and low-invasive substances that have been used in the biomedical field for hyperthermia, drug targeting as well as magnetic resonance imaging (MRI). This type of particles, called *superparamagnetic iron oxide nanoparticles* (SPIONs), is usually produced with methods, especially the most used wet chemical routes, that use high temperature/pressure and have multiple steps of production to obtain the final product, giving low yields of production. An external coating of the particles is required for use in biomedical fields, adding another step to the process.

Our research group has developed an innovative, sustainable, fast and patented[1] one-step synthesis that works at ambient temperature and pressure, allowing the production of SPIONs in aqueous suspension; the lack of secondary products ensure a high yield of production and a potential scalability of the process, thus overcoming all the major disadvantages of the current methods of production.

Therefore, we researched how to extend this method to the production of coated SPIONs for the biomedical field. Poly(ethylene glycol) (PEG), a water-soluble polymer, was chosen as candidate for the preparation of various samples, produced at different polymer concentrations and iron reagents molarity. Each sample was analysed and compared to the bare SPIONs produced with this method through X-Ray diffraction (XRD), infrared spectroscopy (FT-IR), transmission electron microscopy (TEM) and magnetometry (AGM).

The results showed that adding PEG to the synthesis didn't affect the crystal structure of the magnetite core obtained, which successfully bonded to the polymer coating. The coated particles presented a spherical morphology, appeared monodispersed and maintained their superparamagnetic behaviour, making them suitable candidates for use in the biomedical field.

[1] G. Taglieri, V. Daniele, and L. Macera, "Procedimento per la sintesi di nanoparticelle di ferridrite o di magnetite mediante resine a scambio ionico," 102019000017981, 2021

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