

Methods of Synthesizing of Superparamagnetic Iron Oxide Nanoparticles and their Surface Modifications for Drug Delivery: A Review

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Abstract

The aim of this review article is to report the different known methods for the preparation of nanoparticles of iron oxide Magnetite (Fe_3O_4) and their applications in drug delivery besides indicating the nanoparticles surface availability for any required chemical modifications which allows the particle for a very wide range of medical applications from diagnosis to therapy. The recent development of biocompatible, functionalized ferrofluids and ferromagnetic particles has directed to a range of novel biomedical and diagnostic applications. The synthesis of nanoparticles of magnetic metal oxides has been reported in recent times by using different chemical methods viz. sonochemical, solvothermal, micro emulsion etc... Magnetite (Fe_3O_4) presents many potential possibilities in biomedicine. Since they range from a few nanometers up to 200 nanometers, they rival the size of most cells, viruses, proteins, and genes. This means that they can interact with these biological units "up close". Superparamagnetic nanoparticles has a very active surface where several modifications can be applied giving them a great chance for accepting different drugs on their surfaces with different compositions. Applications of Magnetite (Fe_3O_4) include uses as drug delivery devices, in bioseparations and hyperthermia treatment. In the clinical area, these particles are being used in a variety of ways, notably as contrast agents for magnetic resonance imaging (MRI). Ferrofluids respond to an external magnetic field enabling the solution's location to be controlled through the application of a magnetic field. This enables the use of magnetic forces for the control of properties and flow of the liquids, giving rise to numerous technical applications, especially for in vivo applications, such as drug delivery.

Keywords: Magnetite, Superparamagnetic nanoparticles, surface modification.

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INTRODUCTION

Magnetite (Fe_3O_4) is a naturally occurring mineral and it is the first magnetic material recognized to man (Matijevic and Sapiensko, 2000). Its liquid form is called the ferrofluid. Through definition a ferrofluid is a colloidal suspension of magnetic nanoparticles (Breitzer and Lisensky, 1999). A ferrofluid includes surfactant coated magnetic nanoparticles in a liquid host that forms a strong colloidal suspension. An average ferrofluid has most effective 5 vol.-% magnetic particles, 10 vol.-% surfactant, and the balance is the provider liquid. The particles are coated with a surfactant that disperses the particles and stops agglomeration by means of overcoming the local magnetic fields and van der Waals forces that exists between particles. As a result, while the ferrofluid is not in the presence of an outside magnetic field source, it has no net magnetization (Willard *et al.*, 2004). Ferrofluids, that are colloidal suspensions of magnetic material in a liquid medium, are an example of a

liquid that responds to an external magnetic source. The coupling of liquid and magnetic properties conducts way that the liquid's location can be manipulated by means of an applied magnetic source. Ferrofluids are genuinely superparamagnetic, which means that a ferrofluid reacts to a magnetic field in the same way as a ferromagnetic or ferrimagnetic, however magnetizes and demagnetizes more hastily because in a ferrofluid, the magnetic domains are of the identical length (Bonadonna *et al.*, 1993; Yamahata *et al.*, 2003; Grob *et al.*, 2002). They may be commonly referred to as being superparamagnetic because, even as on a microscopic state they're ordered, they may be magnetized as an entire in the presence of an externally carried out magnetic field (paramagnetism). The interaction among the ferrofluid and a magnetic area makes it ideal for targeting in terms of drug transport due to the fact its movement may be managed. Using ferrofluids in a drug transport is a technique this is being studied around the world (Breitzer and Lisensky, 1999).