Application of magnetic nanoparticles Fe$_3$O$_4$ in the field of orthopedics and medicine

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Abstract. Magnetic nanoparticle Fe$_3$O$_4$ have super paramagnetic, biological cell compatibility, low toxicity, antibiosis and bacteriostasis, drug loading, sustained release and thermal effect. Using magnetic nanoparticles Fe$_3$O$_4$ as magnetic source, magnetic masoporous glass two-dimensional bone framework was synthesized under the action of external magnetic field, which provides growth space for bone repair, cell proliferation and metabolism, and contribute to mineralizing. The same time, The application of graphene, especially magnetic nanoparticles Fe$_3$O$_4$, in bone materials, bone repair and related medicalfields was discussed.

1 Introduction

The lead-in note the ultrapolat material grapheme is divided into power and film [1,2]. When the external magnetic field exists [3], the Fe$_3$O$_4$ is drawed into the glass to prepare powdery individual with a high magnetic dimensional hexagonal mesopore [4].

Figure 1: Due to the large surface area, rapid magnetization and super paramagnetic the stability of the particles is improved. The same time it’s observed that the sustained release of antibiotics has a long period, which provide a good drug [5] sustained release system for anti-infection treatment after bone repair. It has stable and effective antibiosis and bacteriostatic effects. [6,7]

To further improve particle stability and expand its application in the medical field, such as nuclear magnetic resonance [8], gene therapy [9], immunity [10] bone repair, tumor targeted therapy hyperthermia.

2 Data and methods

162 articles related to magnetic nanoparticles Fe$_3$O$_4$ are published from 2006-2020; including china full-text database and pubmed database. The argument is reliable figure 2 (analysis and collation)

Fig 2. Please give the Caption of the Figure 2.

3 Results

3.1 Preparation fo magnetic nanoparticles Fe$_3$O$_4$

Preparation of magnetic nanoparticles Fe$_3$O$_4$ is divided into physical method [11,12] and chemical method the particles prepared by the physical method have low purity uneven large particles and less use. The chemical method is formulated with small and uniform particles, high purity and ultra-magnetic compliance is widely used.

3.2 Frequently used chemical methods

Frequently used chemical methods: co-precipitation hydrothermal gel micro-emulsion, etc. [12] Magnetic nanoparticles Fe$_3$O$_4$ was obtained by coprecipitation method, [13,14] hydrothermal method is divided into oil-in-water type, and water-in-oil type, which prevents
particle aggregation and obtains dispersed nanoparticles. Hydrothermal method obtained at high temperature and high pressure.

### 3.3 Surface modification

Commonly used modified materials are inorganic material, organic small molecules, macromolecules, SiO2 modification, etc. According to different requirements polymer forces are combined to the surface of magnetic nanoparticles Fe3O4 [15–16]. Double bonds are introduced to make its surface potential sufficient. Commonly used coprecipitation method to extract nanoparticles Fe3O4. Used heat treatment method to obtain sodium oxide water particles. Used gel latex method to obtain polymerized latex in three-dimensional space. Used microemulsion method to form oil-in-water, water-in-oil for preventing particles from aggregating together. Inorganic materials are coated to form a shell-core structure such as a large number of hydroxyl groups on the surface of hydroxyl groups on the surface of SiO2[15,16], which has good biological activity, stabilizes the properties of nanoparticles Fe3O4 and is low in toxicity and acid resistant [17]. Fe3O4/Ag composite material has antibacterial properties. [18-20] the cytotoxicity of and acid resistant [17]. Fe3O4 nanoparticles have good biocompatibility which increases the imaging ability of the body. The results showed that Fe3O4 nanoparticles had better biocompatibility and activity in vitro. The inorganic material SiO2[15,16] has the advantages of acid resistance, low toxicity, and magnetic nanoparticles Fe3O4 form a core-shell structure to stabilize its performance.

### 4 Application of magnetic nanoparticles Fe3O4 in orthopedics and some medical fields. Shell-core structure.

The antibacterial and bacteriostatic effects of graphene oxide have attracted peoples attention. [31,32] Graphene oxide has paid more attention to the antibacterial properties of Staphylococcus aureus, Salmonella Escherichia coli, Pseudomonas aeruginosa, etc. [33].

Intraosseous implants are easy to infect, and it is very difficult for bacteria to form biofilm after infection. It has been reported [34,35] that the use of graphene oxide at a certain concentration of silver ions can inhibit the formation of biologic.

The magnetic nanoparticles Fe3O4 are spinel ferrite models of Staphylococcus aureus and soft magnetic material. In the light sensing, photoconductive function, coatings, biomedical aspects have penetration [25] The most common method is chemical coprecipitation.

At the same time, silver was reduced to its surface with Fe3O4 nanoparticles in the core, and the shell core powder was produced at a certain temperature without ascorbic acid. The catalyst can be recycled.

At the same time, silver was reduced to its surface with Fe3O4 nanoparticles in the core, and the shell core powder was produced at a certain temperature without ascorbic acid. The catalyst can be recycled [26]

The effect of silane coupling agent on magnetic Fe3O4 particles were surface modified [28], introducing hydrophobic groups to improve their dispersion ability at the interface and reduce aggregation.

The shape and physical and chemical properties of graphene nanoparticles play an important role in cells, tissues and tubes; the smaller the size, the easier it is to degrade. Graphene oxide is rich in oxygen groups, and organic macromolecules modify its function. Including: polyethylene alcohol, polyethylene imine, bovine serum protein, and other organic macromolecules. Reduce Escherichia coli, reduce the infection of intraosseous implants, and improve the cure rate after infection [36].

It has also been reported that metallic peptides coated on graphene oxide have destructive and inhibitory effects on the biological model of Staphylococcus aureus137 Thus, graphene oxide has a killing effect on free bacteria and bacteria forming biofilms [38,39].

#### 4.1 Special shell structure

Introducing magnetic nanoparticles Fe3O4 into common glass. [21] Under the action of external magnetic field, a specific graphene powder is developed. Used magnetic nanoparticles Fe3O4 to obtain [22] Super paramagnetic, expand the surface area, and provide three growth spaces for cell metabolism in bone repair. The results showed that Fe3O4 nanoparticles had better biocompatibility and activity in vitro. The inorganic material SiO2[15,16] has the advantages of acid resistance, low toxicity, and magnetic nanoparticles Fe3O4 form a core-shell structure to stabilize its performance.

#### 4.2 magnetic nanoparticles Fe3O4 form a core shell structure to stabilize its performance.

Application in the field of biomedicine.

Therapeutic amount of drugs and non-toxic magnetic nanoparticles Fe3O4 under the action of in external magnetic field, [8-9] so that the concentration of drugs in the lesion site is increased, azithromycin and magnetic nanoparticles Fe4O3 are used to make microspheres, and the sustained release of drugs is increased for a long time.

Graphene can be combined with related drugs by using drug-loaded sustained release. Under a certain PH value [6], it is placed into the joint cavity, and the medullary cavity, coupled with the antibacterial properties of graphene itself to achieve the therapeutic purpose. Coated twice with sodium oleate and dextran, it shows super paramagnetic, and the specific binding force of tumor cells is improved. At the same time, dextran is used to modify its surface.

The obtained contrast agent is hydrophilic, stable and has good biocompatibility which increases the imaging effect. Using the thermal effect of magnetic nano-water particles Fe3O4 in the magnetic field, it is used for tumor hyperthermia and magnetic hyperthermia.

#### 5 Conclusion

Graphene Magnetic Nanoparticles Fe3O4 has become a hot
spot due to its unique characteristics: [11] super paramagnetic, antimicrobial properties, drug-loaded sustained release properties, and shell and core structure. It has a good potential application in orthopedics and other medical fields. For example: antimicrobial properties for bone and joint surgery is used to reduce postoperative infection. Drug-loaded sustained-release properties is used for antimicrobial and bacteriostatic Hyperthermia, gene therapy, etc. Magnetic nanocomposites have good magnetic properties.[22]

which will be widely used in tumor targeted drug delivery, magnetic resonance imaging.[13] antinfection, anti-tumor, promoting the proliferation of bone marrow mesenchymal stem cells, bone [23] implantation and other fields.

Due to FeO, nanoparticles are cheap and have good magnetic response, and their combination with biomedicine makes them have a broad application prospect in the field of biomedicine. Although great achievements have been made in the single properties of FeO nanoparticles, such as magnetic responsiveness and biocompatibility, how to optimize the comprehensive properties to obtain different particle sizes and different magnetic response intensities, so that the biocompatibility can be more extensive and applicable to more organisms, and improve the relevant theoretical mechanisms for clinical application.

It is believed that in the near future, with the continuous cooperation, cooperation an innovation of Biomedical workers and nanomaterials workers, FEO, nanotechnology will make a greater contribution to the benefit of mankind.

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