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Preparation of Au nanomaterial particles and medical research

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Abstract: Gold nanoparticles have good stability, ease of operation, sensitive optical properties and good biocompatibility, making them widely used in food safety testing, environmental safety testing and medical detection and analysis. In this work, the main preparation methods of Au nanoparticles are reviewed, including chemical reduction method, two-phase method, seed growth method and template method, as well as the structural characteristics and characteristics of Au nanoparticles. At the same time, the application of Au nanoparticles in biomedicine is elaborated, and the results show that their outstanding surface plasma resonance properties have unique advantages in the field of loading drugs and transporting drugs. Finally, the application of gold nanoparticles in cancer treatment, biochemical analysis and biosensors is prospected.

Keywords: Au nanoparticles; Preparation; Biomedical.

1. Introduction

Gold is a typical inert element, made of gold historical artifacts can retain thousands of years of brilliant luster does not tarnish, is widely Used in jewelry, coins and electronics, etc. Because of their good stability, easy handling, sensitive optical properties, easy surface modification and good biocompatibility, gold nanoparticles are widely used in food safety testing, environmental safety testing and medical testing and analysis [1-3].

Gold nanoparticles are joined colloids with diameters of0.8-250 nm, which have surface effect, small size effect and macroscopic quantum tunneling effect. Due to their relatively tiny structure, these particles are better able to accumulate at sites of inflammation or tumor growth than small molecules. Gold nanoparticles with efficient phototransfer thermal properties can be applied to specifically ablate infected or diseased tissues.

Gold nanoparticles have been used to improve cancer radiotherapy or CT diagnostic imaging because of their ability to absorb large amounts of X-rays.

The current methods of synthesizing nanomaterials can be categorized into two types, namely, the "top-down" method represented by the physical method of crushing and the "bottom-up" method represented by the wet chemical method of synthesizing gold nanoparticles by chemical reduction. It is obvious that the top-down approach can better regulate the morphological size and dispersion of nanoparticles.

2. Structural properties of Au nanometer particles

2.1. Surface effects

As the size of nanoparticles decreases, the ratio of the number of atoms to the total number of atoms on the surface of the particles increases rapidly, and the specific area also increases at the same time, which leads to a dramatic increase in the surface tension and surface energy of nanoparticles, and eventually leads to a change in the properties of nanomaterials. For example, when the nanometer size is10nm, the percentage of nanoparticles on the surface is 40%. Due to the high surface energy caused by their high specific surface area, and the fact that nanoparticles contain many suspended and unsaturated bonds, they become very active and can easily undergo physical and chemical changes to become stable. For example, metal nanoparticles are rapidly oxidized and burned in air, and inorganic nanoparticles undergo adsorption in air.

2.2. Small size effect

When the nanoparticle size is less than or equal to the physical characteristic dimensions of light waves, de Broglie wave wavelength, coherence length and transmission depth when the matter is in the superconducting state, the periodic boundary conditions of nanoparticles are broken, while the surface atomic density is reduced. The small size effect of nanoparticles is the result of the change in the physicochemical properties of nanoparticles. For example, copper nanoparticles are insulators, while silica nanoparticles can conduct electricity. The small size effect of nanoparticles has a wide range of applications in solar energy conversion and infrared sensitive components.

2.3. Quantum size effect

For nanometer-sized particles, the continuous electron energy levels near the Fermi energy level become dispersed and the energy level spacing increases gradually. Nanoparticles exhibit unusual properties when the energy level spacing of nanoparticles is higher than the photon energy, magnetic energy, thermal energy, electrostatic energy or superconducting state aggregation energy, i.e., the quantum size effect of nanoparticles. For example, some metal nanoparticles have a very high absorption capacity for light, and there are also metal nanoparticles with altered optical properties such as blue shift phenomenon. All these phenomena are concrete manifestations of the quantum size effect.

2.4. Macroscopic quantum tunneling effect

Macroscopic quantum tunneling effect is one of the fundamental quantum phenomena in nature, which refers to the quantum phenomenon that can still penetrate the potential barrier when the total energy of macroscopic physical

quantities (e.g., charge, magnetization intensity, magnetic flux) is below the height of the barrier. For example, superfine nickel powder appears superparamagnetic in low temperature environment. The macroscopic quantum tunneling effect and quantum size effect provide the basis for the development of future microelectronic devices.

3. Preparation of Au nanomaterial particles

Currently, the main methods for preparing metal nanomaterials are physical, chemical and biological, depending on the experimental means. The physical method refers to the transformation of macroscopic materials into nano-sized materials by mechanical physical means, such as microwave method, mechanical grinding method [etc.; the chemical method refers to the chemical reduction reaction to make metal compounds into metal nanomaterials, such as co-chemical reduction method, photochemical reduction method and crystal seed method, etc.

3.1. Physical method

Physical preparation of metallic nanomaterials is the use of dispersion techniques to disperse metallic materials in a macroscopic sense, into nano- sized materials. Silver nanoparticles can be prepared by using laser ablation in the presence of surfactants. At the same time, using mechanical balls to grind several times, large metal crystals are ground into small metal crystals and then changed into nano-scale metal materials, and silver nanomaterials of 20 NM can also be prepared successfully. The microwave method was also able to synthesize gold nanoparticles. Physical method synthesis. The conditions of metal nanoparticles are harsh, but the synthesized metal nanoparticles have good stability and purity [5,6].

3.2. Chemical reduction method

Sodium citrate reduction is one of the classical methods for the synthesis of gold nanoparticles, and citrate is a weak protective agent that can be easily replaced by other ligands, so it can be used as other gold nanoparticle- based materials or molecular devices. Foreign researchers have successfully prepared gold nanoparticles by this method, the main principle of which is the protective reduction of tetra chloroauric acid by sodium citrate, further on the basis of which the concentration of fixedAu3+was found, and the size of gold nanoparticles was successfully regulated by adjusting the amount of sodium citrate added. In recent years, it has been shown that gold nanoparticles can be prepared from citrate by adjusting the time, pH, concentration and heating method. Inorganic salts that can be used to reduce chloroauric acid to synthesize gold nanoparticles also include boron.

Sodium hydroxide, sodium borohydride is somewhat more reductive than sodium citrate, and it is more reductive when used as a polymer or alkane smaller size gold colloids can be synthesized under the condition that the base thiol acts as a protective agent. agents and surface coating agents to prepare biocompatible gold nanoparticles, the stability of the gold nanoparticle colloids was significantly improved by cross-linking and amination of dextran to adapt them to biological coupling.

3.3. Crystalline growth method

The crystalline growth method uses two steps, crystalline synthesis and crystalline growth, to complete the synthesis of gold nanoparticles. Since the generation of new nuclei can be avoided during the growth of seed gold, the particle size distribution of this method is narrower than that of the one-step method. The crystalline seed generation method was used in the preparation of gold nanorods: first, the synthesis of crystalline seed solution, 0.60mLNasBH4 (0.01 mol/L) cold solution was added to a mixture of 0.25 mLHAuCl4 (0.01 mol/L) and 7.50 mL CTAB (0.1 mol/L) and left for 2 h for the next reaction ; followed by the preparation of crystal growth solution, 0.032 mL ascorbic acid (0.1 mol/L) was added to a mixture of 0.20 mLHAuCl4 (0.01 mol/L), 0.0.35mLAgNO3 (0.01 mol/L) and 4.75 CTAB (0.1 mol/L), and finally 0.020 mL of crystal seed solution was added to the above crystal growth solution, and the reaction was mixed for 30 s and then left for 5 h. The crystal seeds were grown into gold nanorods. The gold nanorods were grown.

4. Au nanoparticles for biomedical applications

Gold nanoparticles have prominent surface plasmon resonance properties, which is due to the interaction of incident light with the free electrons of gold nanoparticles: when the wavelength of incident light is resonantly coupled with the vibrational frequency of the free electrons, surface plasmon resonance will be generated. Moreover, depending on the shape and size of the nanoparticles, the degree of aggregation and the environment, the nanoparticles will have different colors depending on the wavelength emitted by the plasma oscillator. This provides a theoretical basis for the biomedical applications of nanoparticles such as biosensing and photographic imaging [7-9].

4.1. Gold nanoparticles for drug loading applications

Gold-based therapy has a long history, which is the natural excellence of gold and its mysterious effect caused by the application of medicinal effects.

Gold-based molecular compounds have been found to significantly limit the growth of HIV. Currently, gold nanoparticles carrying drugs are commonly used to target cancer cells. Radioactive gold seeds are implanted into the tumor to deliver radiation therapy to its interior for brachytherapy.

Very small diameter gold nanoparticles (capable of penetrating into cells and cellular compartments (e.g. nuclei). Gold nanoparticles with their non-toxic larger size surface modification reagents have bactericidal and cancer cell killing efficacy, and have the stress capacity to induce cellular oxidation, prompting interaction between damaged mitochondria and DNA. Photothermal therapy is the core application of gold nanoparticles in medical treatment. The ability of nanogold to absorb light energy converting it into heat and being used to destroy cancer cells and viruses is a fascinating property. Thus, laser-exposed gold nanoparticles can be used directly as therapeutic agents without the need for drug binding. Gold nanoparticles are highly efficient in absorbing electromagnetic waves in the near-infrared region, and the attenuation in biological fluids and tissues is extremely small. Also, the functional groups complexed or coupled with gold nanoparticles can be used in the therapeutic field. In some cases, some functional groups carrying drugs are adsorbed on the surface of gold nanoparticles, making the

gold nanoparticles passivated.

4.2. Gold nanoparticles as stabilizers for drug delivery

In addition to their potential for drug loading, gold nanoparticles are also used to stabilize the delivery of drug carriers, such as liposomes and microcapsules. Liposomes have been widely used as drug carriers, however, their poor anti-fusion stability and restricted release from plasma and other organs have limited their use and development. Foreign researchers have investigated the effect of nanoparticles on the stable delivery of phospholipids by demonstrating conclusively that the stable delivery of gel liposomes by nanoparticles can be observed with the aid of fluorescence and calorimetric instruments, i.e., by increasing the temperature by a few tens of degrees, the phase change sites of nanoparticles adsorb and stably deliver gel liposomes, and since only 25% of the nanoparticle outer surface is occupied by liposomes, the nanoparticles improve the stability of the liposomes without any leakage of payload. Gold nanoparticle-stabilized liposomes were used to selectively release antimicrobial agents to the infected sites. Functionalized gold nanoparticle chitosan was used to stabilize the liposomes and to block the solution Aggregation of nanoparticles. When nanoparticle-stabilized liposomes approach bacteria, the pores caused by bacterial toxins form a liposomal structure that facilitates the release of their payload.

4.3. Unique applications of gold nanoparticles in the medical field

The idea of gold nanoparticles delivering drugs to lesions has attracted the attention of many researchers, because it means that the smallest nanoparticles used in medical applications will greatly reduce drug side effects, and it means that localized highly concentrated therapeutic agents are targeted to desired target sites and their effective utilization will be greatly increased. Currently, there are two categories of applications in biomedical science.

Nanoparticle targeting technology:(i) passive targeting;(ii) active targeting. Based on the high permeability and retention effects of tumors, passive targeting Aggregation of nanoparticles toward the tumor site. The active targeting mechanism relies on tumor-targeting ligands modified on the surface of gold particles, commonly used are folic acid, epidermal growth factor receptors and their antibodies, which allow gold nanoparticles to enter cells, thus improving drug efficacy and reducing adverse effects [10].

5. Conclusion and outlook

Through recent studies, it can be seen that the preparation of gold nanoparticles is no longer done by a single method, but by a combination of various methods to prepare gold nanoparticles with excellent morphology and dispersion performance, which will be the development trend of gold nanoparticle preparation in the future. Due to the surface effect, small size effect, quantum size effect, macroscopic quantum tunneling effect and bioaffinity of nanoparticles, nanomaterials have good application prospects in the field of biomedicine, and gold nanoparticles themselves have special photoelectric properties, good biocompatibility and low toxicity, easy surface functionalization, and their characteristic plasmon resonance absorption in the visible region, and their plasmon resonance absorption Summit with the change of size and frequency shift, so gold nanoparticles can be applied to cancer therapy, biochemical analysis, biosensors and other medical.

Currently, the direct challenges to achieve clinical applications are: how to achieve reproducible scale mass production of nanoparticles, and also the need to reduce the circulatory reaction of the immune system with gold nanoparticles, enhance the localization selectivity of gold nanoparticles, and develop strategies to significantly improve the efficient transport of gold nanoparticles. As gold nanoparticles transition from benchtop to clinic, researchers will also study the fundamental interactions between related nanomaterials and biological systems. We look forward to reports of new functions and properties of nanomaterials and new insights into biomedicine from researchers. We will further follow up the new applied research of nanomaterials in the medical field and review the relevant research results in return for nanobiotechnology. We have more expectations for the golden age of gold nanoparticles in biomedical applications.

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