Self-assembly of plasmonic nanoparticles in supramolecular gels

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ABSTRACT

Nanoparticles constitute a considerable field of research in today's world. Their unusual properties combined with their small size distinguish them from bulk materials. One of the most interesting phenomena related to nanoparticles is localized surface plasmon resonance (LSPR). What is more, to achieve superior optical properties caused by LSPR, we can self-assembly nanoparticles in highly ordered structures. A new idea for achieving these structures is creating helical structures in supramolecular gels.

MAIN OBJECTIVES OF THIS PROJECT

- Optimisation of synthesis methods for obtaining monodisperse, spherical gold nanoparticles, about 15 nm in diameter,
- Synthesis of a chemical compound which can form chiral, supramolecular gels,
- Obtaining helical, chiral materials consisting of spherical, gold nanoparticles and supramolecular gels.

ORGANIC SYNTHESIS

The first stage of our work was the synthesis of 4,4',4''-[1,3,5-benzenetriyltris(carbonlimino)]trisbenzoic acid methyl ester, a derivative of compounds which are known in literature to create chiral supramolecular gels[1,2]. The synthesis was conducted in accordance with the regulations available in the literature [3,4]. The process was divided into two stages. First lead to obtain 1,3,5-benzenetricarbonyl trichloride in a reaction between trimesic acid and thionyl chloride. Secondly, by acylating the amine with an acid chloride, the final product was made.

^{1}H NMR (500 MHz, DMSO 25 °C, TMS): δ = 3.859 (s, 9 H), 8.012 (s, 12 H), 8.760 (s, 3 H), 10.910 (s, 3H)

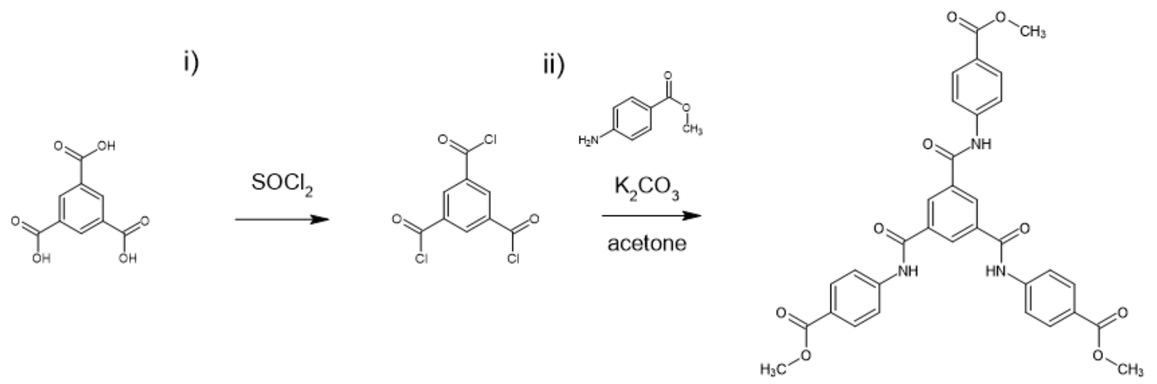
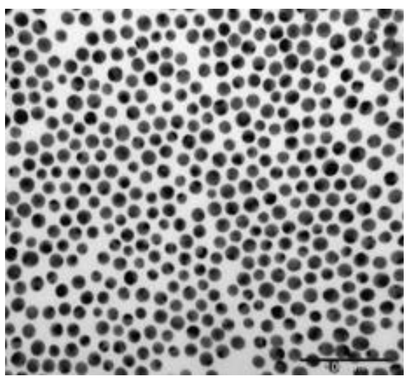


Fig. 1. Synthesis of 4,4',4''-[1,3,5- benzenetriyltris(carbonlimino)]trisbenzoic acid methyl ester.

NANOPARTICLE SYNTHESIS

a)



b)

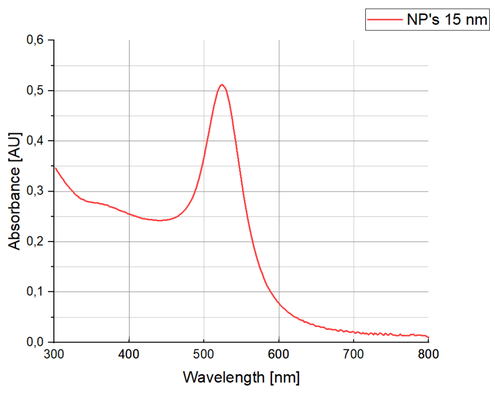
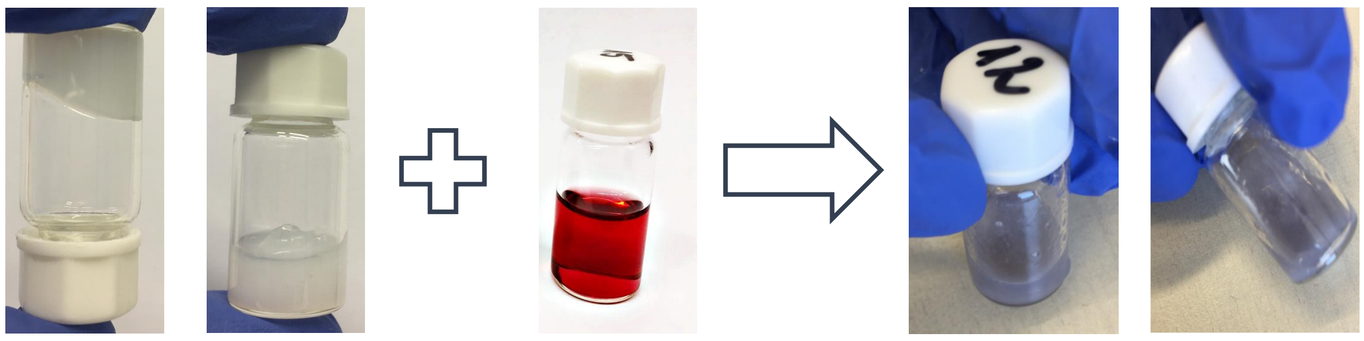


Fig. 2. TEM image (a) and UV-vis absorption spectra (b) of obtainded gold nanoparticles.

The next objective of our research was the synthesis of spherical, gold nanoparticles, about 15 nm diameter. To prepare them, methods described in the literature[5] were used. The advantage of this synthesis was that, only three reagents were needed. The precursor of gold atoms was tetrachloroauric acid, while the reducing agent was oleylamine at high temperature. As a solvent, toluene was added. Afterwards, transmission electron microscopy (TEM) was used to determine the morphology of prepared nanoparticles (Fig. 2a). Additionally, the optical properties of obtained nanoparticles were measured with ultraviolet-visible spectroscopy (UV-vis) (Fig. 2b).

SUPRAMOLECULAR GELS WITH NANOPARTICLES

The main purpose of this work was to create hybrid materials made from gold nanoparticles and supramolecular gels. According to the methods described in the literature[2,6], we developed approach to obtain stable supramolecular gels consisting of 4,4',4''-[1,3,5-benzenetriyltris(carbonlimino)]trisbenzoic acid methyl ester. In the process of gelation, the dimethylformamide (DMF) and water in right proportions were used. To obtain stable gels, appropriate amount of nanoparticles was added. It was observed that mixing nanoparticles with gel spoils its structure only to a small extent, the gel becomes more fluid.



GEL **NANOPARTICLES** **GEL WITH NANOPARTICLES**

Fig. 3. The proces of obtaining supramolecural gel with gold nanoparticles.

CONCLUSION

As part of this research, materials consisting of spherical, gold nanoparticles and supramolecular gels, were obtained. The next stage of this research will be to explore their chiral properties using circular dichroism spectroscopy. The foregoing results are a great motivation to self-assembly various types of nanoparticles by using organic matrices made from supramolecular gels.

LITERATURE

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