SYNTHESIS OF HIGHLY SERS ACTIVE GOLD NANOPARTICLES REDUCED BY GLUCOSE AT ROOM TEMPERATURE

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Introduction

Nanoparticle synthesis has become an important multidisciplinary research area in recent years due to the wide array of uses that nanoparticles can provide. Various types of nanoparticles, be them of different sizes, different shapes or even different materials can have a multitude of bio-medical applications due to their unique, specific properties.

Gold nanoparticles in particular present several properties that offer them a great advantage over other types of nanoparticles, especially in biological applications, the most notable ones being their reduced reactivity and their specific electromagnetic radiation absorbance range. Gold nanoparticles are also invaluable in SERS spectroscopy as they, alongside silver nanoparticles, provide an increased Raman signal amplification.

Therefore, there is an increasing interest in the use of gold nanoparticles for a variety of biological applications including their use as contrast agents, delivery vehicles and therapeutics [1].

Aim

The aim of this research was to develop a novel method of synthesizing gold nanoparticles that can be used for the applications mentioned above. An important feature of this type of nanoparticles is their biocompatibility, thus choosing the synthesizing agents becomes an important task.

The here proposed nanoparticles are therefore coated in glucose, which is a polysaccharide that is actively sought out by cells. This should also give these nanoparticles the ability to be internalized more easily by most cells [2].

The big interest in glucose as a reducing agent also comes from the fact that glucose can be easily substituted by much stronger ligands such as amines, amides, albumin and sulfur-containing compounds, giving the nanoparticles a great advantage with regards to SERS detection of other molecules [3].

Discussions

As it can be seen from the accompanying UV-Vis spectra, the nanoparticles are reproducible with slight variations in their morphology from one preparation to another (Fig. 1).

Transmission electron microscope (TEM) images (Fig. 2) show that the as synthesized nanoparticles are spherical and have a mean diameter of 8.5 nm. TEM images also show the range of diameters from within the sample (Fig. 3), which accompanied by DLS measurements (Fig. 4) imply a narrow size distribution with nanoparticles ranging from 7 nm to 10 nm through the entire colloid. As such, the synthesis at room temperature had no negative effect on the size distribution of the nanoparticles, with the colloid forming almost instantly.

The SERS spectra (Fig. 5) shows that the as synthesized nanoparticles are highly SERS active, allowing detection of a large number of analytes such as rhodamine 6G, crystal violet chloride, cresyl violet chloride, rose bengal and 4-(2-pyridylazo)resorcinol (PAR) Cu(II) complex in micromolar concentrations. As such, the nanoparticles are comparable to most conventional colloids.

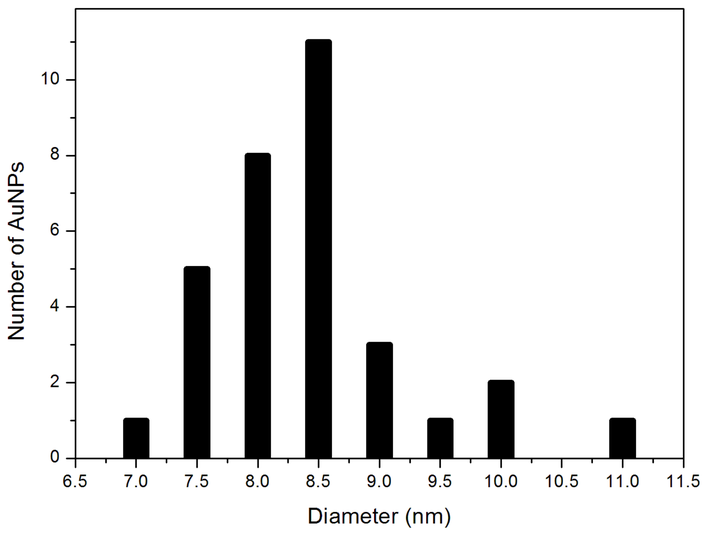

Fig. 3 Distribution of nanoparticle diameters gathered from TEM micrographs of the nanoparticles

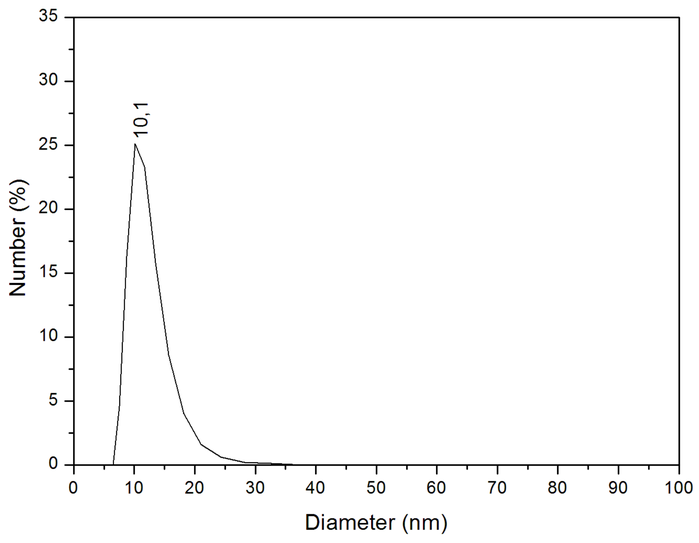

Fig. 4 DLS spectra of the as synthesized nanoparticles showing size distribution throughout the whole colloid

Conclusions

The as synthesized nanoparticles have proven to be highly SERS active and given their glucose coating and use of entirely biocompatible reaction agents, they should be highly biocompatible.

The properties mentioned above, coupled with the high functionalization rate of other ligands enable the nanoparticles to provide a viable method for bio detection by means of SERS spectroscopy.

Acknowledgement

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References

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2. Liu, J.; Qin, G.; Raveendran, P.; Ikushima, Y. *Chem. Eur. J.* **2006**, *12*, 2131.
3. Ishizaka, T.; Ishigaki, A.; Kawanami, H.; Suzuki, A.; Suzuk, T.M. *Journal of Colloid and Interface Science* **2012**, *367*, 135–138.

Results

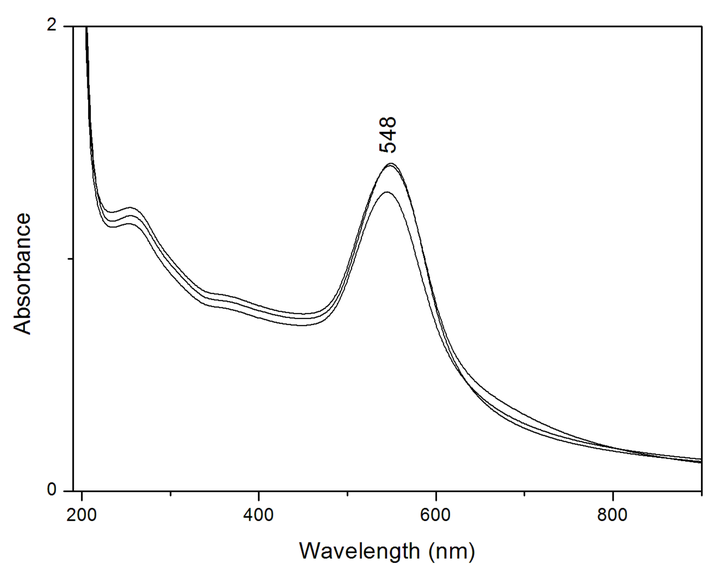

Fig. 1 UV-Vis spectra of the as synthesized nanoparticles

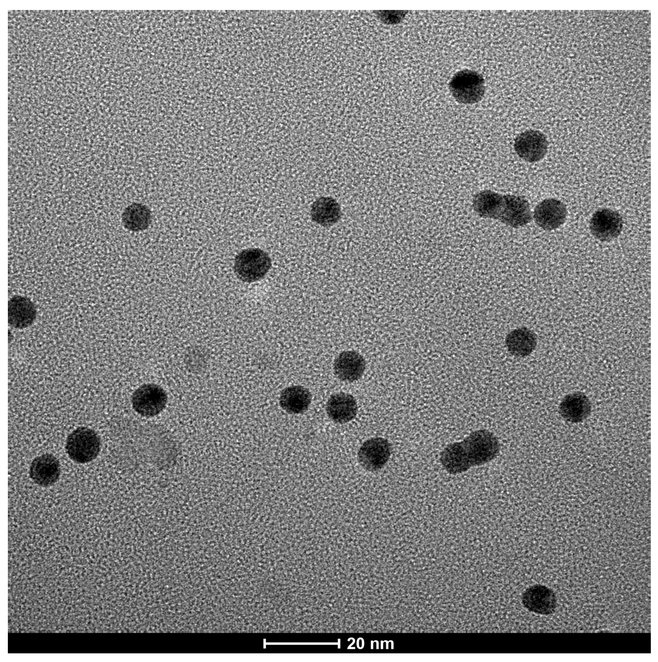

Fig. 2 TEM micrograph of the nanoparticles

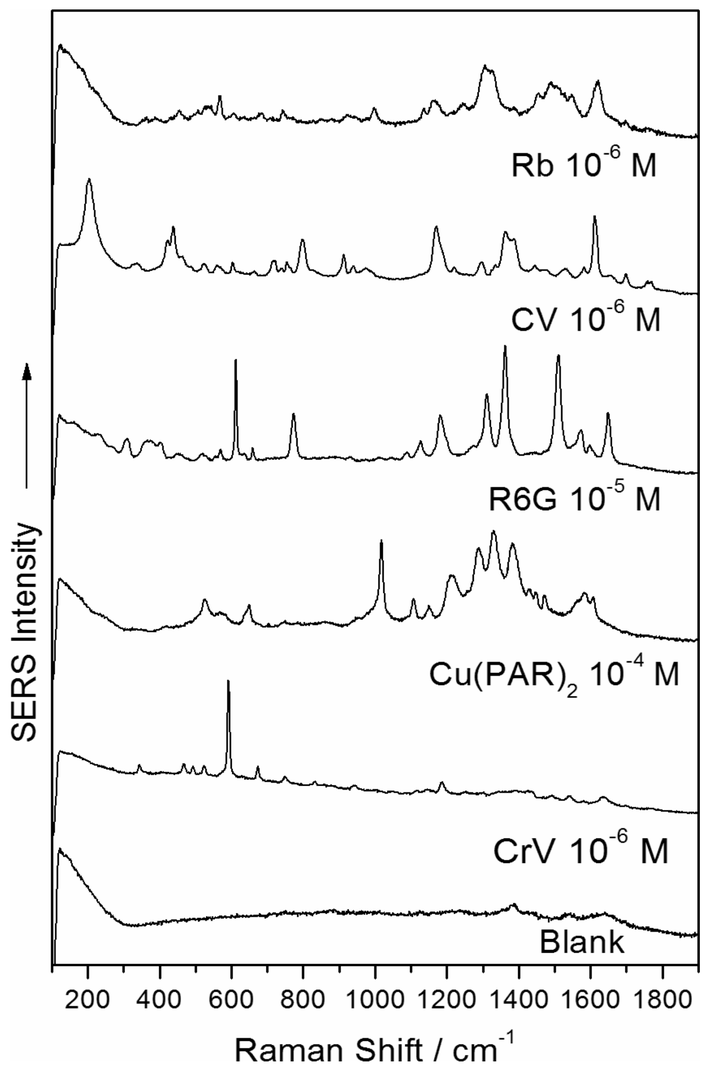

Fig. 5 SERS spectra of several analytes in micromolar concentrations with the as synthesized nanoparticles acting as a substrate