SYNTHESIS OF POPCORN SHAPED NANOPARTICLE ASSEMBLIES

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Introduction

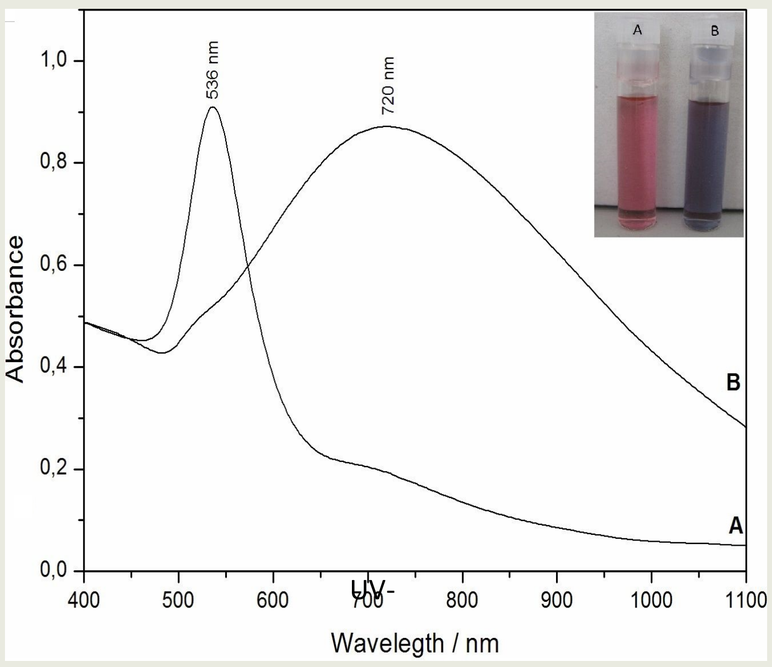
In recent years metal nanoparticle synthesis has evolved substantially, now being possible to control their shape, size and surface chemistry. Gold nanoparticles are one of the most important types of nanoparticles with biomedical application, due to their utilization in live tissue as contrast agents, delivery vehicles, therapeutics etc [1]. Nanoparticles are known to self-assemble into larger structures during the growth processes, which are governed by a delicate balance between electrostatic repulsion and Van der Waals attraction [2]. Many nanoparticle superstructures with new properties and applications have been developed, mimicking the behavior of efficient natural machines (e.g., enzymes, proteins, biopolymers, or viruses) [3].

Methods & Materials

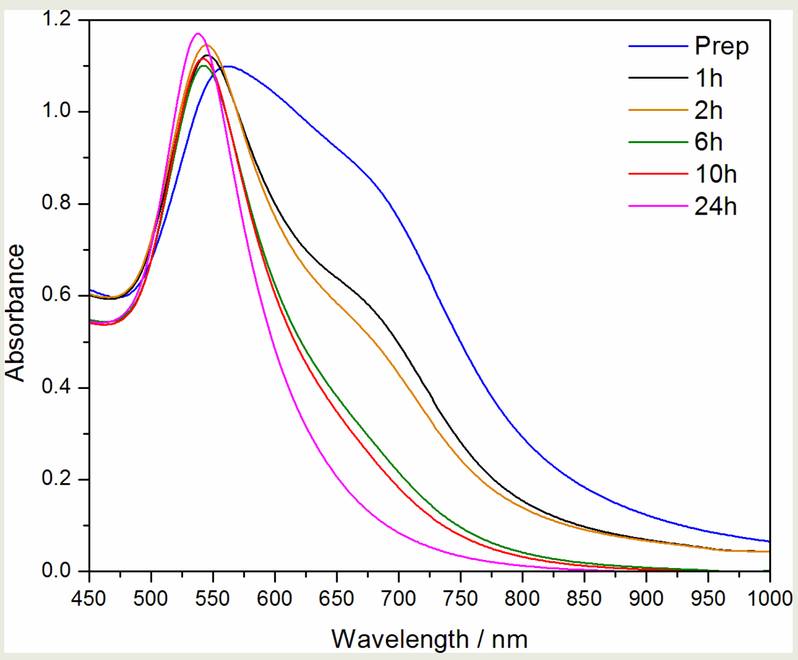
A novel synthesis approach for gold nanoparticles assemblies (NPAs) at room temperature is proposed in this study. The nanoparticles were prepared at room temperature using hydroxylamine as reducing agent. By varying the experimental conditions, their size can be controlled between 20 and 120 nm. The characterization of the nanoparticles were carried out by using UV-Vis, TEM and surface-enhanced Raman scattering (SERS) spectroscopy.

Results

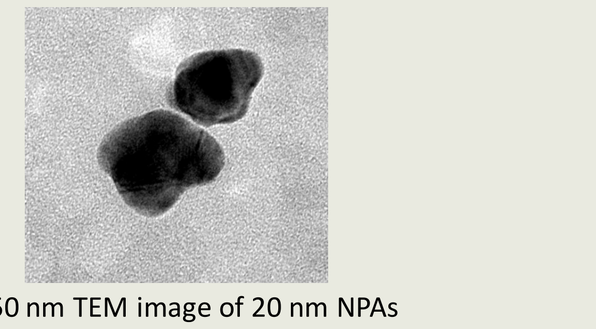
SEM and TEM measurements revealed a popcorn-like shape of the NPAs . The NPAs of the size of 20 and 120 nm show absorption maxima at 536 and 720 nm, respectively. The 20 nm NPAs have shown an at least ten times higher surface-enhanced Raman scattering (SERS) activity than the conventional citrate reduced gold nanoparticles.



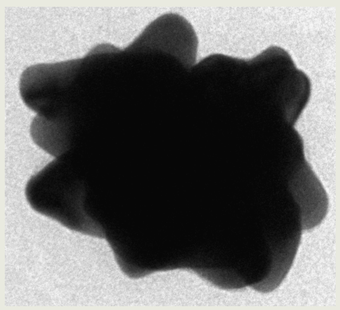
UV-Vis spectra of hydroxylamine reduced GNPs, accordingly to 20nm NPA and 120 nm NPA. The inset image shows a picture of the two colloids



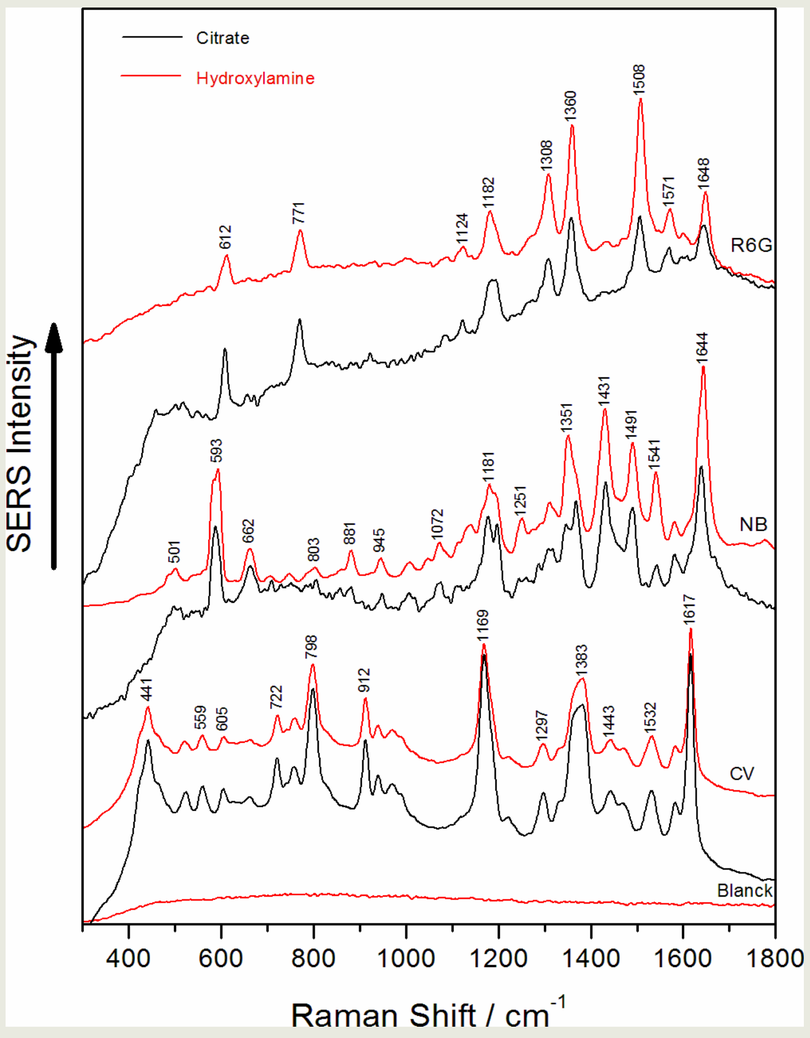
UV-Vis spectra of the 20 nm NPAs at different phases of the reduction process.



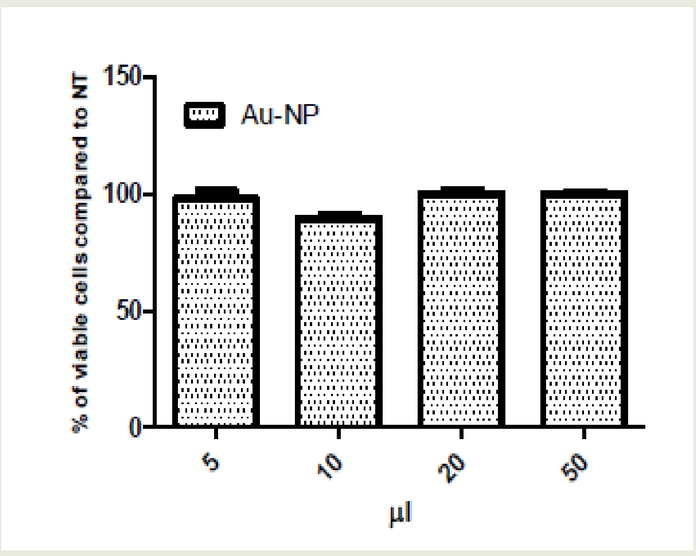
50x50 nm TEM image of 20 nm NPAs



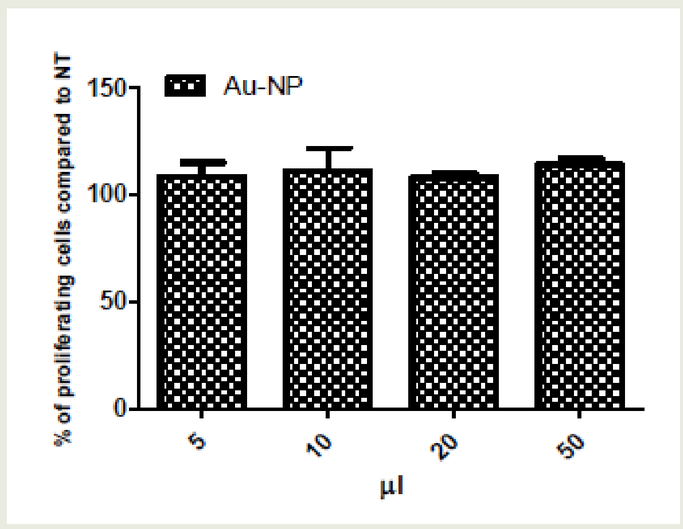
100x100 nm TEM image of 120 nm NPAs



SERS spectra of Crystal Violet (CV), Niel Blue (NB) and Rhodamine 6G (R6G) obtained by using hydroxylamine (h) (CV 10^{-7}M, NB $5x10^{-7}$M, R6G 10^{-7}M) and citrate (c) (CV 10^{-6}M, NB 10^{-6}M, R6G 10^{-6}M) reduced gold colloids.



Cytotoxicity test of the 120 nm NPAs



Proloferation test of the 120 nm NPAs

Conclusion

The possibility to modify the surface with highly biocompatible molecules, the proposed gold nanoparticles could become important transporting vehicles for drugs like heparin and C-reactive protein. Furthermore, due to the fact that these nanoparticles can be functionalized with different ligands and their absorption maximum is in the NIR region they should provide a viable option for photothermal therapy too.

Acknowledgements

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References

[1] E. C. Dreaden, et al., Chemical Society Reviews 41, 2740-2779 (2012).
[2] Y. Xia, et al., Nature Nanotechnology 6, 580-587 (2011).
[3] B. Pelaz et al., ACS Nano 6, 8468-8483 (2012).