Synthesis of luminescent gold nanoclusters

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Introduction

Gold nanoparticles (GNPs) are widely used in biomedicine as agents for imaging, photothermal therapy, and drug delivery. A large variety of applications of GNPs is based on their unique physical and chemical properties such as surface plasmon resonance as well as clusterization effect, which causes the photoluminescent properties.

The luminescent gold nanoclusters can be obtained from chloroauric acid and biologically active agent of bovine serum albumin (BSA). BSA forms a shell around the inorganic aurum core, which makes it possible to obtain nanoclusters with luminescence properties in the long-wave area. Therefore, BSA contains a lot of functional groups that can be efficient for further surface functionalization of clusters, and their application in chemical analysis.

Synthesis of gold nanoparticles samples

In our work, we used chloroauric acid and BSA for luminescent gold nanoclusters formation at different synthetic conditions. We explored thermal synthesis at 100 and 37ºC with a time of 0.5-1 and 12 hours, respectively.

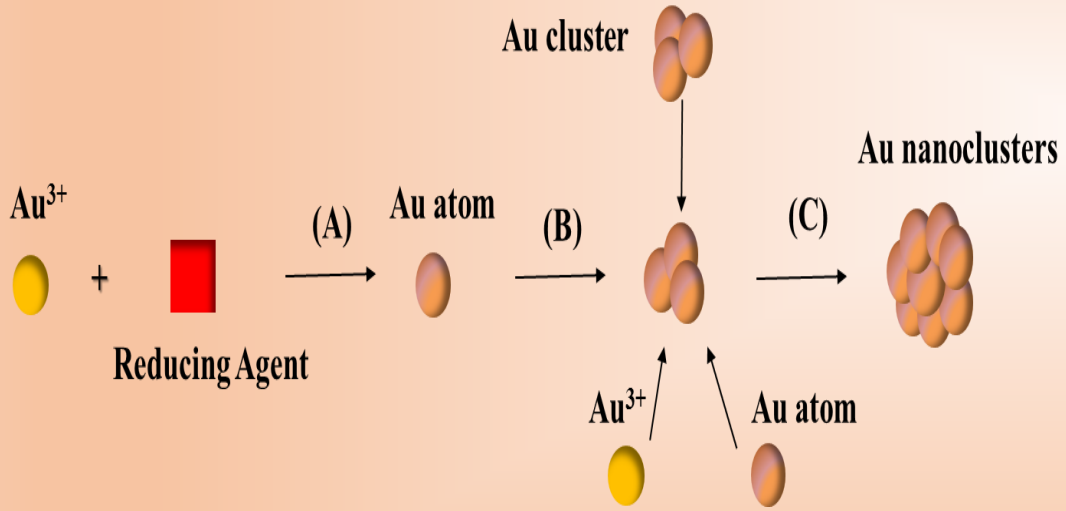
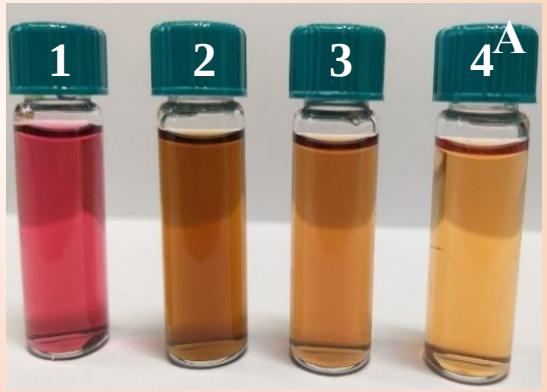


Fig. 1. Scheme of luminescent gold nanoclusters formation



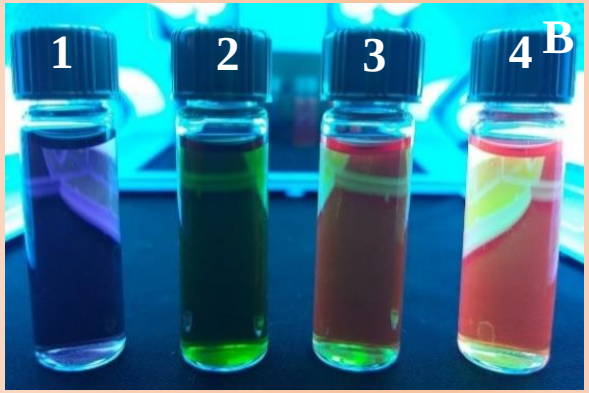


Fig. 2. Solutions from left to right: 1 – GNPs reduced with sodium citrate, gold nanoclusters clusters: 2 – 60 min, 100 ^{0}C; 3 – 30 min 100 ^{0}C; 4 – 12 h, 37 ^{0}C at daylight (A) , in UV-lamp (λ_{ex} ~ 365 nm) (B)

Results

Solutions: 1 – GNPs reduced with sodium citrate, gold nanoclusters clusters: 2 – 60 min, 100 ^{0}C; 3 – 30 min 100 ^{0}C; 4 – 12 h, 37 ^{0}C

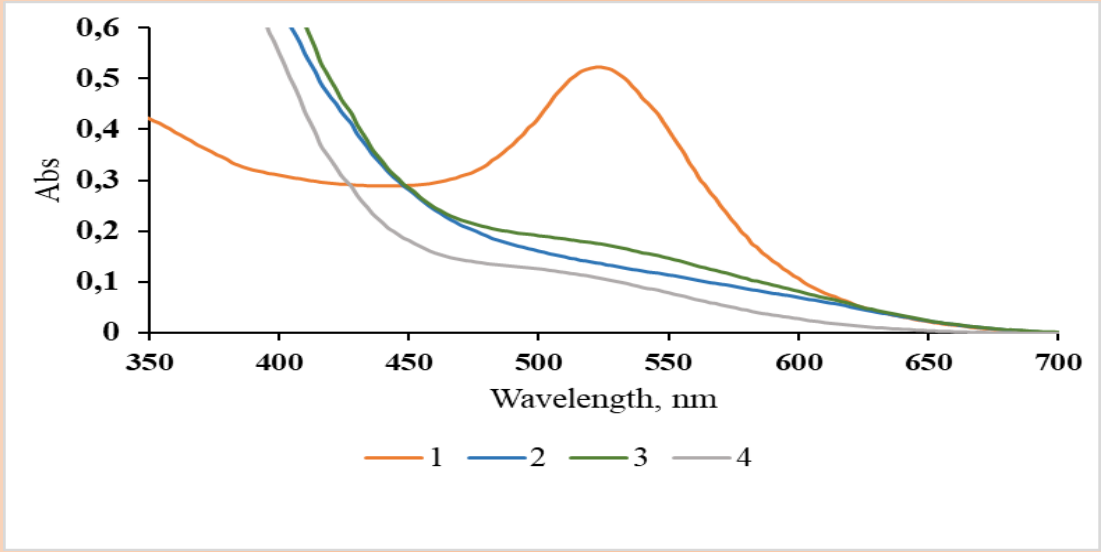


Fig. 3. Absorption spectra of samples 1-4

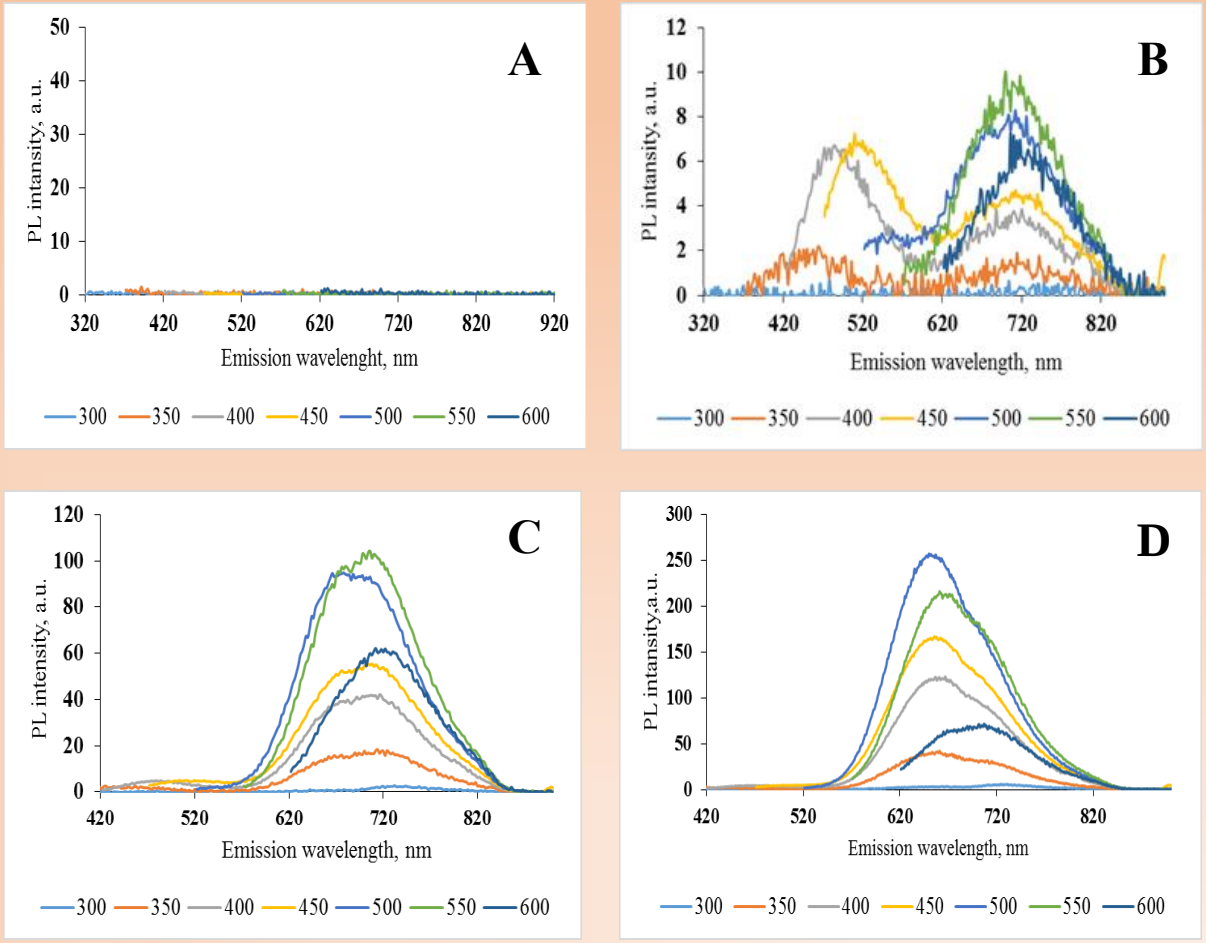


Fig. 4. Emission spectra at different excitation (300-600 nm) of 1 (A),2 (B), 3 (C) and 4 (D) samples

Results

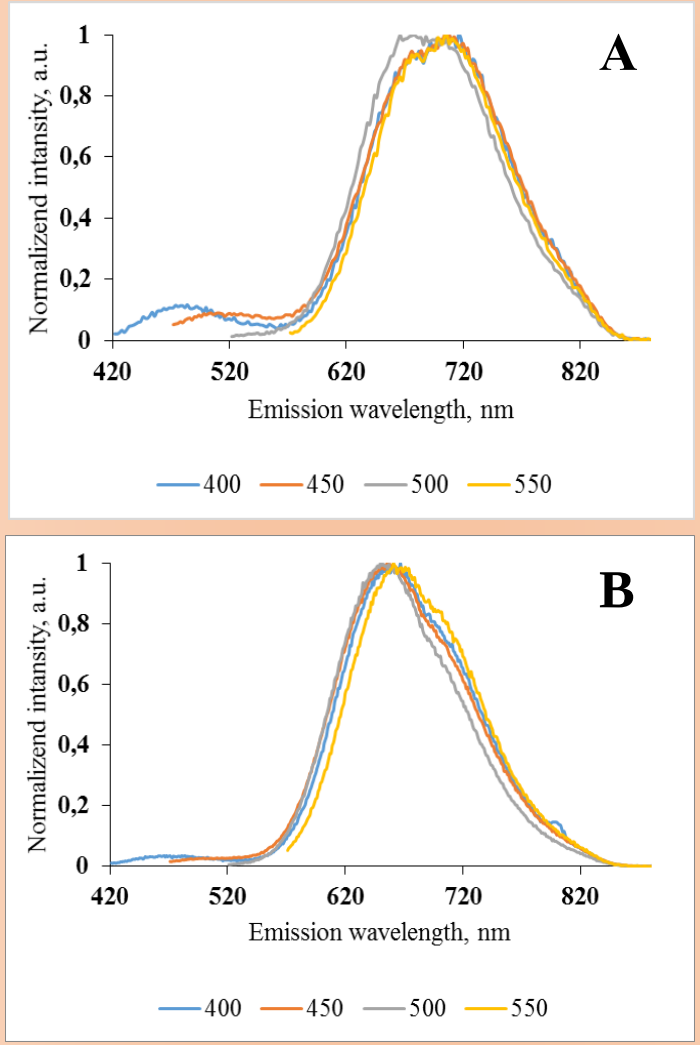


Fig. 5. Normalized emission spectra of samples 3 (A) and 4 (B)

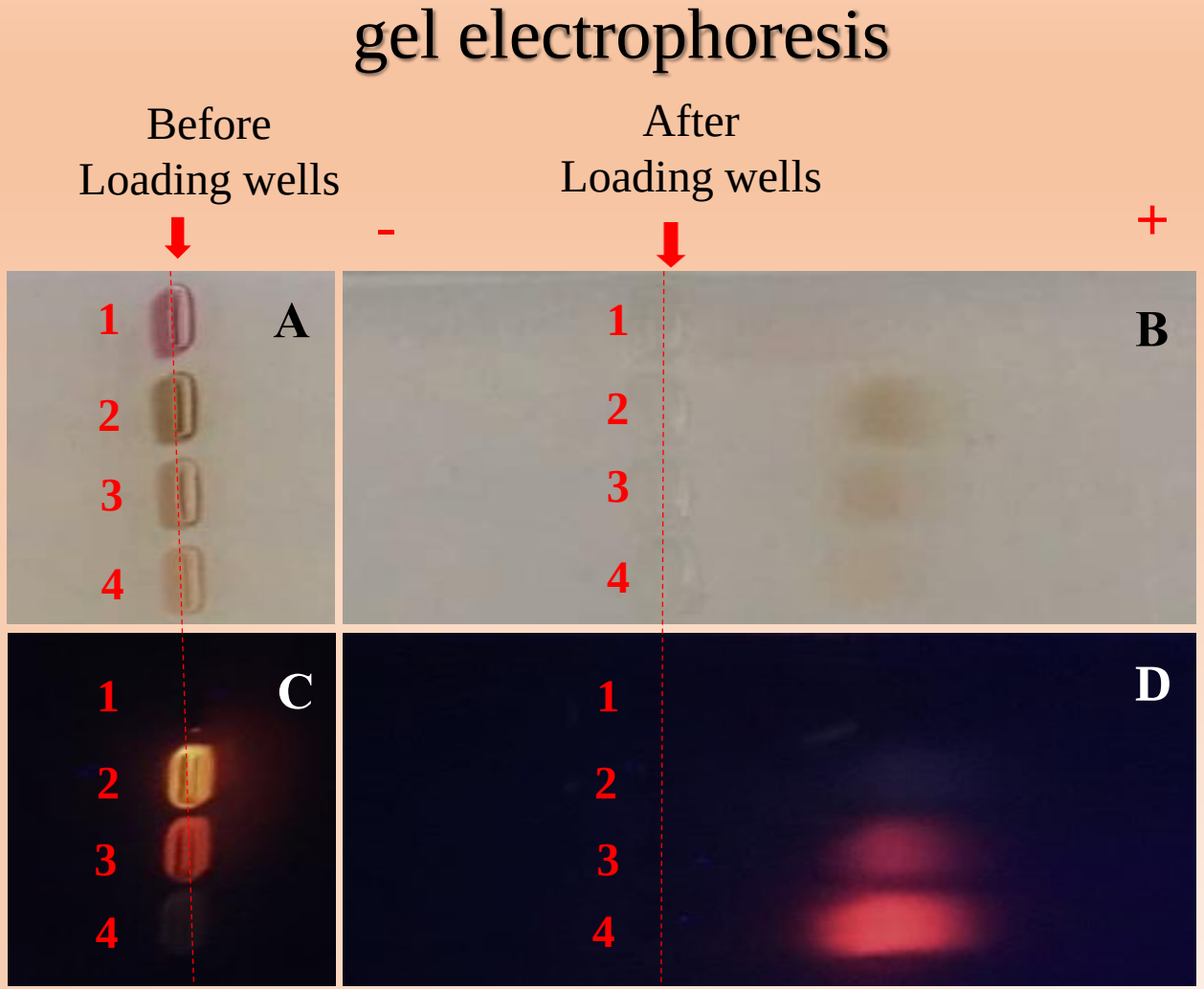
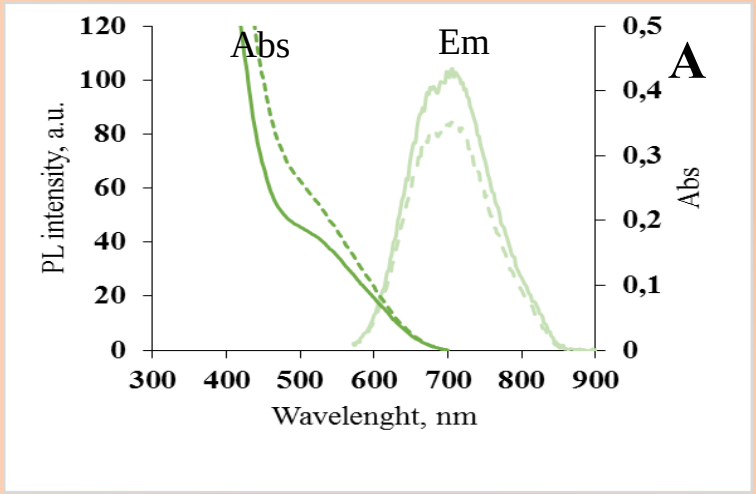


Fig. 6. Samples in daylight and UV-lamp ($\lambda_{ex} \approx 365$ nm) before (A, C) and after gel electrophoresis (B, D) from top to bottom: samples 1, 2, 3, 4

Results



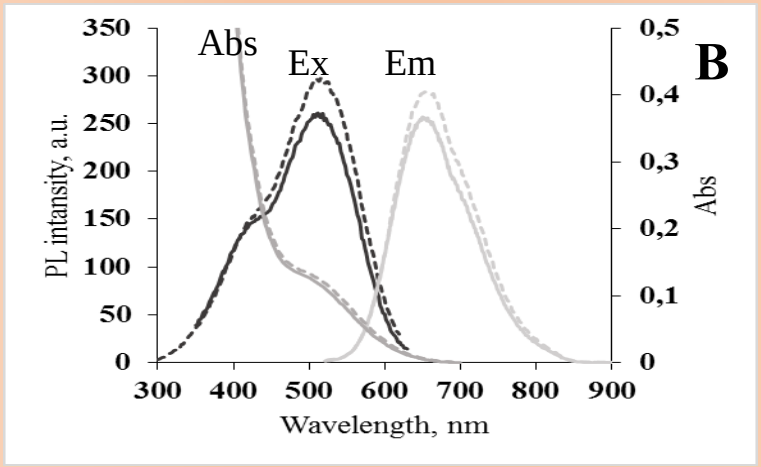


Fig. 7. Absorption, excitation, and emission spectra of samples 3 (A) and 4 (B). Solid line – sample after synthesis, dotted line – after 60 days.

№ Samples	QY, % Samples after synthesis	QY, % Samples after 2 months
3	4±1	2±1
4	10±2	9±2

Fig. 8 – Values of the relative quantum yields

Conclusion

In the work, luminescent gold nanoclusters were obtained by three methods. The optimal synthetic conditions were heating at 37^0C for 12 hours. The luminescent nanoclusters had the highest luminescence at 650 nm and a few size distribution that was proved by the luminescence and gel electrophoresis methods. The nanoclusters had a negative charge. The quantum yield was 10±2 %, which decreased by 5% over 60 days of storage at 4 ^{0}C.

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