Tanino rūgšties ir trinatrio citrato santykio įtaka pusiau monodispersinių sidabro nanodalelių augimo kinetikai

Dependence of semi-monodispersed silver nanoparticles growth kinetics on tannic acid and trisodium citrate ratio

Nadzeya Khinevich[1,3], Asta Tamulevičienė[1,2], Sigitas Tamulevičius [1,2]
[1]Kauno technologijos universitetas, Medžiagų mokslo institutas, K. Baršausko g. 59, LT-51423, Kaunas
[2]Kauno technologijos universitetas, Matematikos ir gamtos mokslų fakultetas, Studentų g. 50, LT-51368, Kaunas
[3]UAB „Nanoversa", K. Baršausko g. 59, LT-51423, Kaunas

nadzeya.khinevich@ktu.lt

Silver nanoparticles are widely used in different fields from biosensing to electronics due to their optical and electrical properties [1]. The control of the monodispersity is important in experiments employing metal colloids, as a film or assembly. The standard procedure to synthesize silver nanoparticles reduction of silver nitrate with trisodium citrate (TC) which serves as stabilizer as well. The drawback of this simple route is that the dispersion of sizes is quite wide. It was shown that combination of trisodium citrate with tannic acid (TA) provided the synthesis of monodispersed silver nanoparticles [2].

In this work, we studied the effect of TA/TC ratio in the step of seeds preparation that are further used in the growth of the silver nanoparticles.

The synthesis of nanoparticles consisted of two steps. At first, seeds were prepared using a solution consisting of silver nitrate in concentration of 0.25 mM, 0.05 mM TC and TA were added to get TA/TC ratio from 0.02 to 0.5. The second step was initiated to grow nanoparticles based on seeds solution. For the growth step, 36 ml of aqueous solution consisting of 1.5 ml of 2.5 mM TA, 1 ml of 25 mM $AgNO_3$ and 19.5 ml seeds were used. Seeds solution was heated to 90°C, and other components were added consistently at vigorous stirring. This process was repeated five times with each seed solution. The optical properties and the kinetics of nanoparticles growth were studied.

Using the described procedure, we were able to get nanoparticles with the mean diameter of 20 nm – 270 nm and the standard deviation of 3% - 40% depending on the growth step.

The absorbance spectra of seeds solutions formed at different TA/TC ratios are presented in Figure 1. With the increase of TA/TC ratio, the absorbance peak shifted from 406 nm to 430 nm and the peak's width increased. Rising the TA concentration during the seed's synthesis led to the increase of the average nanoparticles' diameter from ~20 nm to ~60 nm, and at the same time, their standard deviation of size distribution rose from 3% to 13%.

We determined that the rate of nanoparticle growth is highly dependent on the initial size of the seeds. When the nanoparticle growth starts from the smaller sized seeds (~20 nm diameter), the growth is slower and the final size of nanoparticles after 5 stages of growth is 70 nm. In the case of bigger seeds (~60 nm diameter) after 5 stages of growth the nanoparticles were 270 nm in diameter. Changing the TA/TC rate during the synthesis of seeds and the number of nanoparticle growth steps we can vary the final size of the nanoparticles in a wide range with a predefined size distribution if necessary to form monodispersed silver nanoparticles.

This methodology already showed their efficiency for silver nanoparticle fabrication with precisely defined mean diameter and size distribution sufficient for particle self-assembly on the template [3].

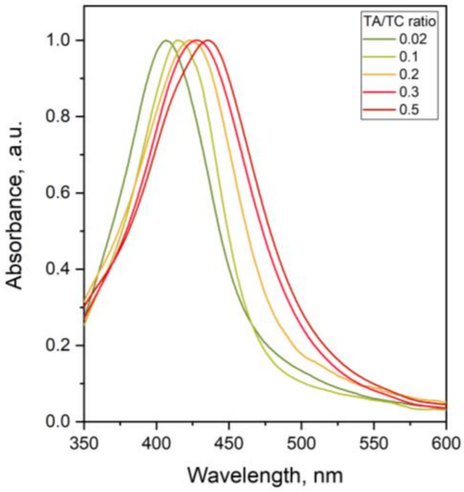

Fig. 1 Absorption spectra of seeds solutions prepared using different TA/TC ratio

Keywords: silver nanoparticles, chemical synthesis.

This research project is funded under the 2014–2020 Operational Programme for the European Union Funds' Investments under measure No. 01.2.2-MITA-K-702 "Promoting the Commercialization and Internationalization of R&D Results"

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