Įvairių formų aukso nanodalelių dinaminių plazmoninių savybių tyrimas skirtuminės sugerties spektroskopijos metodu

The investigation of dynamic plasmonic properties of various shape gold nanoparticles employing transient absorption spectroscopy

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The plasmonic metal nanoparticles due to their localized surface plasmon resonance (LSPR) properties have shown great promises in various electro-optical applications like sensors, solar cells, photocatalysis, medicine, etc. [1]. The practical use of these nanoparticles depends on the metal, their shape, size, and their homogeneity. At the moment, gold nanoparticles show the best promises for practical applications, due to their great stability and well-developed synthesis procedures. The advanced synthesis methods of gold nanoparticles allow preparing high-quality nanoparticles of various shapes like spheres, nanorods, bipyramids, decahedra, etc. [1].

In our research, we have demonstrated the transient absorption spectroscopy (TAS) method as a perspective tool for the analysis of plasmonic and optomechanical properties of various size/shape gold nanoparticles. In addition to the TAS measurements, we have used steady-state UV-VIS absorption, and transmission electron microscopy (TEM). We have analyzed gold nanoparticles of different shapes like nanorods, decahedra, and spheres (Fig. 1 a, d, c) prepared by methods of wet chemical synthesis and demonstrating different absorption spectra due to localized surface plasmon resonance (Fig. 1 b, e, h).

According to the TAS measurements for the gold nanoparticles, there are two absorption peaks in the case of Au nanorods (515 and 720 nm) (Fig. 1 b) and two negative peaks in TAS spectra (520 and 710 nm) (Fig. 1 c), similarly to the LSPR absorption spectrum. One can see as well that decahedra have one negative TAS peak at 572 nm and one steady-state absorption peak at 572 nm (Fig. 1 e, f). While nanospheres have two peaks in TAS spectra (530 and 700 nm) and only one peak in a steady-state absorption spectrum (525 nm) (Fig. 1 h, i). One could expect that Au nanospheres should produce only one negative TAS peak at around steady-state absorption spectra peak [2]. On the other hand, in Fig. 1 g one can see that besides Au nanospheres some nano rod-like nanoparticles are present. We suggest that these nano rod-like structures (Fig. 1 g) are responsible for the recorded negative TAS signal at around 700 nm in Fig. 1 i. According to the TAS measurement data, this method is much more sensitive to the shape of Au nanorods in comparison to the steady-state absorption (Fig. 1 h) which shows no peak of absorption at 700 nm. All in all, the TAS was found to be an efficient technique for the detection of small amounts of Au nanorods in the sample where Au nanospheres dominate.

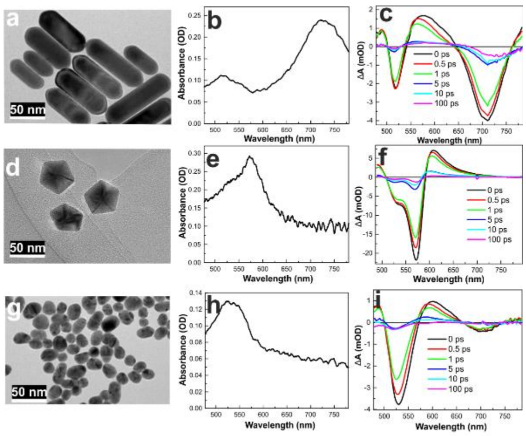

Fig. 1. TEM, UV-VIS absorption and TAS spectra measured under excitation at 350 nm of Au nanorods (**a**, **b**, **c**,), Au high-quality decahedra's (**d**, **e**, **f**,) and our Au nanospheres (**g**, **h**, **i**).

This research has shown that TAS can be an effective tool for shape analysis and control of spherical Au nanoparticles.

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Keywords: Au nanospheres, Au nanorods, transient absorption spectroscopy, localized surface plasmon resonance, optomechanical oscillations.

References

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