Optimization of bimetallic nanoparticle morphology for plasmon-induced polymerization

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Idea: investigate the possibility of influencing polymerization processes by controlling plasmonic heating of spherical bimetallic nanoparticles by changing their geometric parameters and/or morphology.

It is known that the polymerization of organic substances containing metal nanoparticles occurs due to their plasmonic heating. Therefore, the study of the frequency and size dependences of the heating of bimetallic nanoparticles is of great interest for solving practical problems of plasmon catalysis.
The frequency dependences of the heating of Au@Ag particles are shown in Fig. 1. The indicated dependences have two maxima in the visible and ultraviolet spectral ranges. Since the heating of nanoparticles is proportional to the absorption cross section, the indicated maxima correspond to the surface plasmon resonance (SPR) frequencies. With the growth of the core radius (a sequence of curves 1 → 2 → 3), there is an increase in the maximum value of the warm-up and a "red" shift of the maximum itself. In turn, with an increase in the thickness of the shell (a sequence of curves 2 → 4 → 5), the maximum heating value also increases, but there is a "blue" shift of the maximum. In fig. 2 shows the dependences of the heating on the volume content of the core metal on the SPR frequency from the optical region of the spectrum for bimetallic nanoparticles of different compositions. The type of these curves significantly depends on the composition of the nanoparticles, which indicates the possibility of controlling the heating of the particle by changing the radius of the core and the thickness of the shell, as well as their elemental composition.

Summary: It is shown that the spectral features of the heating of bimetallic nanoparticles coincide with the spectral features of the absorption cross section. It has been established that the heating of bimetallic nanoparticles significantly depends on the volume content of the core material and its elemental composition, which indicates the possibility of controlling plasmon heating and, accordingly, polymerization processes.

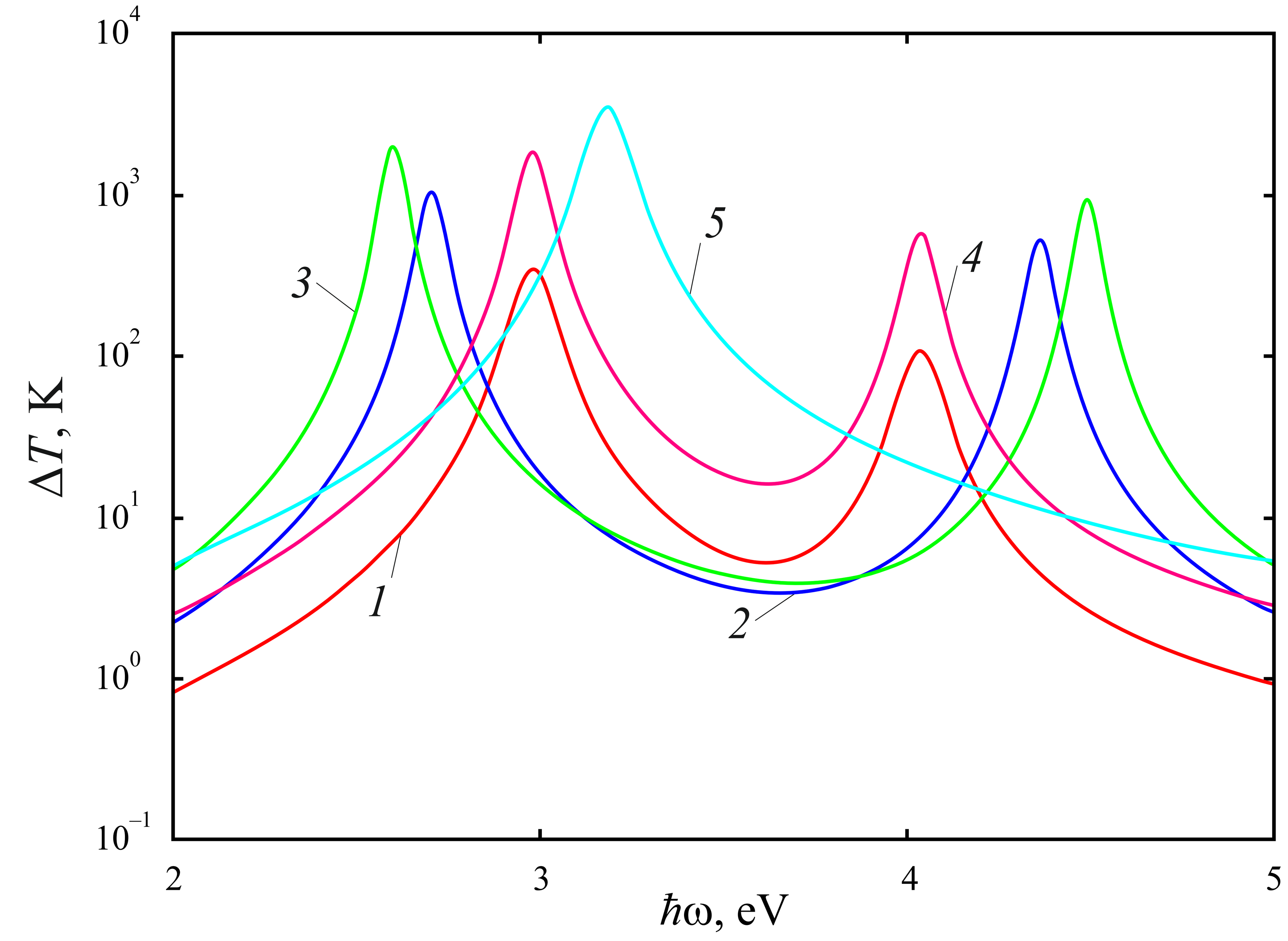

Fig. 1.The frequency dependencies for the heating of the neighborhood of the nanoparticle under the different radii of the core and the thicknesses of the shell: *1* – R_c = 10 nm, t = 5 nm; *2* – R_c = 20 nm, t = 5 nm; *3* – R_c = 30 nm, t = 5 nm; *4* – R_c = 20 nm, t = 10 nm; *5* – R_c = 20 nm, t = 20 nm.

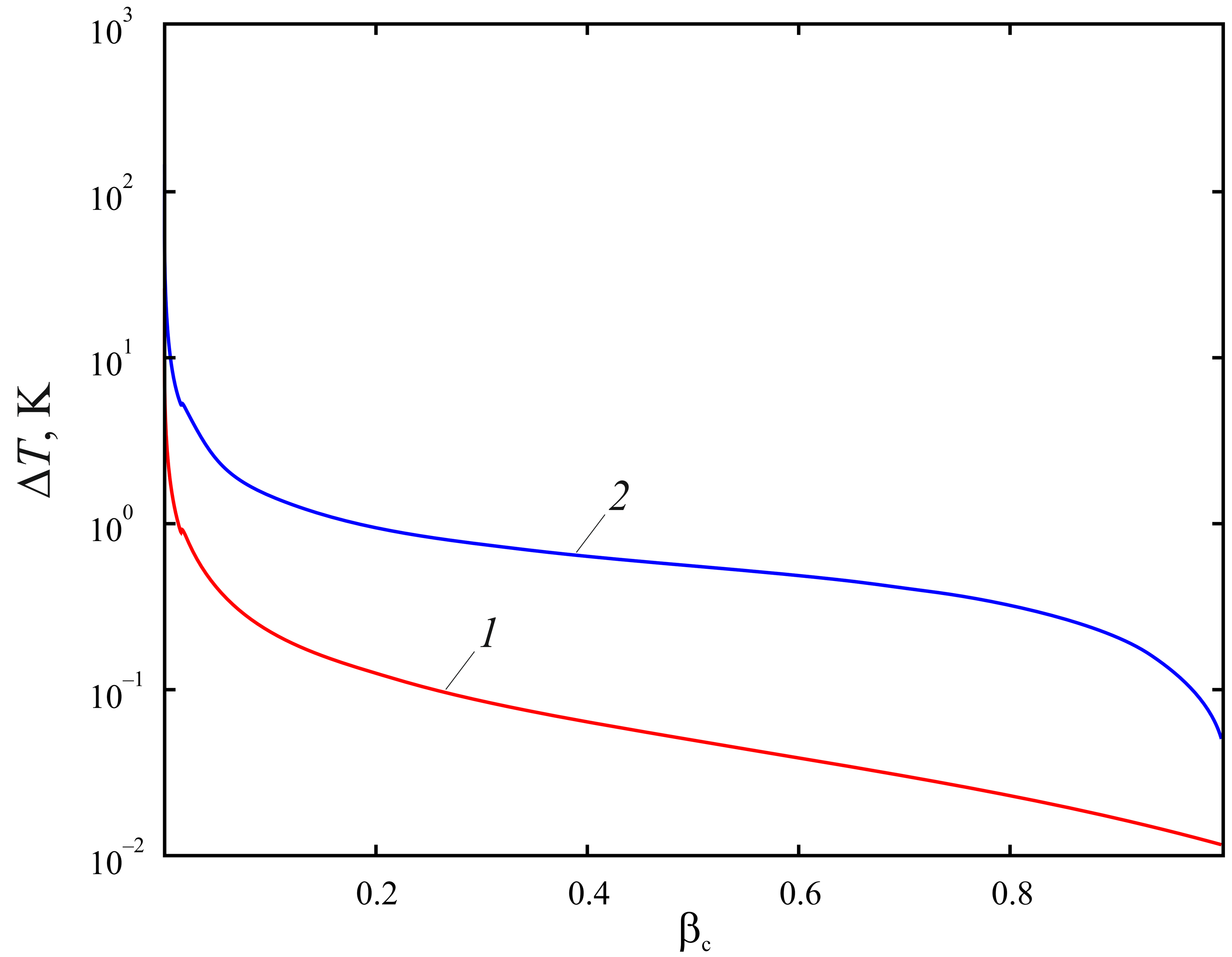

Fig. 2.The dependence of the nanoparticle neighborhood heating on the volumetric content of metal of the core under the frequencies $\omega = \omega_{sp}^{*@(+)}$(*1*) and $\omega = \omega_{sp}^{*@(-)}$(*2*)