SIMULATION OF THE OPTICAL CHARACTERISTICS OF ORGANIC SOLAR CELLS WITH THE ADDITION OF NOBLE METALS OF DIFFERENT SPHERICAL SHAPES

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Abstract The effect of the geometrical parameters of the organic solar cell (OSC) and its components on the absorption and reflection of light was investigated. In the simulation, the main elements affecting the optical characteristics of OSC were poly(3,4-ethylenedioxythiophene):polystyrenesulfonate (PEDOT:PSS), poly(3-hexylthiophene):[6,6]methyl ether of phenyl-C61butyric acid (P3HT:PCBM) on silver nanoparticles. The thickness of the PEDOT:PSS layer was equal to 50 nm, with a subsequent increase to 80 nm, it contained nanoparticles of silver (NP's Ag) and gold (NP's Au), the distance between the centers of the particles did not change and was 60 nm, with changes in the vertical and horizontal dimensions of the particles. The thickness of the P3HT:PCBM layer always remained equal to 100 nm. According to the graphs, you can find out the optimal parameters for the study of solar cells with inclusions of precious metals.

1.Introduction

The study of the properties of metallic nanoparticles (MN) is not only of purely scientific interest but also of practical importance in certain applications. The research of optical properties of MN has a long history. In particular, the expression for the absorption cross-section of a plane electromagnetic wave with the frequency ω by a spherical nanoparticle, whose sizes are smaller than the radiation wavelength, has been known for a long time[1]. The most general and referenced theory of the optical properties of small particles is the Mie theory [2]. The study of small particles of precious metals added to solar cells introduces additional opportunities for collecting and reflecting solar energy, which in turn will improve the adhesive properties of the cell from the transformation of sunlight into electricity.

2. Theoretical model

For our research, we used the cell shown in Fig. 1

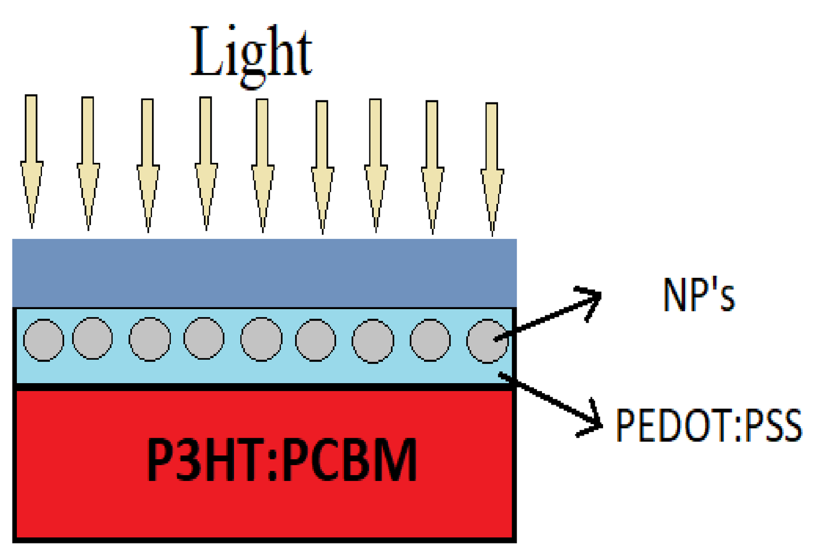

Fig. 1. Schematic representation of the studied solar cell

Silver and gold were used as particles. The distance between the centers was 60 nm. The shapes of the particles changed from elongated (vertical) to flattened (horizontal). They were marked Rv and Rh, respectively. A schematic representation of the particles is shown in Figures 2 and 3

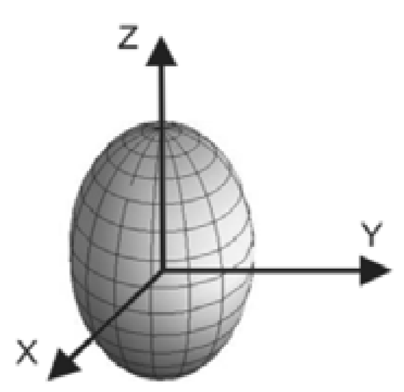

Fig.2. Elongated biaxial spheroid Rv (z>(x=y)).

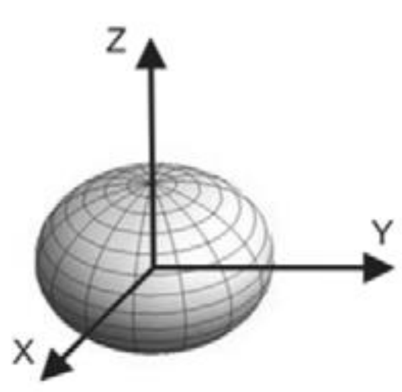

Fig.3. Flattened biaxial spheroid R_h ((x=y)>z).

Theoretical calculations of the optical parameters of the OSC were carried out using the finite difference time domain (FDTD) method. This method is a powerful tool for modeling nanoscale optical devices. FDTD solves Maxwell's equations directly without any physical approximation, and is limited only by the amount of available computing power. The FDTD method solves Maxwell's equations on a grid and calculates E and H at grid points spaced Δx, Δy, with E and H alternating in all spatial dimensions

3. Results of computation calculation and discussion

Here we present the results of computation calculation and discuss them. Analyzing the graphs, it can be seen that the presence of different shapes of particles causes significant changes in absorption (A), transmission (T), reflection (R).

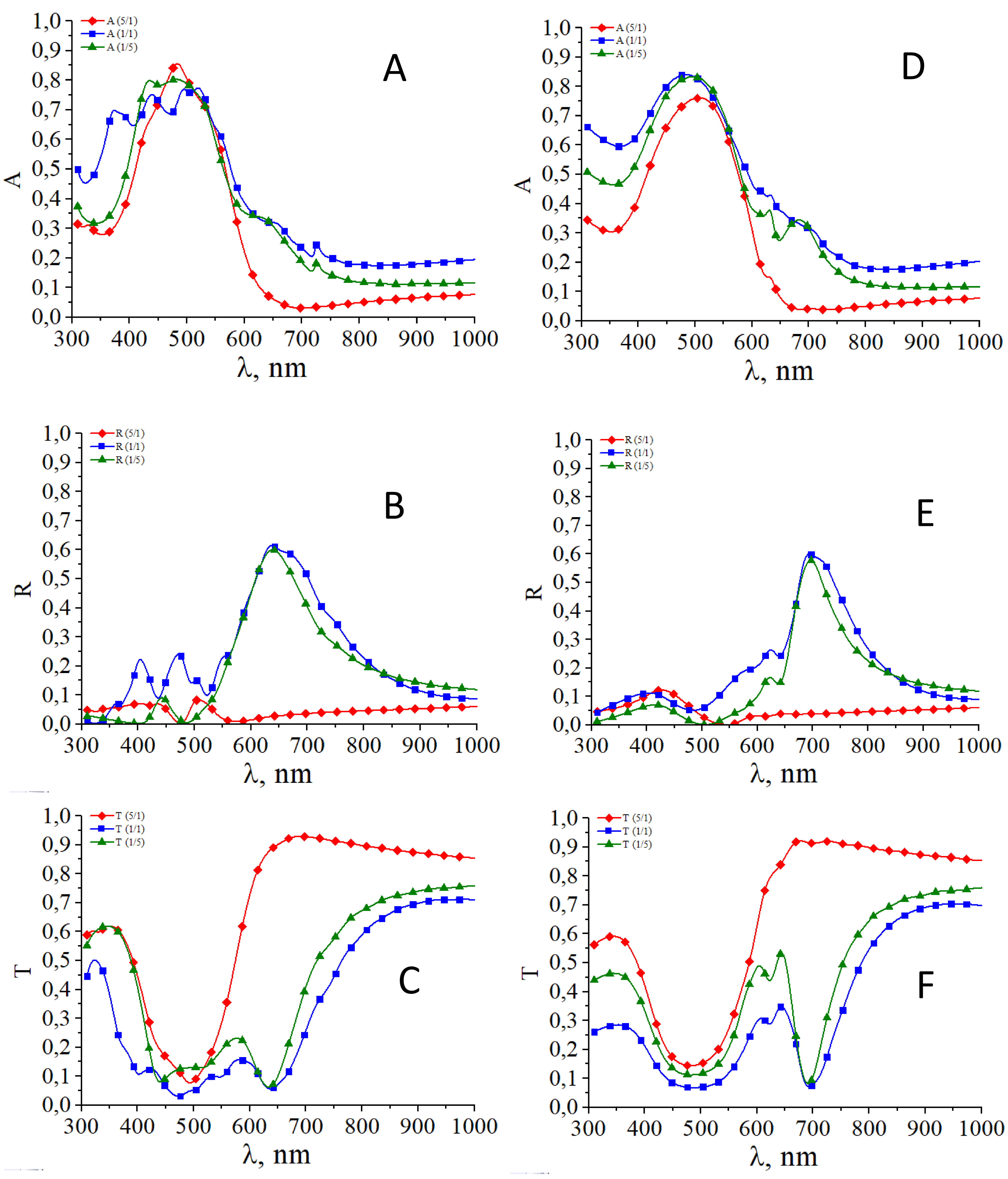

Fig. 4. Research results for Ag (A, B, C) and Au (D, E, F)

4. Conclusion

Analyzing the results of the study, it can be seen that the optimal results for solar cells with added nanoparticles of noble metals are the optimal conditions for particle sphericity. The elongation or elongation of the particles will help for further research into specific properties to improve the efficiency of solar cells.

References

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