Bartłomiej Bończak MSc Eng.
supervisor: dr hab. Marcin Fiałkowski, profesor instytutu
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Nanoparticles functionalized with ligands containing electro- and photoactive groups

Abstract

The main goal of the presented doctoral dissertation was to synthesize and investigate properties of materials that consist of gold nanoparticles (AuNPs) whose surface is modified with ligands containing electroactive as well as photo- and thermoactive moieties. Fully conjugated fullerene C_{60} derivatives were used as the first class of ligands and species containing donor-acceptor Stenhouse adduct (DASA) were used as an example of the second category.

In the experimental part of the dissertation, the synthetic strategies for molecules that can serve as AuNPs ligands are presented. The library of fully conjugated fullerene C_{60} derivatives that possess a sulfur atom in the form of thiono and thioacetyl moiety is described. Due to the usage of organic azides in the synthesis, azahomofullerenes were obtained which maintained conjugation throughout the whole molecule. Furthermore, the synthesis of DASA containing ligand for AuNPs is presented. The molecule can be easily modified to serve as a ligand for various other materials.

The following part outlines results obtained for AuNPs modified with synthesized ligands. The gold-fullerene heterostructure turned out to be an insoluble solid. However, it was possible to solubilize it in toluene solutions of cationic surfactants. What is more, the solid was able to be dissolve by lithium naphthalenide in tetrahydrofuran. The latter procedure allowed for quantification of the amount of electron that can be absorbed by the material. The heterostructure absorbs a significant amount of electrons and exhibited an “electron sponge” ability. The theoretical model is proposed that explains observed phenomena. Moreover, an example of a practical application of the investigated fullerene-gold heterostructure was presented. The material was implemented in perovskite solar cells as an electron transport layer.

The second part of the research focuses on exploring the thermally reversible photoinduced self-assembly of DASA-modified AuNPs onto water-toluene interface. Cross-linking of obtained films leads to the achievement of thin semiconducting material. Finally, a summary of each part which points to the scope of the further potential development of the presented topic is described.