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PHOTOPHYSICAL PROPERTIES OF CDSE/ZNS QDS-TPP NANOCOMPOSITES IN BIOPOLYMER

Sewid. F. A. (ITMO University),
Scientific supervisor – Professor, Dr.Sc. Orlova. A. O.
(ITMO University)

Nanocomposites based on CdSe/ZnS QDs and tetraphenylporphyrin (TPP) molecules passivated by chitosan were formed. The nanocomposite showed a high singlet oxygen generation compared to free TPP at the same concentration. Simultaneously, it was demonstrated that the FRET efficiency from QDs to TPP in nanocomposites is close to 50%.

Introduction. Porphyrins and their derivatives are mostly used as photosensitizers (PSs) in photodynamic therapy (PDT) and sonodynamic therapy (SDT) of oncology diseases due to their unique properties, e.g., the high quantum yield of singlet oxygen (SO) generation and efficient accumulation in tumor cells. Nevertheless, they have some drawbacks, e.g., low solubility in water, the release of phototoxic products, and slow excretion from the body.
In the last decades, hybrid nanostructures based on PSs and various nanoparticles have been actively studied because a combination of PSs with nanoparticles allows a significant improvement of PSs' functional properties. PSs' challenges can be efficiently overcome using a combination of PS with colloidal semiconductors quantum dots (QDs) as a platform for developing new and effective drug systems for PDT. QDs have unique optical and chemical properties. The application of a QDs-porphyrin hybrid structure is easily aggregated in aqueous media and is usually greatly hampered by the toxicity of the structure.

Main part. A combination of porphyrin, especially TPP with QDs, and then encapsulated in the cationic biopolymers such as chitosan and yield the water-soluble and biocompatible nanocomposite to improve its delivery and distribution in the cells.
Chitosan is a natural polysaccharide derived from natural sources and it has interesting properties such as biodegradability, biocompatibility, bioactivity, and nontoxicity. Chitosan is used as a stabilizing agent and a carrier for photocatalysts and photosensitizers and encapsulated quantum dots has been developed in recent years. QDs-TPP nanocomposites will show promising results in PDT in terms of transferring the hybrid structures to aqueous media with retaining their photophysical properties.

Conclusion. In this work, we demonstrate a new approach to form nanocomposites based on CdSe/ZnS QDs-TPP in chitosan solution. The encapsulation of QDs-TPP nanocomposites with chitosan has significant characteristics, such as making these structures biocompatible, improving photophysical properties, decreasing the distance between QDs and TPP, and enhancement the efficiency of SO generation.