This project is part of the research trend that develops relatively young interdisciplinary field of science called nanophotonics. In the most general sense, it studies the interaction of light with matter spatially limited to the order of several to several hundred nanometers, hence processes such as generation, absorption, emission, light scattering, propagation and light processing on a scale smaller than that limiting the classic optical diffraction limit. Matter spatially limited to sizes on the nanometric scale show new properties, also optical, completely different from the classic macroscopic ones characterizing the given solid material. They result from the limitation of the spatial electronic structure, as well as the increase of the surface area of the material to its volume ratio. As an example, very interesting optical and electrical processes are occurring in semiconductor nanoparticles. Such nanoparticles, called semiconductor quantum dots, show absorbance and fluorescence depending on the size of the nanoparticles in the range from ultraviolet to near infrared (Fig.1). They can be widely used in optoelectronics, in the production of device components such as light emitting diodes, lasers, photodetectors, filters or optical switches, as well as solar cells. Under the influence of high-power laser light, quantum dots exhibit multi-photon absorption. Thanks to this feature, quantum dots can also serve as optical markers in bio-imaging of cancer cells with multi-photon microscopy techniques, which is characterized by high resolution and contrast, allows for three-dimensional imaging and work in region of the so-called the biological transparency window. The ability to functionalize the surface of quantum dots through appropriate ligands, allows to attach to them the specific peptides, antibodies and photosensitizers, thanks to which they can selectively penetrate into cancer cells and serve both in diagnostics and therapy.

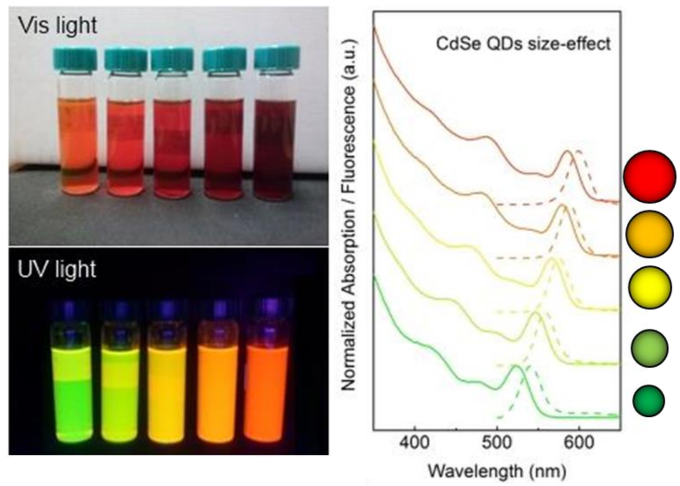

Fig. 1. Pictures of a chloroform solutions of the CdSe QDs of various sizes in visible light and under UV excitation, together with the corresponding absorption and emission spectra.

The main motivation of the following project is the development of new, more accurate and advanced methods for the characterization of non-linear optical properties of nontoxic nanomaterials used in optoelectronics, such as cadmium- and indium-free semiconductor quantum dots, and the study of their potential as optical markers in multiphoton microscopy. Third-odder optical effects will be tested using amplified femtosecond laser pulses. It should be emphasized here that the impulse lasers that our team has in laboratories are high-power tunable lasers in the range from ~500 to 2000 nm. This implies the possibility of determining non-linear parameters in a wide optical spectrum. The modified z-scan technique with the closed and open aperture option, and more accurate two-photon excited fluorescence technique will be used to measure the absolute parameters of the nonlinear refractive index and the effective multiphoton absorption cross section. The role of new and sophisticated nanomaterials research techniques relevant to medical and photonic applications will play an increasingly important role day by day. Advance laser techniques used in this proposal for the characterization of nanomaterials will give us information about their new physico-chemical properties impossible to obtain by methods known so far.