

Title: "Functionalization and optical investigation of inorganic nanocrystals for application in biomedicine".

## Abstract

This dissertation consists of seven chapters which describe the path that the nanocrystals must follow in order to become a biomarker, i.e. from synthesis through toxicological evaluation, ending at application in the living organism. The first chapter serves as an introduction, describes the current state of biomarkers and defines the aims of this work. In brief, they are: (i) facing the issues of surface engineering, bioconjugation, and toxicity analysis of new subjects in the laboratory; (ii) determining the potential of the scientific team in the context of the above topics; (iii) establishing the NCs surface functionalization protocols and (iv) developing the methodology that enables for evaluation of NCs toxic effects. In the second chapter, the theoretical background of two types of nanocrystals is presented, namely lanthanide doped nanocrystals (RENCs), represented by fluorides ( $\text{NaLnF}_4$ ) and semiconductor colloidal quantum dots (SNCs), in this case CdSe/CdS core-shell structures. What is more, their optical and structural properties are described, along with synthesis methods as well as experimental techniques used for NCs characterization. The third chapter focuses on the theoretical and practical aspects of the surface functionalization performed on the examined structures. Within this work, three main approaches to this issue were developed: Ligand Exchange (LE), Ligand Attraction (LA), and Ligand Protonation (LP). The results obtained for RENCs and SNCs are presented in the fourth and fifth chapter, respectively. These results indicate that the goals (i-iii) of this research were fulfilled. NCs obtained in this work were: water soluble; with surface groups attached to their surface; bioconjugated; and stable (optically and chemically) enough to explore their application potential. The sixth chapter is devoted to toxicological investigations of said nanomaterials. The *in vitro* immunotoxicity tests, neurotoxicity results and MRI investigations provide a solid statement that they can be used for optical bioimaging, simultaneously fulfilling the (iv) goal of this work. Ex vivo visualization of the melanoma tumor using the RENCs proves that they can be applied as an optical biomarker, indeed. The final chapter summarizes this dissertation and contains conclusions, perspectives as well as the author's suggestion on further work to be performed on these nanocrystals.