Protein adsorption is often a highly undesirable phenomenon leading to artificial organ and implant failure, inflammatory response, blocking of sensors, fouling of ultrafiltration units. It can also exert adverse effect on *in vivo* applications of drug delivery systems based on microcapsules and nanoparticles because of inactivation of immunoglobulins at their surfaces. In response to an essential significance of these issues, various means were developed in order to minimize or prevent protein adsorption at solid substrates. Most often one applies grafting of macromolecules forming homogeneous and hydrophilic layers at substrate surfaces. However, these homogeneous coatings lose their protein resistance properties when exposed to complex biological media, e.g., blood serum because of their susceptibility to oxidation. In order to eliminate this disadvantage, in this research project, a new concept of the preparation of protein repellent substrates is formulated. Accordingly, the heterogeneous substrate surfaces are created in a reproducible way by a controlled self-assembly of noble metal and oxide nanoparticles. This method is versatile and flexible because one can use nanoparticles of various size, shape and surface charge (negative and positive) that can be regulated by pH and ionic strength of the suspension. In this way, substrates of desired topology and charge distribution can be formed that opens a wide spectrum of unexplored possibilities. Another advantage of such procedure is that by using silver nanoparticles one can prepare chemically and temperature resistant surfaces also incorporating an antibacterial property.

Therefore, the main goal of this research project is to develop a comprehensive and quantitative description of the mechanisms governing protein adsorption at such heterogeneous substrates by performing thorough experimental studies exploiting efficient *in situ* methods and theoretical modeling.

It is expected that the research works envisaged in this project allows one to determine crucial parameters governing the serum protein interactions with heterogeneous nanoparticle monolayers. In this way, a complete understanding of nanoparticle deposition and protein adsorption mechanisms at heterogeneous surfaces is achieved, especially the role of electrostatic interactions is unequivocally elucidated. This is important given the lack of such information in the literature. The obtained results could facilitate developing new substrates characterized by pronounced antifouling and biocidal properties, devising immunonsensors of high sensitivity and the invention of efficient therapies involving nanocapsule drug delivery systems.