Scientific and Technical Report

Analysis of the interactions between nanoparticles and biomolecules to understand the role of nano-bio-interface in predicting nanoparticle behavior and effects on biological systems

Project duration: 24 months

Execution phase nr. 1/2018

Project director,

Dr. Miruna Stan

Objectives of this phase execution

Objective 1. Purchasing and characterization of nanoparticles with different properties. Analysis Time evolution analysis of the NPs-protein corona formation and dynamics – part I. Data correlation according to nanoparticles' characteristics – part I

Activity 1.1. Selecting and purchasing the NPs

Activity 1.2. Measurement of the macromolecules' influence on the NP size, dispersion and stability state

Activity 1.3. Evaluation of morpho-structural and conformational changes on proteins after the interaction with NPs

Activity 1.4. Data analysis and correlation of experimental results obtained on NP-biomolecule interactions

Abstract of project phase

At this stage, quantum dots of graphs (G-QDs) have been purchased from Sigma-Aldrich, USA, and various nanoparticles have been obtained from different research institutes in Romania to be tested in this project: silicon QDs, titanium dioxide nanoparticles of various sizes and functionalities, carbon nanotubes and iron oxide nanoparticles (Fe_3O_4 - magnetite). Measurement of the hydrodynamic diameter, polydispersity index and zeta potential for different types of nanoparticles was performed using the Dynamic Light Diffusion (DLS) and Doppler Laser Velocity (LDV) method using a Malvern Zetasizer Nano-ZS instrument. Incubation of the silicon QDs with fetal bovine serum resulted in a rapid increase in zeta potential compared to particles suspended only in water, suggesting that the proteins affected the stability of QDs due to their rapid and continuous interaction with nanoparticles. The time-dynamic analysis of the Si/SiO_2 QDs hydrodynamic diameter after the incubation with human hemoglobin showed that particle size increased due to protein adsorption on nanoparticle surface. Regarding the incubation of G-QDs with different proteins for 30 minutes or 24 hours, it was found that albumin was the best protein to ensure the dispersion of particles. FTIR analysis showed changes in the BSA secondary structure after incubation with silica QDs, such as the loss of α-helix structure by 30% and increased β-turn content after the first 5 minutes of incubation. Subsequently, the percentage of α-helix increased during the next hours, when the secondary structure resembled to that of native BSA. Also, a dynamic interaction of BSA with magnetite particles in time was revealed, resulting in an important adsorption followed by desorption. The

results obtained were processed and disseminated in one international scientific paper, a book chapter, a review and at one international conference. In conclusion, the activities related to Stage 1 of the project activity plan A1.1, A1.2, A1.3 and A1.4 were completely fulfilled.

The results were analyzed and corelated in order to conclude the main effects of the interactions between nanoparticles and biomolecules. These were disseminated as:

- poster at international conferences

• Strugari A., Stan M.S. Nanoparticle intestinal transport characterization using in vitro co-culture models. Proceedings of 1st International Online-Conference on Nanomaterials, DOI 10.3390/IOCN_2018-1-05480.

- research article published in ISI journal

• Stan MS, Badea MA, Pircalabioru GG, Chifiriuc MC, Diamandescu L, Dumitrescu I, Trica B, Lambert C, Dinischiotu A. Designing cotton fibers impregnated with photocatalytic graphene oxide/Fe, N-doped TiO2 particles as prospective industrial self-cleaning and biocompatible textiles. Mat Sci Eng. C 2018, 94:318-332. Impact Factor: 5.080 (2017), Relative influence score: 1.105 (2017). DOI: 10.1177/1528083718779447

- book chapter

• Stan MS, Strugari AFG, Balas M, Nica IC. Biomedical applications of carbon nanotubes with improved properties. In: Fullerenes, Graphenes and Nanotubes: A Pharmaceutical Approach (ed. Grumezescu AM), Elsevier, Oxford, UK, 2018, p. 31-65. Print ISBN: 978-0-12-813691-1.

- review paper

• Nica IC., Stan M.S., Dinischiotu A. Current photocatalytic applications of nano-scaled titanium dioxide in the new era of "smart" technologies. Rev. Biol. Biomed. Sci. 2018; 1(2): 43-53. DOI: 10.31178/rbbs.2018.1.2.1.