Project title: STIMULI RESPONSIVE NANOSTRUCTURED (BIO)COMPOSITES

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Research team:

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Project summary: The project objectives follow to design stimuli-responsive multifunctional (bio)composites, by using new synthesis strategies, and to identify their specific applications by the correlation of composite structures with their response to different stimuli. Thus, some different types of nonionic/ionic composites will be synthesized, such as: nanostructured organic/inorganic hybrids based on glutathione, glutathione type -analogues hybrids carriers including metal nanoparticles; biocompatible hybrids for the preparation of peptido-conjugates to bind some anti-carcinogenic drugs, the kinetic studies of drug delivery at the cellular level being a new approach in a highly impact field of research; fast-responsive composite hydrogels, with potential for the retention and separation of biological micro- and nanoparticles, synthesized at temperatures below the freezing point of the reaction system, known as cryogels, their morphology (pore size and pore size distribution) being tailored by the synthesis parameters (temperature, monomer concentration, initiator concentration); organic/inorganic ionic hybrids stabilized by covalent bonds responsive to more stimuli (solvent, ionic strength, ph, temperature) obtained by using some reactive organic oligomers and syloxane oligomers with chloromethylene groups; stimuli-responsive interpenetrated networks composite hydrogels based on biocompatible polymers with adsorption properties of low molar mass organic compounds and metal cations; stimuli responsive composite membranes; organic/inorganic ionic hybrids based on silica with high mechanical strength to be used at high pressure.

Project objectives: The project proposes to accomplish both some specific objectives of high interest and general objectives according to the main requirements of the exploratory research projects.

General objectives:

1. Deepings the knowledge in the top field of smart (bio)composite nanostructurated materials, bu using a large variety of ionic synthetic and natural polymers with pre-established functionalities and architecture, and the increase of international competitiveness of the Romanian research, by an interdisciplinary research, finally leading to the increase of the international visibility of the Romanian contributions in the project field by publishing the original results in journals with high impact index from abroad – during all the project period.

This objective achievement is guaranteed by the sustained activity of both the project manager and the experienced researcher who published a numerous articles in journals with high impact factor from abroad and from Romania, based on the fundamental researches of the team, most of them based on an interdisciplinary approach.

2. Captivating young researchers in a top field of research and partial financing from the project of some PhD positions leading to blossom and stimulation in the future of self undertaking of young researchers, thus stimulating researcher's training in a high scientific quality medium.

In the working team of the project are involved four young PhD students. The project financing will create the necessary conditions for development of the capabilities and research abilities of young researchers involved in the project – during all the project period.

3. Establishment of new international partnerships with fameous scientists in the field of smart nanostructured (bio)composites, and strengthening the existent collaborations (Universities: Konstanz, Budapest, Istanbul, Wroclaw, Sofia, etc) – during all the project period.

Specific objectives of the project focused on the design of new smart materials as stimuli-responsive nanostructurated (bio)composites by understanding the synthesis conditions – structure – interactions (physical/chemical) – stimuli-responsive rate relationship, aiming to obtain new materials with multiple applications.

1. Synthesis of some hydrogels and ionic organic/inorganic hybrids, peptide-conjugates containing radicals with drug effect, peptides with high retention metallic ions capacity, with novel structures and properties.
2. Characterization of the new synthesized biopolymers and their complexes by using high performance methods agreed by world wide scientific community (mass spectrometry, circular dichroism, atomic force microscopy, SEM, FT-IR, ^{1}H-NMR 400 MHz, etc) .
3. Clinical (controlled drug delivery, studies of toxicity and tolerance, biomimetics) and industrial (decontamination, water purification, immobilization on polymeric resins and on inorganic nanomaterials) trials, as well as fundamental research on the conformational modifications during transition towards complexes.
4. Synthesis of metal – crosslinked organic substrate composites – precursors for the metal controlled release as a function of the environment.
5. New strategies to design stimuli - responsive hydrogels with potential for the separation of biological nano - and microparticles (viruses, cells, etc.) mainly oriented on the synthesis at temperatures below the freezing point of the system, leading to superfast stimuli-responsive hydrogels, called cryogels.
6. New strategies to design multifunctional ionic hydrogels like IPN nanostructurated composites based on biocompatible polymers and reactive clays.
7. Synthesis of new nanostructurated ionic organic-inorganic hybrids as microparticles with high mechanical strength to be used at high pressure.
8. Preparation and characterization of stimuli-responsive composite membranes by layer-by-layer deposition of some weak synthetic and natural polyelectrolytes.

Economical impact. The project will contribute to realize financial equivalent positions of our PhD students with those from abroad. The proposed solutions for decontamination will bring economical benefits because some extremely toxic compounds will be converted in nontoxic compounds.

Social impact. This project will bring contribution to find solution for some degenerative disease problems. The research capacity of the involved PhD students will be developed. The contribution and competitiveness of Romanian researches at international level (by publication, conferences, communications, etc) will rise, starting new international cooperation, financed by external sources. The results will be used by the young researchers involved in this project in their PhD theses elaboration, and to develop new partnership with industry, university and environment agency.

Environment impact. The project achievement has scientific-technical major impact due to fast and ultra sensitive detection of metallic ions as well as their monitoring in environment.