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HABILITATION THESIS SUMMARY

Micro- and Nanostructured Materials with Applications in Medicine and Environmental Protection

The habilitation thesis entitled „Micro- and nanostructured materials with applications in medicine and environmental protection” presents a review of the didactic and academic activities, in particular my scientific results from 1999 to 2020, subsequent to the support of the doctoral thesis.

The thesis is structured in three distinct chapters: Chapter I presents the main didactic, academic and scientific contributions; Chapter II refers to the most important own scientific achievements in the current context of the fields addressed; Chapter III refers to the perspectives on the evolution and development of my professional career.

Chapter I presents the professional achievements obtained during the 32 years of activity as a teacher (assistant, lecturer, associate professor and professor) in Department of Organic, Biochemical and Food Engineering, „Cristofor Simionescu” Faculty of Chemical Engineering and Environmental Protection, from „Gheorghe Asachi” Technical University of Iaşi.

Between 1988 and 2020 I was the holder of courses and applications in a series of disciplines for students from „Cristofor Simionescu” Faculty of Chemical Engineering and Environmental Protection (FCEEP) and other faculties in „Gheorghe Asachi” Technical University of Iasi, respectively: Biocompatible materials (MSc, Pharmaceutical and Cosmetic Products, FCEEP); Materials characterization and testing methods (MSc, Pharmaceutical and Cosmetic Products, FCEEP); Sensory evaluation of food (MSc, Food Control and Processing, FCEEP); Chemistry (BSc, 1st year, Faculty of Machine Manufacturing and Industrial Management, Faculty of Materials Science and Engineering, Faculty of Mechanics, Faculty of Electrotechnics); Materials

analysis techniques (BSc, 2nd year, Faculty of Materials Science and Engineering); Ceramic and composite materials (BSc, 4th year, FCEEP); Unconventional procedures for separating and conditioning natural and biologically active products (MSc, Natural Products, FCEEP).

The didactic activity was supported by the publication of 11 books, respectively: 8 courses/textbooks/monographs (of which 7 as first author/sole author) and 3 laboratory guidelines (as first author/sole author) published in CNCSIS recognized publishers. I have also created 6 course and laboratory supports on the Web for the study and self-instruction of the students, for a number of the disciplines supported.

During the years I have guided the research activity of the students: Bachelor theses (3); dissertation theses (34); research projects and doctoral thesis (2 doctoral students under the coordination of prof. dr. chem. Constantin Luca); scientific works of students for scientific events organized at the faculty level (workshops, student symposia, etc.).

Between 2010 and 2013 I was expert in the education sciences at 2 educational projects POSDRU, respectively: "Training and evaluation system centered on the student, online, in the basic disciplines of Bachelor's and Master's degree in higher technical education" (contract POSDRU/86/1.2/S/62485) and "National Network of Continuous Training of Teachers in Pre-university and Technical Education - CONCORD" (contract POSDRU/87/1.3/S/61397).

In the academic community I was involved with other activities, such as: member in various commissions (faculty admission, faculty schedule, tenure on teaching positions, student scientific workshops, dissertation, doctorate); counsellor and mentor for the students; member of the board of the department of Organic, Biochemical and Food Engineering; member of the council of the Faculty of Materials Science and Engineering and others.

The scientific research activity started with the registration of the doctorate study in the scientific field CHEMISTRY, in November 1990, under the supervision of prof. dr. chem. Nicolae Bâlbă, "Al.I. Cuza" University of Iaşi, Romania. In 1999 I defended the thesis: "The crystalline microporous zeolites of SAPO-n type; the structural-adsorptive characterization and reactivity", receiving the title of DOCTOR (PhD) in Chemistry in 2000.

During the last 21 years (after the completion of the doctoral thesis), my scientific activity was mainly focused on conducting theoretical and experimental studies in the field of micro- and nanostructured materials, especially apatite biomaterials and porous membranes with applications in medicine and environmental protection.

The results of my own scientific research were materialized in the publication of scientific articles in national and international journals, obtaining patents, as well as participating in national/international symposia.

Also, by winning 6 research contracts/grants at national (3) and international (3) level, as a contract manager, I was able to coordinate the

research team and thus have obtained significant results regarding a series of porous materials (biomaterials, membranes) as well as aspects related to their applications. These results were highlighted by the publication of scientific articles and participation in national and international symposia. Improving the research infrastructure in the laboratories of our faculty through the funds allocated from contracts, laboratories where teachers, students, masters and doctoral students work, is another component of my scientific activity because no research can be performed to the international requirements without modern and performing equipment.

The didactic and scientific research activity carried out during my university career is materialized in the following achievements:

- Articles published: 192
  - 55 articles published in ISI journals (35 first author and/ or corresponding author; 31 in abroad journals);
  - 62 articles published in indexed journals in BDI databases / CNCSIS;
  - 39 articles published in CNCSIS journals, not indexed in databases;
  - 36 articles published in proceedings (15 in ISI proceedings);
- Books: 11;
- Patents: 3;
- Conferences/symposia: 206 (68 international; 138 national)
- Grants/research contracts: 25
  - 20 grants/contracts national (3 as manager);
  - 5 grants/contracts international (3 as manager);
- National and international awards and diplomas: 21 (8 international);
- Member in national and international professional associations: 10 (6 international);
- Article reviewer for various international ISI journals.

Chapter II describes in detail my scientific contributions in the **Chemistry** scientific field, having as the main research direction the study of Micro- and nanostructured materials, respectively: *Apatitic biomaterials* (especially those based on hydroxyapatite) and *Porous membrane materials*, with applications in medicine and environmental protection.

The results of the studies carried out are described in 3 sections, as follows:

- In **„*Subchapter II.1. Introduction*”** is briefly presented the main research directions and the results (articles, books, patents, contracts) obtained by me during my career.

- In **„*Subchapter II.2. The current state of research in the field*”** there are presented important current and perspective aspects of the specialized literature on the evolution of scientific knowledge worldwide in „Apatitic Biomaterials” and „Membrane Materials” fields.

- In **„*Subchapter II.3. Own contributions*”**, the most significant results of the scientific research obtained by my regarding the micro- and

nanostructured materials with applications in medicine and environmental protection are described, respectively: *Nanocrystalline hydroxyapatite* (synthesis, characterization), *Cerium or bismuth-substituted hydroxyapatite* (synthesis, characterization), *Multifunctional hybrid materials* (hydroxyapatite deposition on metal or polymeric support; drug-controlled release systems; porous membranous composites) and *Hydroxyapatite as adsorbent* (adsorption of metal ions, dyes and drugs).

The biomaterials described in this thesis are biomaterials from 3rd generation that are intelligent and adaptive materials, able of stimulating specific cellular responses to regenerate tissues restoring their function. These biomaterials are created by combining the properties of bioactive materials and absorbable materials, and these new materials are able to activate genes and stimulate regeneration of living tissue at the molecular level. The hydroxyapatite-based biomaterials presented in this thesis were obtained in the form of nanocrystalline powders, thin films or 3D porous matrix (scaffolds) for tissue engineering applications. These biomaterials allow improving the functioning of the conventional bone implants by overcoming the limitations of the individual materials and imitating the structure of the calcified tissues, while preventing the microbial infections that may occur.

Due to the possibility of designing material properties by coupling organic and inorganic components, hybrid multifunctional materials have been created for medical applications (e.g. biomaterials for tissue regeneration) or for environmental protection (e.g. composite membranes for separations).

Also, nanocrystalline hydroxyapatite has been proven to be a high efficiency, cheap and environmentally friendly adsorbent, with a high specific surface area, high porosity and very good ion exchange capacity, suitable for treatment processes of water contaminated with organic and heavy metal pollutants.

Chapter III of the habilitation thesis refers to the future directions of professional career development. The continuity and novelty elements that will be reflected in the evolution of my professional career are briefly presented.

Finally, regarding our mission as professors and researchers, I can only to quote Robert M. Hutchins: "*Education is not to reform students or to make them expert technicians. It is to vibrate their minds, widen their horizons, inflame their intellects, and teach them to think straight, if possible*".

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