UNIVERSITATEA "ALEXANDRU IOAN CUZA" din IAŞI

HABILITATION THESIS

SUMMARY

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SUMMARY IN ENGLISH
Polymer materials. Atmospheric-pressure plasma processing

The habilitation thesis is presenting a synthesis of the major contributions of the author, related to the scientific and teaching activity.

The scientific contributions are grouped into three categories: contributions on the development of atmospheric-pressure plasma techniques, for both fundamental research and surface processing applications, contributions on the development of complex new methods for producing polymer and composite materials with special properties, for designed applications, and contributions on the knowledge on polymer surface modification mechanisms, understanding of plasma – polymer interaction, and control of fluid – solid interface processes.

Related to the contributions on atmospheric-pressure plasma techniques, the author is presenting two types of plasma reactors, designed and developed to work at atmospheric pressure, demonstrated as most effective non-thermal plasma sources. These reactors, belonging to the dielectric barrier discharge (DBD) type, were constructed and used in various configurations, aiming for surface processing of materials. An extensive range of investigations focused on applications, aiming to define and optimize the operational parameters, in various gaseous environments. Besides, the study had a fundamental component, aiming to analyze the discharge mechanisms, the role of high energy species of helium and the influence of the dielectric barrier on the discharge working regime and surface processing outcomes.

Related to the contributions on methods for producing polymer-based materials with special properties, the author is presenting several types of materials, obtained by physical, chemical and plasma methods. Thus, poly(ε-caprolactone) (PCL) copolymers and nanocomposites were analyzed, aiming to establish the factors acting at the interface between the components of the blend, so allowing better dispersion and homogeneity. Also, hydrophobic polymer films were obtained by atmospheric-pressure plasma deposition, offering applications as non-adherent materials. Then, an inorganic-organic polymer material, with enhanced UV-protection properties and high hydrophobicity was obtained, using ZnO coating of polyester textiles, thus combining time stability, water repellent and UV blocking properties, offering enhanced performance under environmental conditions, comfort and time stability of the garments.

Related to the contributions on the processes involved at the interfaces between polymers and various environments, the author is presenting results and conclusions of several studies, carried out in a frame where surface pre-treatment is usually required to tune the adhesion of the material in its working environment, for various applications.

Therefore, the relationship linking the surface polarity, the chemical structure and composition and the crystalline/amorphous phase contribution in the surface modification mechanisms of plasma-exposed polymers was explored, for polymers chosen as comprising various structures, functionality, degree of oxidation, crystallinity, exposed to the DBD plasma. Also, the plasma ability to control the fluid – solid interface processes was demonstrated and analyzed in a study on the surface modification of synthetic woven textiles. Then, an analysis on the processes by which a treated polymer surface tends to reorganize, as to achieve stability, on the relation between the polymer surface characteristics and the surface dynamics, and on the factors allowing controlling the interaction, on a time-space scale, was carried out.

The contributions related to the teaching activity, developed during 20 year of academic carrier, are also presented. These cover various Physics disciplines, for which the author prepared support materials, for both the theoretical and applied part (practical work, exercises), receiving warm appreciation from the reviewers. The competences of the author to organize and manage teaching activities are also presented, as she is coordinating all the activities for courses, seminars and practical work for students studying for their Bachelor's degree, for disciplines related to Physics of Atoms and Molecules, using a modern approach, based on a profound understanding of physical phenomena and making connections between various Physics disciplines. The author is also responsible for disciplines related to Polymer Physics, for Master students, where the contents, for both the theoretical and applied part, represent an original contribution, developed using also her research experience that covers comprehensive aspects related to polymeric materials. Then, the author is involved as director for Bachelor's and Master thesis, and as member of PhD thesis guiding committees, where she is using her ability to manage interdisciplinary research relating Physics, Chemistry, Materials Science and Biology.

The capacity of the author to coordinate research teams and to manage scientific research is also presented, demonstrated by direction of three scientific grants, stressing that the work carried out as project director contributed to develop and consolidate, at national level, research directions of interest at international level, related to atmospheric-pressure plasmas and their applications. Also, these projects had an important component in human resources development, employing teams of young researchers.

The last part of the habilitation thesis presents some perspectives regarding the research and teaching activities of the author. New research directions are identified, in the frame of current achievements in the fields of polymeric materials and plasma processing of polymers. Adjusting the properties of polymer materials is an important challenge from fundamental as well as from applied point of view. In this respect, new plasma reactors will be designed and constructed, as to allow obtaining specific polymers, under reproducible controlled conditions. Polymeric materials with special properties will be obtained using atmospheric-pressure plasma methods, complementarily to the chemical methods and the low-pressure plasma techniques. In parallel, other physical and chemical methods will be explored for obtaining hybrid materials, composites and nanocomposites, targeting special polymer properties. Besides, the author aims to exploit her teaching skills, her ability to manage interdisciplinary research and her experience in managing teams of young researchers to achieve performance with students at PhD level.