Morphological and structural properties of materials with potential in optoelectronics, tissue engineering and photocatalysis

- Abstract -

The most important changes occurred in our live in the last decades were principally due to the science development. The chemistry contribution was extremely noticeable at the beginning of the 20th century, when large production of ammonia, sulphuric acid, cement, iron, aluminum, drugs, fibres, dyes, polymers, plastics, petroleum products, etc. changed considerably the world. In the 1950s and beyond, the physics signature gained a huge interest, when the advent of semiconductor facilitated the development of electronics. There are researchers who anticipate that the next period would be of the materials and biology. The evolutions in synthesis and characterization of the nanostructured materials have proved the remarkable potential of some materials and devices to exhibit unique capabilities. Once the nanotechnology gets into our lives, the dimensionality of a system starts to play a crucial role on its physical behavior. Sometimes, the nanostructures exhibit distinctive properties and morphological flexibility that confer them both a multifunctional character and, an adequate compatibility with organic and inorganic systems. On the other hand, a large palette of concerns governs our life, and, as a consequence, the progresses occurred in various domains like ecology, biomedicine or energy production become vital. Therefore, it is highly likely that the interfaces between disciplines rather than the disciplines themselves would especially contribute to the future developments. Having in mind all these aspects and taking into consideration the research topics where I was involved in the last years, the Habilitation thesis comprises just a collection of results originating from investigations of materials that were found to exhibit real potential in optoelectronics, bio-medical and environmental applications. Thus, after a short introduction, in which the thesis sections are described, the scientific and professional results are presented, and finally, several development directions of my academic career are pointed out. The scientific information closely related to the research activity I performed in the last years can be found in the chapter entitled Scientific and professional results. In this section, the structural properties of materials with potential in optoelectronics will be firstly discussed, the attention being focused on the structural particularities of the systems based on Bi_2O_3 and B_2O_3 and the structural analysis of the glasses

and glass-ceramics based on Bi_2O_3 and B_2O_3 containing high transition metal oxide content (Fe_2O_3 and V_2O_5). Then, the results obtained from the morphological and structural investigations of a few materials with potential in tissue engineering applications are presented. In this respect, aspects related to the structural features of the bioactive systems based on P2O5 and SiO_2 were discussed alongside the morpho-structural properties of phosphate glasses containing silver oxide, and, at the end of this subsection, the hydrogen peroxide influence on the textural and structural characteristics of bioactive silicate glasses was analysed. The chapter entitled Scientific and professional results ends with the descriptions of the analyses performed on materials with potential in photocatalytic applications, the interest being especially directed to the study of the morphological and structural particularities of the materials based on TiO_2. Morphological and structural details related to the aerogel like structures are presented, including the optimization of the titania nanoparticles for efficient photodegradation of the chemical pollutants, the nano-size effects in anatase titania crystallites and the photocatalytic behavior of the porous nanocomposites based on TiO_2 and Au/Ag nanoparticles. Based on the scientific experience I accumulated in the last period and taking into consideration the current progress in material science domain, the development directions of my future academic career will be mainly focused on the morphological and structural analysis of materials with potential in biomedical and environmental applications. Briefly, they will be related to the following two topics: (a) studies of the structural particularities of the surfaces and interfaces of various systems with applicative potential in tissue engineering and environmental domains, and (b) morphological analyses of the porous nanostructures involved in biomedical and environmental applications. These development directions will be permanently correlated with the academic courses, seminaries and laboratories in which I will be involved. In this way the students will have the opportunity to better understand the reasons behind the studies conducted on materials with targeted applications as well as the way in which the structure-properties correlations could be controlled.