NANOSTRUCTURED OXIDE MATERIALS AND FUNCTIONALIZED MATERIALS WITH APPLICATIONS IN ENVIRONMENTAL PROTECTION

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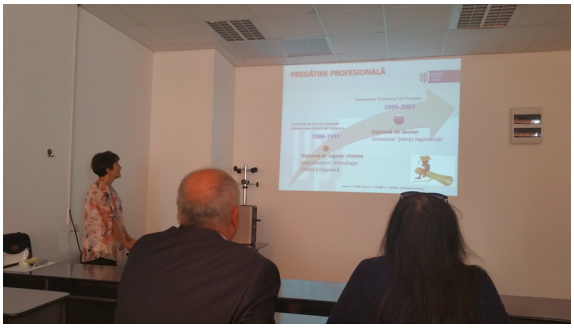
Abstract

The habilitation thesis is structured in two parts, and is based on 28 personal scientific papers (14 as lead author), of which 24 published in ISI ranked journals and 4 published in journals indexed in other international databases.

In the first part of the thesis are presented the main professional, scientific and academic achievements obtained after the candidate defended the PhD thesis in 2004.

The scientific research activity that is the subject of this thesis was directed towards the synthesis and characterization of two types of materials: nanostructured oxide materials and materials functionalized by impregnation with various extractants. Some of the materials obtained have been tested in environmental applications. These have been successfully used for the adsorption of dyes and metallic ions from dilute aqueous solutions, in view of applying these processes either for treating wastewater or for recovering valuable chemical species.

For the synthesis of nanostructured oxide materials, the thermal decomposition of carboxylate complexes (precursor) was used. This method produces oxide powders with nanometric particles at relatively low temperatures, with a yield of practically 100 %. Carboxylate precursors were obtained by the redox reaction between metal nitrates and polyols. The decomposition of carboxylates at relatively low temperatures (300-350°C) led to single/mixed oxide mixtures with high reactivity. By calcining them at suitable temperatures, the oxide systems with the desired compositions were obtained. With this new method, several spinel oxide systems with nanometric particles were prepared: ferrites MFe_2O_4 (M = Co, Cu, Ni, Zn), maghemite γ-Fe_2O_3 and zinc aluminate $ZnAl_2O_4$. ZnO-Zn_2SiO_4-SiO_2 nanocomposites having different compositions and properties were prepared by the sol-gel method modified by an original procedure, involving the thermal decomposition of Zn (II) carboxylates dispersed in the pores of silica gel. Cobalt, copper, nickel and zinc ferrites have been tested for adsorption of Congo red dye from aqueous solutions, and have proven to be materials with remarkable adsorbent properties.



In view of improving their adsorbent properties, magnesium silicate and Amberlite XAD7 resin have been functionalized with extractants containing nitrogen, phosphorus and sulfur functional groups (tetrabutylammonium dihydrogen phosphate, tetraethylammonium bromide, sodium β-glycerophosphate, and thiourea), which are considered "green", being environmentally friendly. The so-functionalized materials were used for the adsorption from aqueous solutions of rare metals ions: Eu (III), La (III) and Nd (III). Experimental results have shown that these are effective adsorbent materials, with remarkable efficiency. Moreover, these materials have the advantage that they have been obtained by easy and non-polluting methods.

In the second part of the habilitation thesis are presented the plan of evolution and development of the professional, scientific and academic career, the proposed objectives and the future research directions.

The full abstract at:
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