HABILITATION THESIS

Heterogeneous photocatalysis process for advanced wastewater treatment – evaluation, modelling and processes optimization

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Summary

Environmental pollution caused by the increase of pollutant loads discharged into water is one of the major problems faced by the international community, requiring the formation of a new/updated framework for regulation and control. Compounds including natural organic matter and synthetic organic micro-contaminants, for example phenols, surfactants, pharmaceuticals, polychlorinated biphenyls, fertilizers and pesticides, are constantly released into the environment by industry, households, and agriculture.

Conventional wastewater treatments remove most of pollutants by cost-effective treatment steps like sedimentation, filtration, adsorption, and biological processes, all of which are deemed relatively effective for the treatment of wastewater. However, biologically toxic and non-degradable organics can often still remain.

In 2020, the industrial use of water in Europe increases the water costs up to 25% of the total production cost, and only 50% of wastewater is treated. The need for innovation will increase significantly in the near future. In the European Union (EU), 2014 marks the start of 5 years of a new environmental priority focus on **improving recycling and wastewater treatment for water reuse**.

In this context, the **photocatalytic technologies of wastewater treatment** must be considered from an environmental perspective, that use of solar light as "green energy" would reduce the environmental impact.

The habilitation thesis entitled **"*Heterogeneous photocatalysis process for advanced wastewater treatment – evaluation, modelling and processes optimization*"** proposes research about **new environment-friendly photocatalytic technologies** for improving the water quality by reducing the pollutant impact of environment, using photocatalytic versatile hybrid materials.

Heterogeneous photocatalysis represents a rather recent approach for water decontamination, being an eco-friendly process based on semiconductor materials. The innovative development of a wide range of environmental applications, such as photocatalytic wastewater decontamination, requires improvements in the performance of semiconductor materials,

particularly band gap engineering for VIS-active applications, rather than the state-of-the art UV-activated materials.

The fabrication of the very stable TiO_2 material in combination with semiconductor offers an important path to combine the different properties of individual components into one system, yielding hybrid materials which provide excellent performance. To support these eco-friendly technologies the materials are obtained by low-cost and up scalable techniques: sol-gel, photochemical precipitation, doctor blade and dip-coating processes, techniques with high confidence in the results reproducibility, along with highly accurate and **environmental friendly techniques.**

The habilitation thesis contains interdisciplinary expertise in photocatalytic application in the environment, wastewater pollution control, monitoring and modelling, materials synthesis and its characterisation, process modelling in semiconductor. All the above can fit into the fields of **environmental engineering and materials engineering.** The habilitation thesis consists of four main parts: **1. Scientific, professional and academic achievements, 2. Contribution to photocatalysis application in wastewater treatment 3. Plan of evolution and development of scientific, professional and academic career and 4. References.**

After obtaining the PhD title in 2010, I have continuously been conducting my research activity at the Transilvania University of Brasov, addressing multidisciplinary topics: **optimizing photocatalytic processes** that involves new solutions, development of photocatalyst based on semiconductors allowed thermodynamic modelling of **band gap position in hybrid systems of two semiconductors**, a new approach to multi-component systems of dyes by simultaneous analysis of mixed solutions of two dyes using first-order derivative absorption spectra of dyes solutions, developed and prototyped of a **laboratory photoreactor with controlled** radiation (UV and/or Vis), **heterogeneous photodegradation of industrial wastewater** from textile industry, photodegradation of wastewater - laboratory and scale-up **experiments in solar pilot plant**.

The scientific recognition has been proven through publishing more than **35 contributions to International Conferences** with posters and oral presentation, over **65 publications in peer-reviewed journals and conference proceedings**, **40 publications** indexed in ISI Thomson Journals (**17 as main author**, 22 as co-author and 1 editorial paper), **2 books** in recognized publishing houses (CNCSIS) and **4 chapters** in books published in international publishing houses. The scientific research carried out so far led to the coordination of the **one project as director** and **1 project as scientific responsible**, **member in over 15 national and international projects.** The impact of international and national scientific activity of the candidate measured by **430 citations in Web of Knowledge** and **index Hirsch is 13**.