Warsaw, 18th September 2017

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Abstract of the PhD thesis

SonoPhotoDeposition: coupling of sonication and photodeposition in the synthesis of titanium dioxide–based photocatalytic materials

This thesis presents basic experimental studies in the field of materials synthesis. The application of green energy sources, ultrasound, and light irradiation in the synthesis procedure of materials with photocatalytic properties is studied herein. In situ coupling of sonochemistry with photochemistry, in so-called sonophotodeposition, for deposition of metal species on the surface of semiconducting material (e.g., TiO_2) may result in the formation of a new powerful methodology. This synergistic action between ultrasound and light irradiation may provide many advantages for this process: no need to add harmful chemical-reducing agents, time-saving, and simplicity of the process, among others.

My dissertation is composed of introduction to the subject area and discussion of the submitted publications. In the introductory part, key information about sonochemistry, photochemistry, and the synergism between the ultrasound and photochemical processes is presented. The research part of this dissertation is submitted in the form of six publications. The first one (patent application) introduces the general idea and the possibilities of the sonophotodeposition method in the synthesis of materials. The next four publications are research articles that study in detail TiO_2-based systems doped with different metals. The first metal deposited on commercial TiO_2 surface by simultaneous use of light and ultrasound was palladium. Next, a possibility of sonophotodeposition of two metals was studied. Combinations of noble metal and transition metal—platinum-iron and palladium-iron pairs—were sonophotodeposited on the self-prepared semiconductor material composed of TiO_2 supported on zeolite Y. Another task concerned deposition of iron oxide on TiO_2/zeolite Y. Iron is a transition metal with a negative reduction potential, which is difficult to reduce; therefore, its photodeposition was scarcely reported in the literature. In a subsequent work, a detailed comparison of this methodology with sonodeposition and photodeposition was supposed to give an answer about the real contribution of ultrasound and light irradiation to the process of sonophotodeposition. The final article of my dissertation is a review that compares the role of ultrasound in simultaneous combination with photodeposition (sonophotodeposition) and with electrodeposition (sonoelectrodeposition) and discusses the utility of these methods in the synthesis of materials.