Abstract of the PhD dissertation
"Preparation of molecular structures and their potential applications"
Author: mgr inż. Martyna Baca
Supervisor: prof. dr hab. inż. Ryszard J. Kaleńczuk
Auxiliary supervisor: dr inż. Małgorzata Aleksandrzak

The main aim of presented PhD dissertation was to obtain molecular structures for hydrogen storage, photocatalytic removal of organic pollutants and photocatalytic hydrogen generation from water splitting. Mesoporous carbon spheres were used as templates, which were further modified through palladium, platinum, titanium dioxide or graphitic carbon nitride, respectively. Analysis of metal-modified hybrids enabled the determination of the optimum size of metal nanoparticles as well as the selection of the preparation method that ensures the highest efficiency of hydrogen sorption. Based on the conducted research, it was established that the gas capture capacity was the result of the following phenomena: physical adsorption, formation of metal hydrides and the "spillover" effect.

The activity of CS/TiO_2 photocatalysts with various titanium dioxide content was assessed in the process of photocatalytic decomposition of Rodamine B under ultraviolet and simulated solar light irradiation. The activity of the CS/GCN photocatalyst was evaluated by Acid Red 18 decomposition under simulated solar light irradiation. The photocatalysts characterization allowed to state that their efficiency compared to the used references (TiO_2 prepared from titanium butoxide for CS/TiO_2 catalysts, graphite carbon nitride for CS/GCN catalysts) can be attributed to a well-developed specific surface area of nanocomposite, enhanced visible light absorption range, greater contact surface between hybrid ingredients and the suppression of photogenerated charge carriers recombination.

The next step of presented study was to determine the influence of the type of mesoporous shell structure on the graphitic carbon nitride deposition efficiency and ultimately the photocatalytic hydrogen generation performance. Based on conducted analytical methods, it was found that both the physicochemical and electrochemical properties of the obtained photocatalysts differ significantly depending on the type of mesoporous shell. It was noted that the composite with a mesoporous ordered shell was characterized by a more homogenous graphitic carbon nitride deposition, which caused the increase in photocatalytic hydrogen evolution.

The influence of the surface modification of graphitic carbon nitride on its physicochemical, electrochemical and photocatalytic properties was also analyzed. It has been proven that the appropriate surface modification of the material (while maintaining similar physicochemical properties) has a significant impact on the design of photocatalytic processes, in particular the photocatalytic decomposition of organic pollutants from water and photocatalytic removal of volatile compounds.

This work confirmed the validity of applying carbon spherical structures to form core-shell composites and their further use as both hydrogen sorbents and photocatalysts.

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