Abstract

The global challenges facing the modern world include environmental pollution, the intensifying greenhouse effect, and the dwindling resources of fossil fuels as conventional energy sources. Therefore, it is necessary to take measures to reduce pollutant emissions or mitigate their negative impact. This work focuses on the development of new photocatalysts that can be used as potential materials for the photodegradation of organic pollutants, the photogeneration of hydrogen as a green fuel, and the photoconversion of carbon dioxide into useful fuels.

The research involved the preparation and characterization of four series of photocatalysts based on NH_2-MIL-125 (Ti). The first series yielded two types of materials: hybrids composed of a metal-organic framework, TiO_2, and noble metal nanoparticles, and framework derivatives modified with noble metal nanoparticles. These materials were tested in model photocatalytic reactions of phenol degradation and hydrogen photogeneration. The second series of materials involved developing a method to modify NH_2-MIL-125 (Ti) with copper and/or silver via metallation, photodeposition, or incorporation. The resulting materials were used for the photoconversion of CO_2 to formic acid under visible-light irradiation. The third series of materials included metal-organic frameworks obtained using a new hot injection molding method and tested for photodegradation of phenol. The powders obtained by this method were also compared to materials obtained by the classical solvothermal method. Based on the new synthetic procedure, materials for the fourth series of studies were obtained, which contained NH_2-MIL-125 (Ti) oxide derivatives modified with Cu, Ni, or Co. The photocatalysts from this series were tested in the photodegradation of pollutants with simultaneous hydrogen generation using natural seawater as the reaction medium. Furthermore, all materials obtained from the four series were comprehensively characterized in terms of their physicochemical properties, and a photoreaction mechanism was proposed.

Based on numerous studies, stable photocatalysts and photocatalytic reaction systems have been proposed. This research has increased the scientific contribution to the field of metal-organic frameworks – particularly to the chemistry of NH_2-MIL-125 (Ti) and demonstrated the application potential of this material.