ABSTRACT

Photocatalytic hydrogen generation is a promising process for obtaining this valuable ecological fuel. However, the efficiency of the photocatalytic process depends largely on the photocatalyst used. One of the most important challenges in the field of heterogeneous photocatalysis is creating a photocatalyst with high photocatalytic activity and stability, which can be achieved by combining appropriate materials into hybrid nanostructures.

The scientific goals of this doctoral thesis were: (*i*) to develop simplified and repeatable methods for the synthesis of new hybrid nanostructures demonstrating increased efficiency in photocatalytic hydrogen generation under the influence of radiation in the ultraviolet and visible ranges, (*ii*) to characterize the physicochemical properties of the resulting structures, and (*iii*) to correlate the synthesis conditions with photoactivity and surface properties. The doctoral thesis consists of two main parts. The first part is a theoretical introduction introducing the topic of photocatalytic hydrogen generation and the application of hybrid materials based on perovskites and Janus nanoparticles. The second part of the work contains four scientific articles, preceded by an introduction to the synthesis methods of individual hybrid photocatalysts and the techniques used to determine their physicochemical properties, a description of the methodology for the photocatalytic hydrogen generation process, and a brief overview of the research presented in each article.

As part of the research, four types of hybrid materials were developed, demonstrating potential for photocatalytic applications. Approaches were employed based on combining semiconductors with noble metals and metal-organic frameworks with perovskite particles.

Photocatalytic activity in the hydrogen generation reaction was measured in the UV-Visible (for series 1, 2, and 4) and Visible (for series 3) radiation ranges. The results of the photocatalytic activity studies and the characterization of the nanomaterials allowed for a thorough explanation of the reaction mechanisms and the influence of the morphology and composition of the hybrid systems on the efficiency of the photocatalytic process.