The Research Group

General Chemistry

has the honor to invite you to the public defense of the PhD thesis of

Ali Moussadik

to obtain the degree of Doctor of Sciences

Joint PhD with Mohammed V University

Title of the PhD thesis:

Nanotechnology and photocatalysis for the treatment of organic pollutants in wastewater

Promotors:

Prof. dr. Frederik Tielens (VUB)
Prof. Mohammed Halim (Mohammed V University)
Prof. Adnane El Hamidi (Mohammed V University)

The defense will take place on

Saturday, October 21, 2023 at 10 – 13h in Rabat

The defense can also be followed through a livestream.
Please contact ali.moussadik@vub.be for more information.

Members of the jury

Prof. Abderrahman Nounah (Mohammed V University, chair)
Prof. dr. Frank De Proft (VUB, secretary)
Prof. dr. Marc Elskens (VUB)
Prof. Mouloud El Moudane (Mohammed V University,MA)
Prof. dr. Monica Calatayud (Sorbonne Université, FR)
Prof. dr. Abdellah Aaddane (University Hassan II, MA)
Prof. Mohamed Kacimi (Mohammed V University, MA)
Prof. Abdellah Benzaouak (Mohammed V University,MA)

Curriculum vitae

Ali Moussadik obtained his MSc degree in Environmental and Analytical Sciences from the Mohammed V University in Rabat (UM5R) in 2017 and then continued his PhD studies. He started his PhD program in the same year at the UM5R within the Laboratory of Materials, Nanotechnologies, and Environment. In September 2021, Ali joined the General Chemistry team at the VUB as a joint-PhD researcher. The aim of his PhD was the preparation of Ag-based nanocomposites and their applications in catalysis and photocatalysis, in particular industrial wastewater treatment. During his PhD, he published six peer-reviewed papers in international journals, and two have been submitted. He also participated at several conferences and has teaching experience at the UM5R.

Abstract of the PhD research

Wastewater pollution by different types of contaminants has become one of the most pressing challenges that threaten our modern society. Among various anthropogenic contaminants, organic pollutants present a serious problem because of their persistence in the environment and high toxicity. The goal of this research is to develop a multifunctional Ag-based material that can effectively eliminate a variety of organic pollutants from wastewater.

In the first part of this thesis, we prepared self-supported Ag nanoparticles (NPs) on the surface of $AgM_2(PO_4)_3$ NASICON-type materials using a facile wet chemical route. The successful growth of Ag NPs on the NASICON matrix has been confirmed through different characterization techniques. The synthesized Ag NPs were also characterized during real-time in situ formation by UV-Vis spectroscopy. The investigated applications of the supported Ag NPs include the catalytic reduction of methylene blue, methyl orange, and 4-nitrophenol, chosen as target organic pollutants. The results showed that Ag NPs can effectively catalyze the reduction of organic dyes and nitrophenol water pollutants. Additionally, we demonstrated that the catalysts have long-term stability, can be used repeatedly for multiple cycles, and can also be recycled several times thanks to the NASICON-type material regeneration abilities.

In the second part of this dissertation, we studied the photocatalytic performance of $AgM_2(PO_4)_3$ for the decomposition of organic dyes under visible light illumination. The optical and electronic properties of the Ag-based photocatalysts have been examined in detail, combining experimental and density functional theory (DFT) studies. The experimental band gaps of $AgM_2(PO_4)_3$ materials were determined using UV-Vis DRS. We used the DFT+U method to investigate the electronic structure of $AgM_2(PO_4)_3$. The results showed that this method can simulate the proper localization behavior of the strongly correlated electrons, cancel the self-interaction error, and consequently reproduce the experimentally observed band gap. Next, we self-supported Ag_2O NPs on $AgM_2(PO_4)_3$ via a sodium hydroxide-assisted precipitation. The successful synthesis of the Ag-nanocomposite was verified by XRD, EDX, and SEM techniques. The visible-light photocatalytic activity was then studied for the decomposition of organic dyes. It was observed that all synthesized Ag-photocatalysts could effectively degrade aqueous dyes under visible-light illumination. Finally, the stability, recyclability, and regeneration of photocatalysts were investigated, and possible photocatalytic mechanisms were proposed.