Essay summarizing the scholarship period

Introduction

The presence of micropollutants on a large scale, particularly in virtually every aquatic ecosystem, has become a major problem. The widespread presence of man-made products, such as pharmaceuticals, dyes, pesticides, plastics, etc., are being detected daily, and investigation into their damaging impact on the biosphere and even human health do not show any positive aspects either. Pollution reaches the environment by different pathways, most abundantly through wastewater treatment. Given the global significance of clean water resources, new processing solutions of wastewater are required. The possibilities of TiO_2 photocatalysis are vast, ranging from clean energy production to water purification using solar irradiation. However, the activity of pure TiO_2 under solar irradiation is hindered by low absorption within the visible spectrum because of its wide bandgap energy and quick photogenerated charge recombination. In order to extend the photoactivity of titanium dioxide into the visible region, highly efficient graphene-based composite catalysts were synthesized by a one-pot hydrothermal procedure using titanium (IV) isopropoxide (TTIP) as a precursor. Commercially available flakes of graphite (particle size $\leq 50\ \mu m$) were used for the synthesis of graphene oxide (GO) by the Hummers method and its reduction (rGO).

The aim of mobility was to characterize and investigate application of TiO_2@graphene-based composite catalysts for enhanced decomposition of various potential pollutants in aqueous solution (such as pharmaceuticals, pesticides, dyes, etc.) using different irradiation source.

Timeframe (12.06-12.08.2022.)

TiO_2@graphene-based composite catalysts were previously prepared during PhD study as experimental part of doctoral studies. To provide information related to the synthesized TiO_2@graphene-based composite catalysts, the advanced characterization of synthesized catalysts was performed. The physical and chemical properties of the synthesized materials were investigated by different characterization methods. More precisely, the prepared catalysts were characterized by micro-Raman spectroscopy, Fourier transforms infrared spectroscopy (FTIR), and thermogravimetric analysis (TGA)/differential scanning calorimetry (DSC). The specific surface area was performed by the Brunauer-Emmett-Teller (BET) method with a nitrogen adsorption analyzer. The stated techniques were necessary to fully understand the nature of prepared catalyst, which then can be used for interpretation of photocatalytic tests.

Photocatalytic degradation of colour and colourless pollutants in the aqueous medium was performed to investigate the photocatalytic efficiency of prepared TiO_2@graphene-based composite catalysts. The synthesized TiO_2@graphene-based composite catalysts were tested for the efficient degradation of methylene blue (MB) dye as a colour pollutant, as well as coumarin and hydroquinone as colourless test compounds. The photocatalytic efficiencies of the prepared TiO_2@graphene-based composite catalysts were monitored under different irradiation sources using UV, UV-Vis, and visible lamps for all used model compounds. In the photocatalytic experiments, coumarin was used as a hydroxyl radical scavenger, while hydroquinone was used as a superoxide radical anion scavenger. Determining and comparing the rate of formation of active radicals facilitated the characterization of catalysts with different compositions. Thus, it was possible to explore the role of the modifying component (reduced graphene oxide).

The degradation of pollutants is monitored by UV-Vis spectrophotometer as well as high-performance liquid chromatography (HPLC) measurements. Mineralisation of irradiated pollutants is analysed by total organic carbon (TOC) measurements.

Concluding remarks

The short study visit scholarship in the frame of a bilateral state scholarship financed by the TEMPUS Public Foundation supported innovation and improved the quality of my PhD thesis on one hand, and on the other hand, mobility experience at the University of Pannonia, in the Research Group of Environmental and Inorganic Photochemistry helped me to expend my scientific knowledge. The strong foundation for further collaboration between the host institution and visiting researcher has been established.