2023 Master internship at University of Gdansk

TITLE : Synthesis and characterization of quantum dot-modified covalent organic frameworks for photocatalytic applications

LAB & PEOPLE

- Name of the hosting lab: Photocatalysis Group (Department of Environmental Technology, Faculty of Chemistry, University of Gdańsk)
- General activities of the lab: nanomaterials synthesis, photocatalysis, materials characterization
- Website: https://chemia.ug.edu.pl/wydzial/katedry/katedra-technologii-srodowiska
- Number of staff / PhD:10 staff members, 9 PhD students
- Supervisor name and contact: Beata Bajorowicz (PhD), Adriana Zaleska-Medynska (Prof.), beata.bajorowicz@ug.edu.pl

TOPIC OF THE INTERNSHIP

- Scientific context of the internship (max 20 lines)

Nowadays, the energy crisis and environmental pollution have become worldwide concerns. Photocatalysis, as a green and sustainable technology that uses solar energy for either hydrogen production via water splitting or environmental degradation of pollutants, is considered to be a promising strategy to overcome these issues [1,2]. However, searching for highly efficient, low-cost, stable, visible-light-responsive photocatalysts is still a challenge in photocatalysis field [3,4]. Among various organic materials, covalent organic frameworks (COFs) show the highest potential for photocatalysis owing to their excellent properties: tunability, crystallinity, stability, large surface area and high porosity, low density [5-7]. Nevertheless, until now, only a small number of COF-based photocatalysts have been explored and development of new modification method (including pore engineering and proper functionalization) of COFs to obtain visible-light-active photocatalytic system is highly desired. The integration of functional materials such as quantum dots (QDs) with COFs can be a novel and promising strategy to extend their absorption edge into the visible light region, improve charge carriers separation and transfer and thus enhance their photocatalytic performances [8].

Therefore, the aims of this project are: (1) to develop a new class of porous organic framework-based photocatalysts by combining COFs with heavy metal free quantum dots into a hybrid system exhibiting enhanced photocatalytic activity; (2) to investigate the influence of QDs size, amount and attachment method to the surface of COF materials on the optical, surface

and photocatalytic properties; and (3) to measure the efficiency of covalent organic framework-based hybrids in hydrogen photogeneration and pollutants photodegradation reactions.

Keywords : quantum dots, covalent organic frameworks, photocatalysis, hydrogen production

Bibliography :

1. Nakata, K.; Fujishima, A., J. Photoch. Photobiol. C (2012) 13, (3), 169-189.
2. Hoffmann, M. R.; Martin, S. T.; Choi, W.; Bahnemann, D. W., Chem. Rev. (1995) 95, 69-96.
3. Koe, W.S., Lee, J.W., Chong, W.C. et al. , Environ Sci Pollut Res (2020) 27, 2522–2565.
4. Rajeshwar, K.; Thomas, A.; Janáky, C. J. Phys. Chem. Lett. (2015) 6, 1, 139–147.
5. Vyas, V. S.; Lau, V. W.; Lotsch, B.V. *Chem. Mater.* (2016) 28, 5191−5204.
6. Wang, H.; Wang, H.; Wang, Z., Tang, L.; Zeng, G.; Xu, P.; Chen, M.; Xiong, T.; Zhou, C.; Li, X.; Huang, D.; Zhu, Y.; Wang, Z.; Tang, J. *Chem. Soc. Rev*.(2020) 49, 4135-4165
7. 7. Liu, S.; Zhang, C.; Sun, Y.; Chen, Q., He, L.; Zhang, K.; Zhang, J.; Liu, B.; Chen, L.F. Coord. Chem. Rev. (2020), 413, 213266.
8. Wang, TX..; Liang, HP.; Anito, D. A.; Ding, X.; Han, BH. J. Mater. Chem. A (2020) 8, 7003-7034.

Tasks and duties entrusted to the student:

The intern will synthesize quantum dots with different sizes, porous organic frameworsks with appropriate functional groups and COFs/QDs hybrid materials using a postsynthetic approach. Photocatalytic activity of the obtained samples will be studied in hydrogen production via water splitting and toluene degradation in the gas phase. All obtained nanostructures will be characterized to estimate morphology (SEM microscopy), optical properties (DRS UV-Vis and PL spectroscopy), surface area and porosity (BET method).

Skills to be acquired or developed:

Depending on the background of the student, skills in the synthesis of novel photocatalysts, nanomaterials characterization technique and measurement of photocatalytic activity in gas and aqueous phases will be acquired or developed. The student will be introduced to the synthesis of covalent organic frameworks, quantum dots and their composites, as well as the methods used to characterize the morphology, optical and surface properties of obtained hybrid materials.

PROFILE OF THE DESIRED STUDENT

- Minimum level of study required: End of Bachelor's

- Field(s) of study: Chemistry, Environmental Technology, Materials Engineering and related fields

- Scientific skills : basics of inorganic, organic and analytical chemistry

- Language skills required : English (spoken, written)

THE INTERNSHIP ASSIGNMENT:

Desired duration of the internship (in months): 3-6 months

Desired Starting date of the mission: November 2023 – July 2024

Indicative weekly schedule: *35h / week*

Remuneration:

Erasmus grant: could be asked to your own university

Internship agreement: *an internship agreement will be signed.*

To SEA-EU students:

If you're interested please send your CV and letter of motivation to the scientist in charge, email : beata.bajorowicz@ug.edu.pl, before the date 01/10/2023.