2023 Master internship at University of Gdańsk

TITLE : SYNTHESIS OF PEROVSKITE/MOF HYBRIDS FOR CO_2 PHOTOCONVERSION – FROM LABORATORY TO PILOT SCALE

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 characterisation
- 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: Adriana Zaleska-Medynska (Prof.) adrian.zaleska-medynska@ug.edu.pl, Anna Pancielejko (PhD) anna.pancielejko@ug.edu.pl

TOPIC OF THE INTERNSHIP

- Scientific context of the internship (max 20 lines)

In today's world, the pursuit of en efficient solution to achive reduction of CO_2 emision to valuable fuels or valuable chemicals is a priority. The pressing problem of climate change and limited fossil fuel resources has created a need for sustainable and environmentally friendly energy solutions. One alternative method is the photocatalytic CO_2 photoconversion in the presece of selected nanomaterials[1].
The main goal this Master's project is to develop a completely ground-breaking class of hybrid materials consisting of new double perovskite nanocrystals (DPNs)[2], enclosed by pioneering metal-organic frameworks (MOFs)[3] with high activity and selectivity in the phototransformation of CO_2 to valuable hydrocarbons (such as methanol). This hybrid system should combine unique properties: *(i)* DPNs (band structure dependent on composition, size and morphology) and *(ii)* MOFs - high stability in the aquatic environment, huge surface area and porosity, high CO_2 adsorption capacity, catalytic activity and structure enabling load mobility[4]. Future application of hybrids materials requires the development production method in larger scale (switch from a few grams production to a few hundred grams or kilograms production. It requires optimizing: *(i)* parameters of synthesis (temperature and pressure in the case of solvothermal reaction, reaction duration, stirring rate, reagents feeding, *etc.,*); *(ii)* type of raw materials (cheap, available, non toxic, etc.); *(iii)* optimization of unit processes and operations.

Keywords: *hybrid materials, nanomaterials, DPNs, MOFs, CO_2 photoconversion*

Bibliography:

[1] Fu Z., Yang Q., Liu Z., Chen F., Yao F., Xie T., Zhong Y., Wang D., Li J., Li X., Zeng G., Photocatalytic conversion of carbon dioxide: From products to design the catalysts, *J. CO_2 Util.* **2019**, 34, 63-73.

[2] Huang H., Verhaeghe D., Weng B., Ghosh B., ZhangH., Hofkens J., Steele J., Roeffaers M., Metal Halide Perovskite Based Heterojunction Photocatalysts, *Angew. Chem. Int. Ed.* **2022**, 61, e202203261.

[3] Ramyashree M.S., S. Shanmuga Priya, Freudenberg N., K Sudhakar, Tahir M., Metal-organic framework-based photocatalysts for carbon dioxide reduction to methanol: A review on progress and application, *J. CO_2 Util.* **2021**, 101374.

[4] Wu L., Mu Y., Guo X., Zhang W., Zhang Z., Zhang M., Lu T., Encapsulating Perovskite Quantum Dots in Iron-Based Metal–Organic Frameworks (MOFs) for Efficient Photocatalytic CO2 Reduction, *Angew. Chem. Int. Ed*. **2019**, 58, 9491 –9495.

Tasks and duties entrusted to the student:

The intern will synthesise DPNs/MOFs hybrid in a pilot scale. It requires optimizing: *(i)* parameters of synthesis (temperature and pressure in the case of solvothermal reaction, reaction duration, stirring rate, reagents feeding, *etc.,*); *(ii)* type of raw materials (cheap, available, non toxic, etc.); *(iii)* optimization of unit processes and operations. Development of chemical and technological concept of hybrid material synthesis, includs selection of reagents, unit processes and operations, flow chart of manufacturing process, conditions and parameters for each unit processes and operations, preliminary mass balance and energy balance). Characterization of product obtained in pilot scale.

Skills to be acquired or developed:

Knowledge of organic/inorganic synthesis of nanomaterials, methods for the characterization of nanomaterials, and experience in laboratory work will be acquired.

PROFILE OF THE DESIRED STUDENT

- Minimum level of study required: **end of Bachelor or Master degree**

- Field(s) of study: **Chemistry, Chemical Technology, Materials Engineering or related fields**

- Scientific skills : **Knowledge of the basics of physicochemistry of surface phenomena, skills into organic/inorganic synthesis of nanomaterials, methods for the characterization of nanomaterials, experience in laboratory work will be acquired.**

- Language skills required : **English (spoken, written)**

THE INTERNSHIP ASSIGNMENT:

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

Desired Starting date of the mission: *(please indicate the level of flexibility)* from October 2023 to December 2023

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 anna.pancielejko@ug.edu.pl before the date 01/10/2023.