NETWORKING EVENT FOR SLOVENIAN AND FLEMISH RESEARCHERS

Example of bilateral scientific projects: S&T project N1-0028 (2015-2018)

Development of advanced TiO_2-based photocatalyst for the degradation of organic pollutants from wastewater

ARRS

Prof. Dr. Nataša Novak Tušar

FWO

Dr. Radu -George Ciocarlan

28 November 2022, Brussels, BELGIUM

SBRA

Slovenian Business & Research Association

NATIONAL INSTITUTE OF CHEMISTRY https://www.ki.si/en/

more than 70 years of tradition

2013 PREGL RESEARCH CENTER

material science life science

AR-STEM (Jeol, ARM 200 CF)
Supra 35 VP EM with EDX analysis
Confocal microscopy (Leica TCS WLL SMD platform)
800 MHz NMR spectrometer National NMR Centre (CERIC/ERIC)
High performance computing cluster

Department of Inorganic Chemistry and Technology

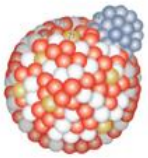
NATIONAL INSTITUTE OF CHEMISTRY

Laboratory for Adsorbents
Laboratory for Catalysts

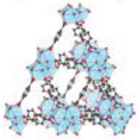
Prof. Dr. Nataša Zabukovec Logar

ZEOLITES
ZEOLITE-LIKE MATERIALS

OXIDE-BASED MATERIALS



METAL ORGANIC FRAMEWORKS (MOF's)



adsorption

catalysis

SYNTHESIS

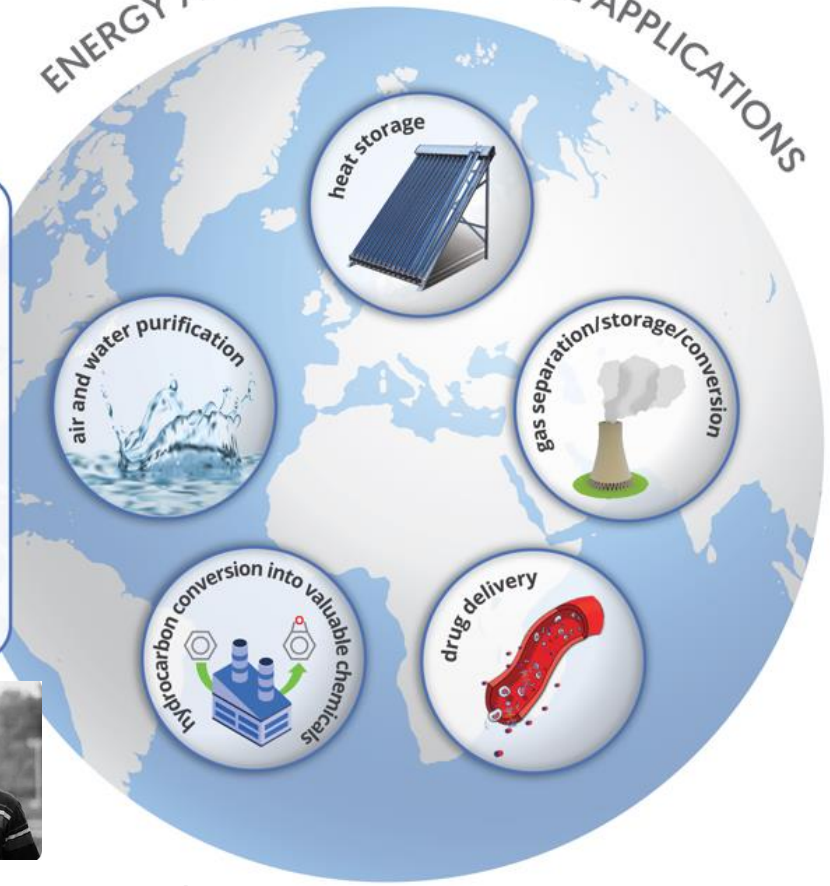
CHARACTERIZATION

CALCULATIONS

TESTING

SCALING UP

Assist. Prof. Dr. Petar Djinović



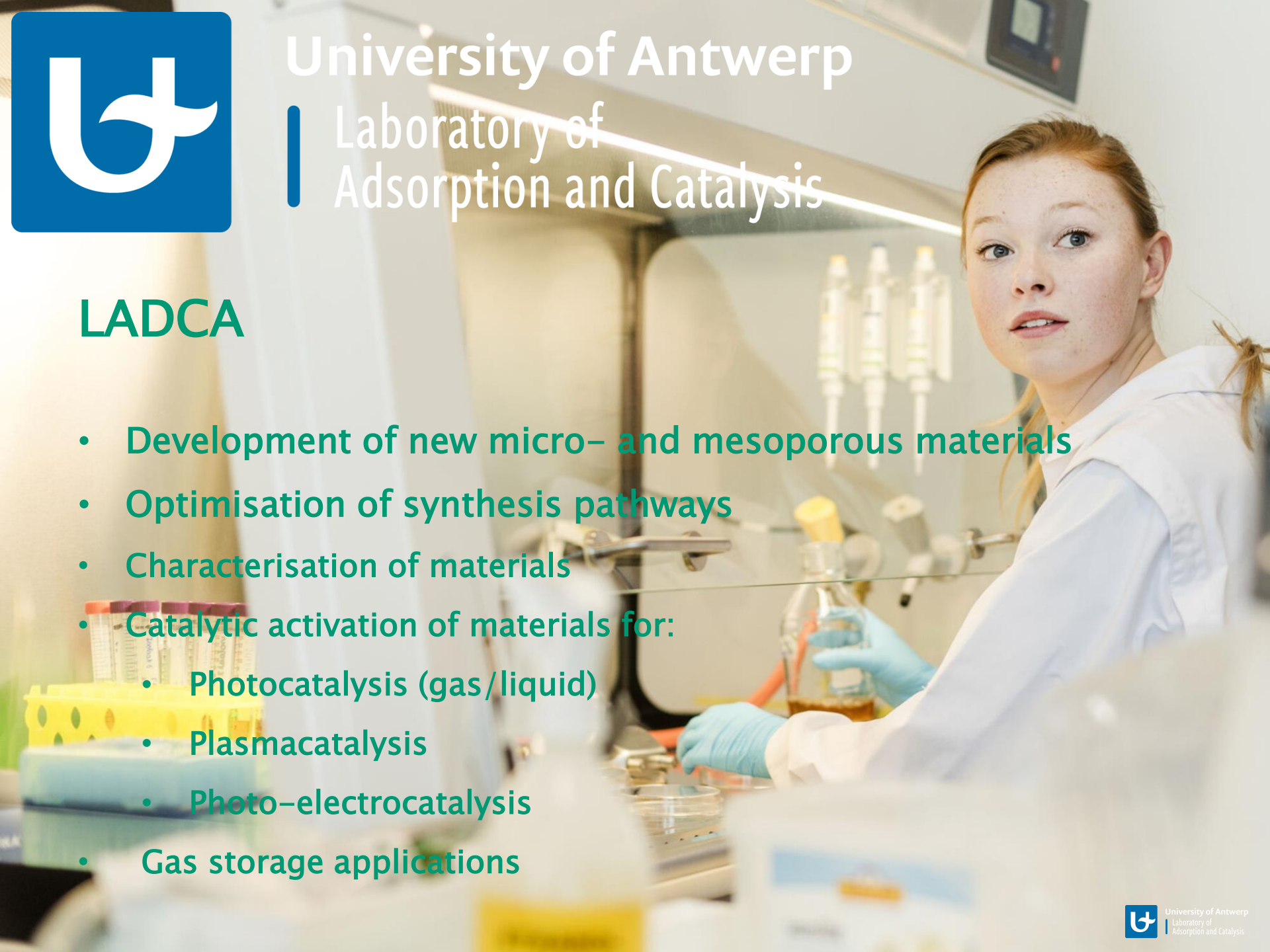
THE BEGINNING

Prof. Dr.
Pegie Cool

Prof. Dr.
Nataša
Novak Tušar

SBRA
Slovenian Business & Research Association


Universiteit Antwerpen
Young University – 2003
>20 000 students
11 Faculties
Faculty of Science
· Bioscience Engineering
· Biology
· Chemistry
· Physics
· Mathematics
· Computer science



University of Antwerp
Laboratory of
Adsorption and Catalysis

LADCA

- Development of new micro- and mesoporous materials
- Optimisation of synthesis pathways
- Characterisation of materials
- Catalytic activation of materials for:
  - Photocatalysis (gas/liquid)
  - Plasmacatalysis
  - Photo-electrocatalysis
- Gas storage applications

Research Foundation – Flanders (FWO)

Fonds Wetenschappelijk Onderzoek - Vlaanderen

Development of advanced TiO_2-based photocatalyst for the degradation of organic pollutants from wastewater

SLOVENIAN RESEARCH AGENCY

Prof. Dr. Pegie Cool

Prof. Dr. Nataša Novak Tušar

UNIVERSITY OF ANTWERP
(FWO: LADCA-UA-BELGIUM):
synthesis of advanced TiO_2 composites and photocatalytic tests of model organic dyes under solar light

Dr. Elena M. Seftel

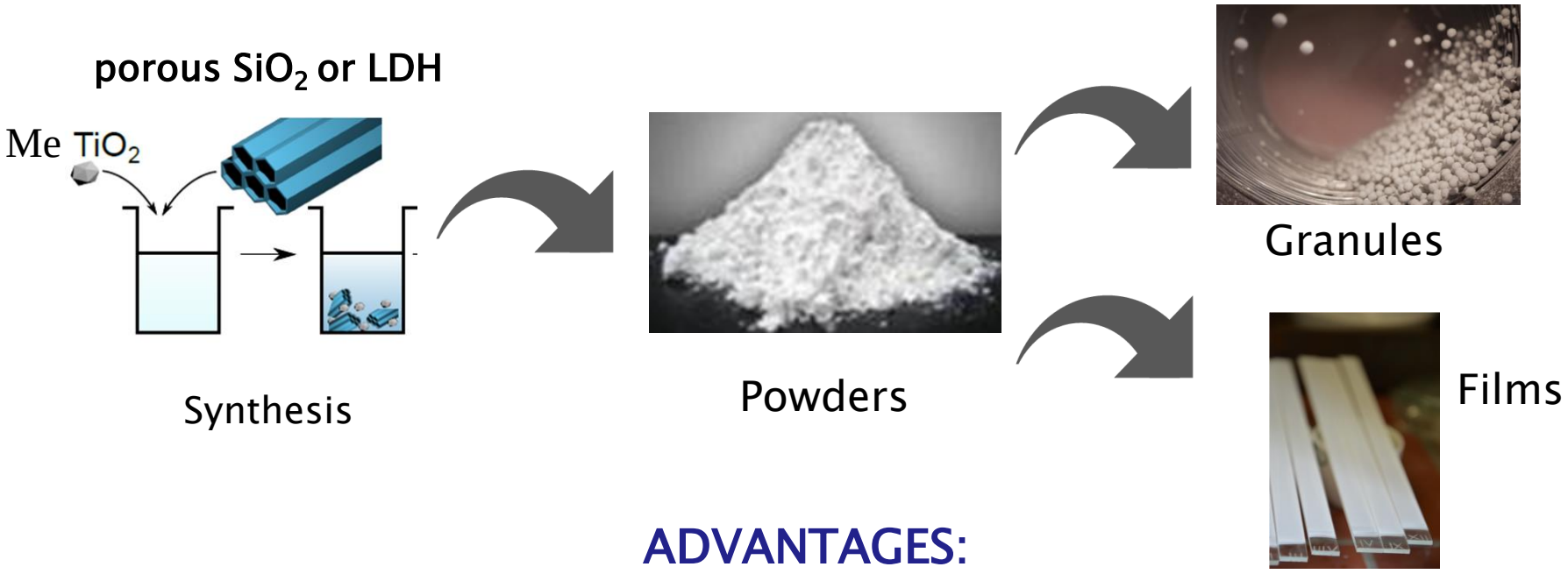
Dr. Radu G. Ciocarlan

NATIONAL INSTITUTE OF CHEMISTRY
(FWO: L09-NIC-SLOVENIA):
advanced characterization of synthesized TiO_2 composites and at the UNIVERSITY OF NOVA GORICA (Laboratory for environmental research) photocatalytic tests of wastewater polluted by dyes under solar light

Dr. Andraž Šuligoj

Prof. Dr. Urška Lavrenčič Štangar

NEW MATERIALS: $MeTiO_2/SiO_2$ and $MeTiO_2$/LDH



ADVANTAGES:

addition of Me – working under visible light
addition of porous SiO_2 or LDH – higher surface area
addition of Fe (LDH) – magnetic properties
films – coating on different carriers
(glass, aluminum, other metals, polymers)

APPLICATIONS:

water cleaning under solar light

Solar photoreactors for water cleaning

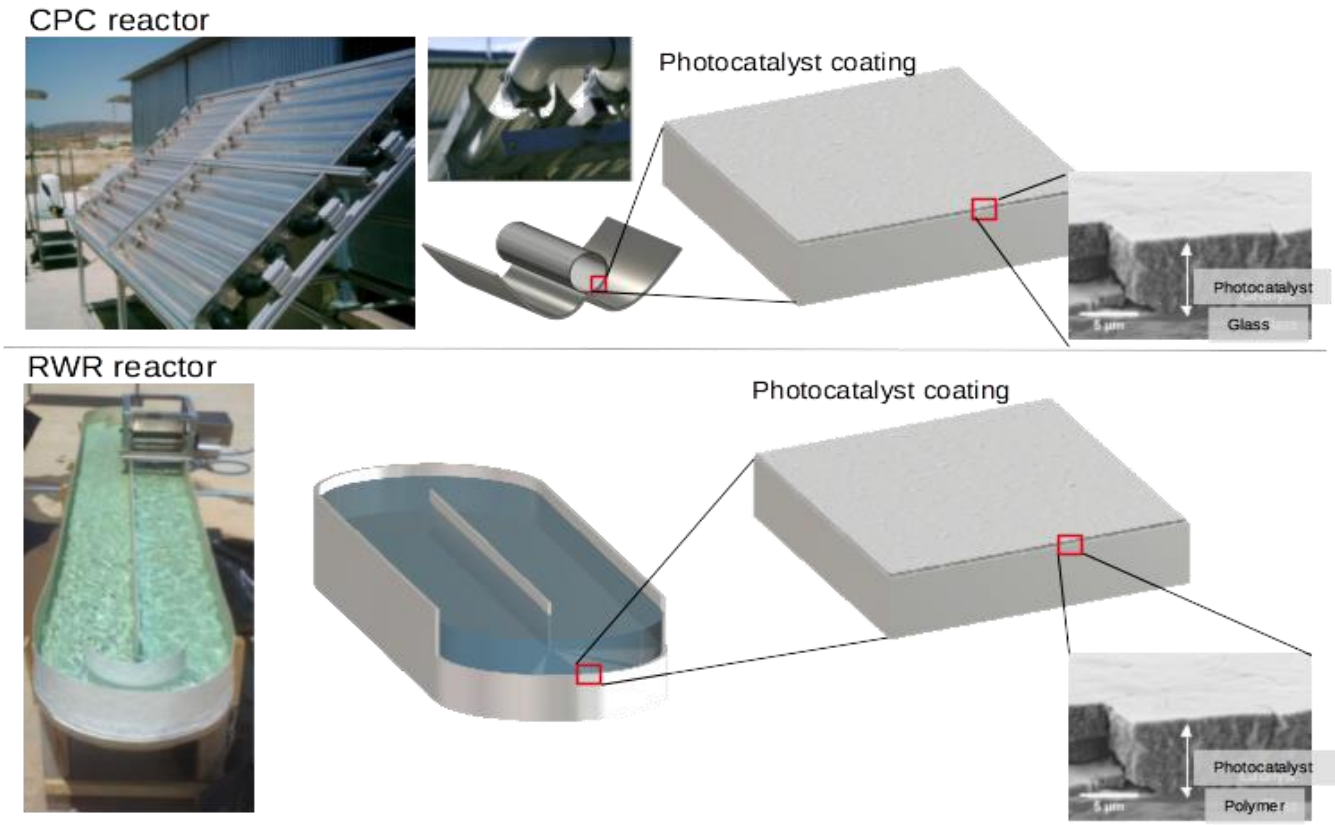


Figure 3: In CPC reactor the tubes will be coated with photocatalyst (stable coatings), which is an important novelty. CPC reactor will be used for industrial wastewater treatment (10 mg organic pollutants per liter). In RWR the walls and the bottom will be coated with photocatalysts (stable coatings) which is also an important novelty. RWR will be used for municipal wastewater treatment (10 µg organic pollutants per liter).

ACHIEVEMENTS
12 published articles

ŠULIGOJ, Andraž, ARČON, Iztok, MAZAJ, Matjaž, DRAŽIĆ, Goran, ARČON, Denis, **COOL, Pegie, LAVRENČIČ ŠTANGAR, Urška**, **NOVAK TUŠAR, Nataša**. Surface modified titanium dioxide using transition metals : nickel as a winning transition metal for solar light photocatalysis. **Journal of materials chemistry. A, Materials for energy and sustainability, 2018**, vol. 6, iss. 21, 9882-9892.
IF = 10.7 ENMIX Award

CIOCARLAN, Radu-G., **SEFTEL, Elena M.**, MERTENS, Myrjam, PUI, Aurel, MAZAJ, Matjaž, **NOVAK TUŠAR, Nataša**, **COOL, Pegie**. Novel magnetic nanocomposites containing quaternary ferrites systems Co0.5Zn0.25M0.25Fe2O4Co0.5Zn0.25M0.25Fe2O4 (M = Ni, Cu, Mn, Mg) and TiO2−anataseTiO2−anatase phase as photocatalysts for wastewater remediation under solar light irradiation. **Materials science & engineering. B, Solid-state materials for advanced technology**, **2018**, 230,1-7. **IF = 3.5**

CIOCARLAN, Radu-George, ARČON, Iztok, PUI, Aurel, MERTENS, Myrjam, **NOVAK TUŠAR, Nataša**, **SEFTEL, Elena M.**, **COOL, Pegie**. In-depth structural characterization and magnetic properties of quaternary ferrite systems Co0.5Zn0.25M0.25Fe2O4 (M=Ni,Cu,Mn,Mg)Co0.5Zn0.25M0.25Fe2O4(M=Ni,Cu,Mn,Mg). **Journal of alloys and compounds. 2020**, 816, 1-11. **IF = 5.3**

Invited lectures:

Nataša Novak Tušar

2016 (AOT-22 and SPASEC-2, Atlanta, USA, 2n Summer Training School of COST FP1306, Leipzig, Germany),
2017 (NANOAPP 2017, Bled, Slovenia),
2018 (NMP-3, Porto, Portugal and Fourth International Conference on Advanced Complex Inorganic Nanomaterials, 2018, Namur, Belgium)

Organizing conference:

Nataša Novak Tušar

NMP-2, International Conference on New Photocatalytic Materials for Environment Energy and Sustainability, National Institute of Chemistry, Ljubljana, Slovenia, July 2-6, 2017

Awards:

Andraž Šuligoj - 2 awards for oral presentations
10th European meeting on Solar Chemistry and Photocatalysis: Environmental Applications (SPEA10), 4.-8. June 2018 Almería, Spain.
2nd Global Conference on Catalysis, Chemical Engineering & Technology, 13.-15, September, 2018 Roma, Italy.

UNIVERSITY OF ANTWERP

Invited lectures

Pegie Cool

28/09/2017 28/09/2017 : Alicante, Spain 6th ENMIX workshop 'Nano-photocatalyst materials with varying metal composition for the efficient Photodegradation of dyes and salicylic acid

05/07/2019 06/07/2019 : Australia IZC19 Pre-conference school, 19th International zeolite conference, 2 hours lecture at the School Nanomaterials for environmental applications (invited talk)

07/07/2019 12/07/2019 Australia 19th International Zeolite Conference, Perth, Australia; lecture The design of nanoporous (photo)catalysts for environmental applications (invited talk)

04/04/2022 07/04/2022 Slovenia NPM-6 and PAOT-7 conferences (New Photocatalytic Materials for Environment, Energy and Sustainability and Photocatalytic and Advanced Oxidation Technologies for the Treatment of Water, Air, Soil and Surfaces), Ljubljana, Slovenia Ti-based nanocomposite materials for photocatalytic CO_2 reduction (this was online lecture)

09/07/2017 12/07/2017 Canada 8th International Symposium on Nanoporous Materials - VIII, Ottawa, Canada: Design of novel LDH-type photocatalysts with varying metal compositions for the efficient photodegradation of dyes, phenol and salicylic acid under VIS-light (lecture)

Organization conferences

Pegie Cool

23/04/2019 - 25/04/2019 Antwerp, Belgium
'New Photocatalytic Materials for Environment, Energy and Sustainability (NPM-4) and Photocatalytic and Advanced Oxidation Technologies for the Treatment of Water, Air, Soil and Surfaces (PAOT-5), University of Antwerp, Belgium

Published articles of doctoral student

Radu-George Ciocarlan

9 published articles
7 conference participations

Experience of doctoral student Radu-George Ciocarlan

5 visits
1 Conference attendance
Research stay at National Institute of Chemistry, Ljubljana, Slovenia

Postojna Cave, Postojna, Slovenia

Experience of doctoral student Radu-George Ciocarlan

Doctoral thesis defense

Research Foundation – Flanders (FWO)

Fonds Wetenschappelijk Onderzoek - Vlaanderen

SLOVENIAN RESEARCH AGENCY

Area of future cooperation with Flemish partners:
projects in the field of
design of catalysts/photocatalysts
for energy and environmental applications –
air and water treatment,
CO_2 conversion,
hydrocarbon conversion to fuels and chemicals

Question on the evaluation process:
Good and bad luck ?

S B R A

Slovenian Business & Research Association

Development of advanced TiO_2-based photocatalyst for the degradation of organic pollutants from wastewater

The treatment of wastewater for the removal of organic pollutants is a world-wide concern. Advanced Oxidation Processes (AOPs) are known as powerful methods, able to decompose toxic organic pollutants. One of the well-established AOP methods for water treatment is photocatalysis with TiO2/UV radiation. The improvement of AOP method for photocatalysis with TiO2 under solar light remains a big challenge. **The main goal of this project is therefore the development of sustainable TiO2 based photocatalysts working under solar light for removal of organic pollutants (dyes) from wastewater.**

Strategies to achieve this goal are:

UNIVERSITY OF ANTWERP (FWO: LADCA-UA-BELGIUM): synthesis of advanced TiO2 composites and photocatalytic tests of model organic dyes under solar light

(i) functionalization of TiO2 with selected transition metals (Me) to modify its electronic properties to make TiO2 active under solar light,

(ii) immobilization of functionalized Me/TiO2 on supports (porous SiO2 and layered double hydroxides - LDHs) to reduce agglomeration and increase the active surface area,

(iii) to transform the Me/TiO2/LDH composites into mixed metaloxide semiconductor photocatalysts with solar light photoresponsive properties,

(iv) photocatalytic tests of synthesized TiO2 composites on solar light with model dyes

NATIONAL INSTITUTE OF CHEMISTRY, SLOVENIA (FWO: L09-NIC-SLOVENIA): advanced characterization of synthesized TiO2 composites and at the UNIVERSITY OF NOVA GORICA (Laboratory for environmental research) photocatalytic tests of wastewater polluted by dyes under solar light

(i) structural characterization of synthesized Me/TiO2/SiO2 and Me/TiO2/LDH composites by advanced characterization techniques (Nuclear Magnetic Resonance - NMR, X-ray Absorption Spectroscopy - XAS, Atomic Resolution – Scanning Transmission Electron Microscopy - AR-STEM),

(ii) to use structural information obtained via (i) to improve and optimize the syntheses of Me/TiO2/SiO2 and Me/TiO2/LDH composites in order to develop advanced TiO2 photocatalysts working under solar light

(iii) photocatalytic tests in real water stream from TEKSTINA Ajdovščina (textile industry, wastewater polluted by dyes)

MEETING with **TREIBACHER** INDUSTRIE AG company 15.6.2022

D09 DEPARTMENT OF INORGANIC CHEMISTRY AND TECHNOLOGY (Head: Prof. Dr. Nataša Zabukovec Logar)

https://www.ki.si/en/departments/d09-department-of-inorganic-chemistry-and-technology/

L20 LABORATORY FOR ADSORBENTS (Head: Prof. dr. Nataša Zabukovec Logar)

https://www.ki.si/en/departments/d09-department-of-inorganic-chemistry-and-technology/l20-laboratory-for-adsorbents/

L21 LABORATORY FOR CATALYSTS (Head: Prof. dr. Nataša Novak Tušar)

https://www.ki.si/en/departments/d09-department-of-inorganic-chemistry-and-technology/l21-laboratory-for-catalysts/