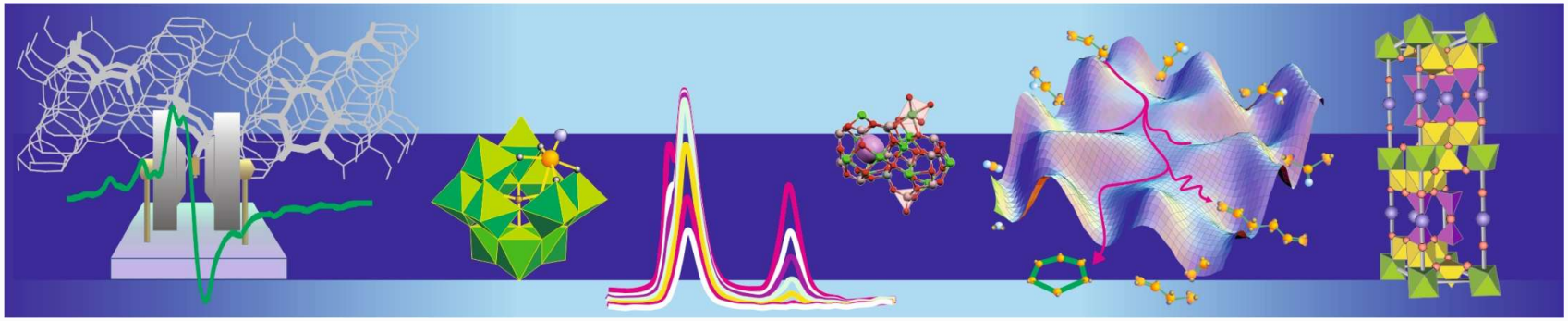
UNIWERSYTET JAGIELLOŃSKI
W KRAKOWIE

Specialization Track

Catalysis and Functional Materials

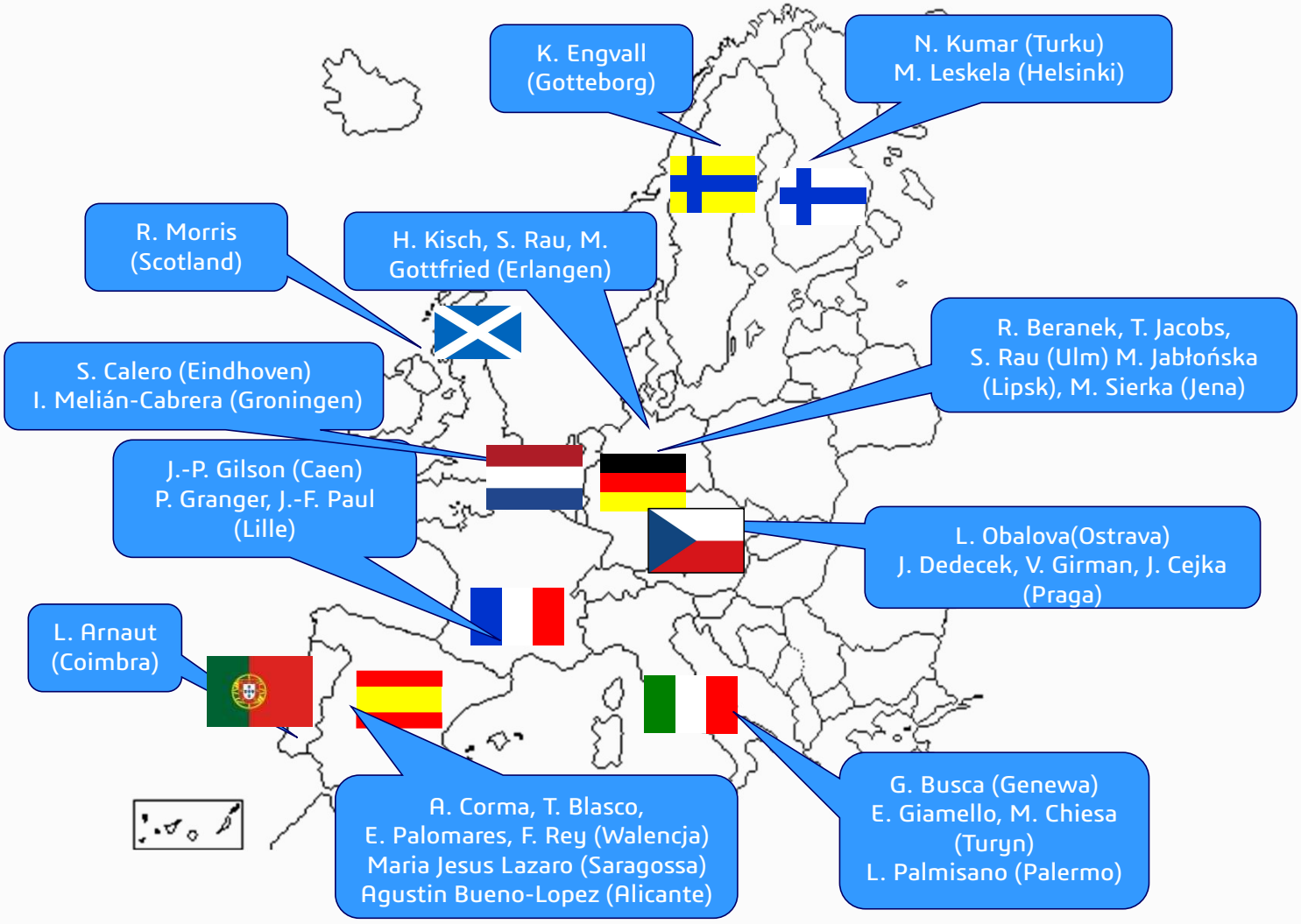


offered by the Department of Inorganic Chemistry
across 5 Research Teams

Track coordinator: Professor Zbigniew Sojka

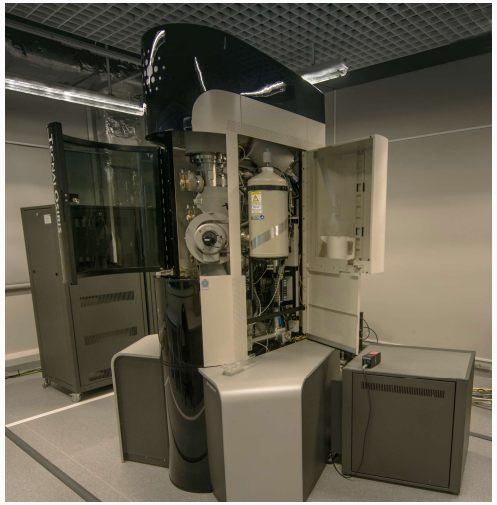
Scientific Collaborations in Europe

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W KRAKOWIE

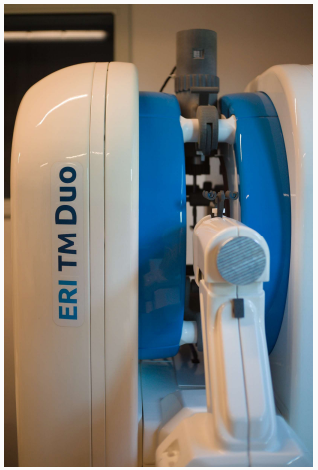
Research Infrastructure



Electron microscopy
TEM/EDX/EELS



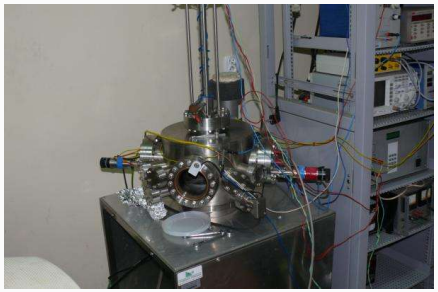
CW-EPR/FT-EPR
spectroscopy



EPR Imaging

Catalysis
gas–solid and liquid–solid
interfacial reactions









Electron microscopy
SEM



IR spectroscopy



Raman spectroscopy



UV–Vis–NIR
spectroscopy

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Research Infrastructure



Hydrothermal synthesis

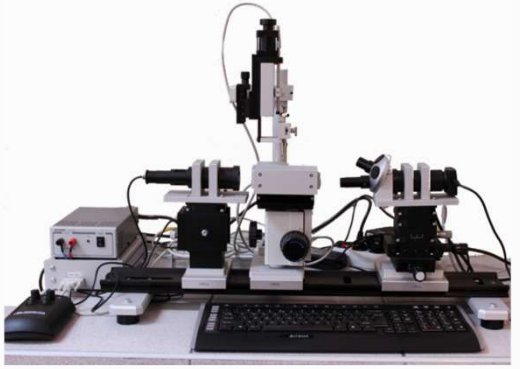
Solid-state reactions

Thermogravimetry





Particle size measurement
by Brownian motion tracking



Measurement of
contact angle



Gas
sorption

Elemental composition

XRF





Work function measurement using a Kelvin probe

Research Infrastructure

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Research Teams and Groups Participating in the Specialization Track

Catalysis and Solid-State Physical Chemistry Team

founded by
Professor Adam Bielański

**“You must have dreams,
because they come true...”**



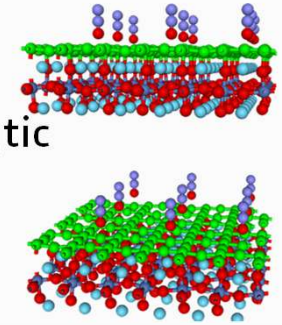
Spectroscopy, Electron Microscopy, Molecular Modelling and Nanochemistry Group

UNIWERSYTET JAGIELLOŃSKI W KRAKOWIE

prof. dr hab. Zbigniew Sojka, prof. dr hab. Krzysztof Kruczała, prof. dr hab. Witold Piskorz,
dr hab. Piotr Pietrzyk prof. UJ, dr hab. Filip Zasada prof. UJ, dr inż. Monika Fedyna, dr Kamila Sobańska, dr Joanna Gryboś

Proposed Research Topics

- Micro- and mesoporous materials – interactions of small molecules with active sites and catalytic functions
- Nanoscale metal oxides – synthesis and applications
- Catalysts for N_2O, NO_x and CH_4 removal – environmental catalysis
- Catalysts for H_2O_2 decomposition and generation of reactive oxygen species
- DFT molecular modelling (coordination compounds, solids, their properties and catalytic reactions)
- TEM electron microscopy and spectroscopy
- Polymer degradation and polymer fuel cells
- Studies of cultural heritage objects

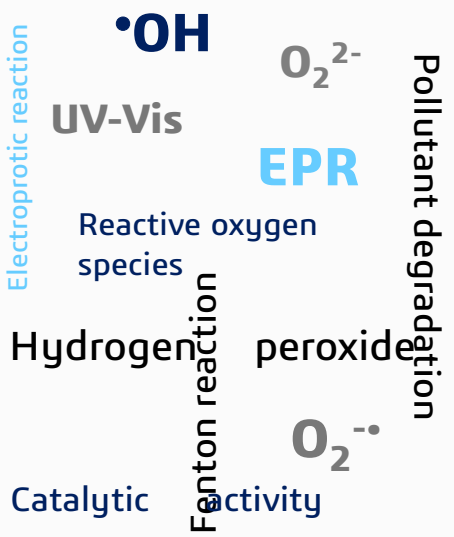


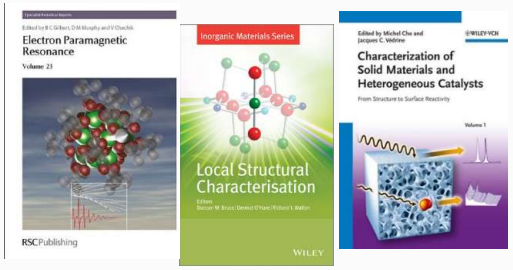
Contact: prof. Z. Sojka

NARODOWE CENTRUM NAUKI
Narodowe Centrum Badań i Rozwoju
Ministerstwo Nauki i Szkolnictwa Wyższego

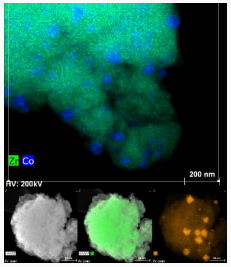
UNIWERSYTET JAGIELLOŃSKI W KRAKOWIE

Spectroscopy, Electron Microscopy, Molecular Modelling and Nanochemistry Group

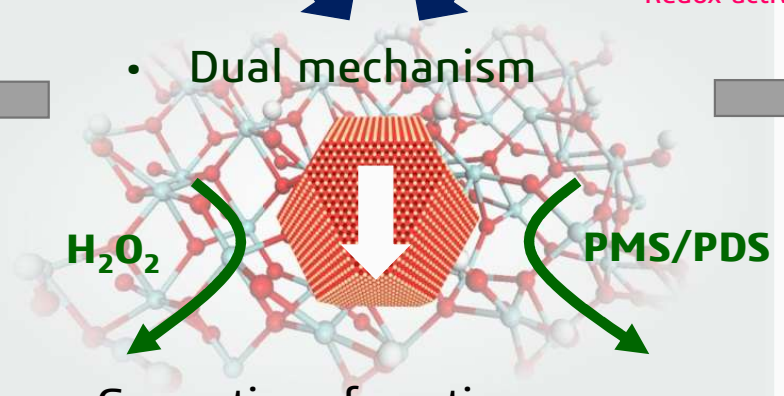




- Amorphous oxides
  - Electroprotic mechanism
  - Support with acid–base properties
- Crystalline nano-oxides
  - Fenton-type mechanism
  - Redox-active phases
- Dual mechanism
- Amorphous –crystalline composites

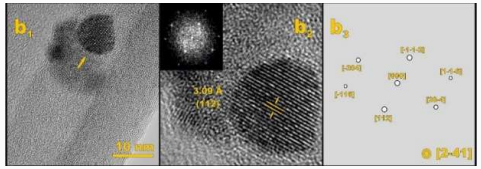


$Co_3O_4@ZrO_2$



- Mixed oxides

PMS – peroxymonosulfate
PDS – peroxydisulfate



$NbCeO_4$

- Generation of reactive oxygen species
- Advanced oxidation processes

Removal of model pollutants (dyes, antibiotics, herbicides)

Scholarships available for MSc and PhD students under NCN-funded projects

Contact: dr hab. P. Pietrzyk, prof. UJ
dr K. Sobańska

Spectroscopy, Electron Microscopy, Molecular Modelling and Nanochemistry Group

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Quantum-chemical calculations and computer simulations

solid state – surface – reactivity

Computing resources:

Research group computing cluster

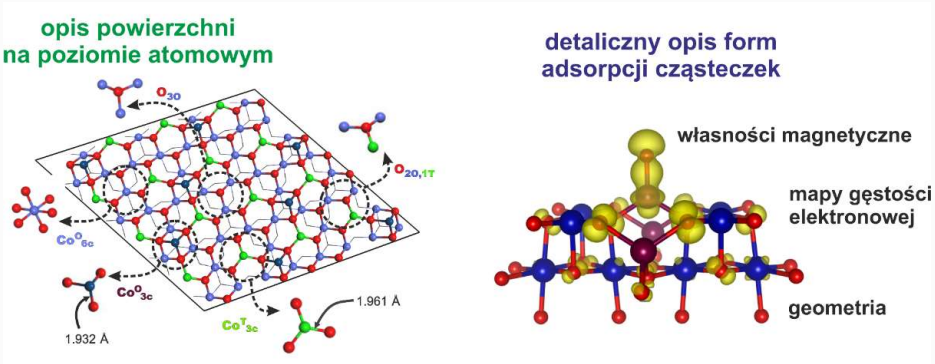
KRYPTON – 1200 CPU

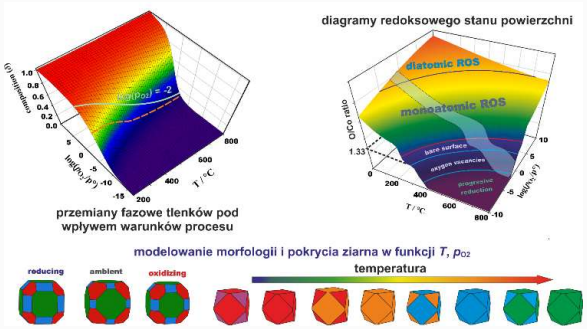
Software:

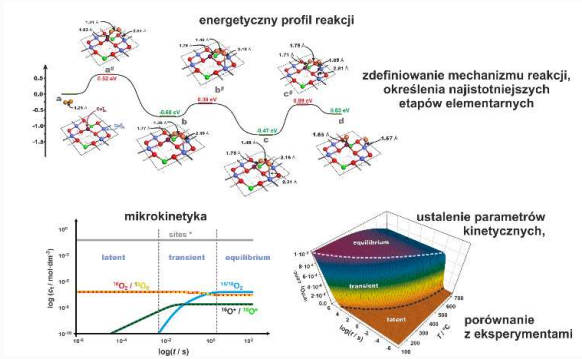
VASP, ADF , Gaussian03

Materials Studio, Orca, VESTA

ChemCraft







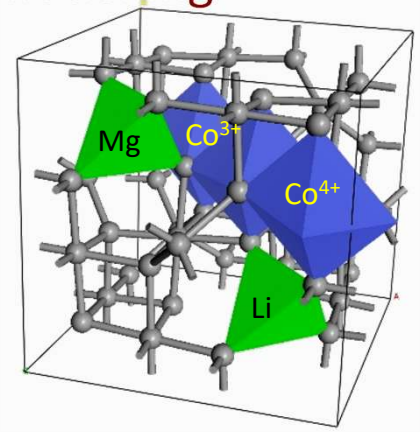


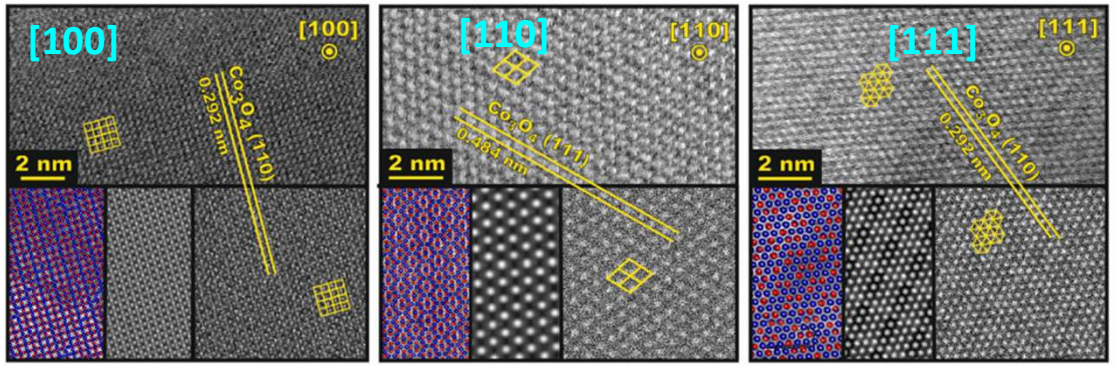
Contact: prof. dr hab. W. Piskorz, dr hab. F. Zasada prof. UJ

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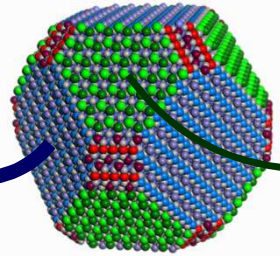
Spectroscopy, Electron Microscopy, Molecular Modelling and Nanochemistry Group

Redox-active metal oxide nanoparticles – synthesis, catalysis, electron microscopy and DFT modelling



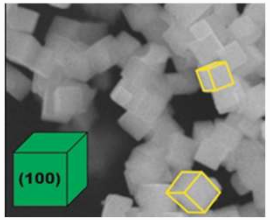




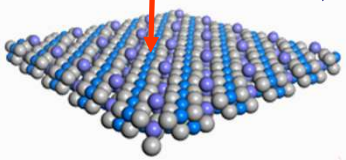


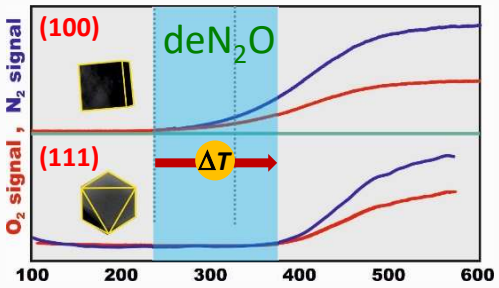
(100)

(111)

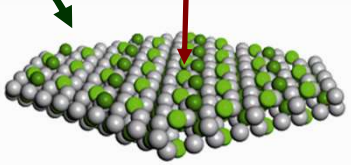


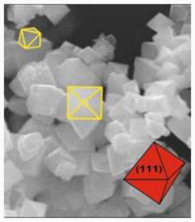
Co^{O}





Co^{T}





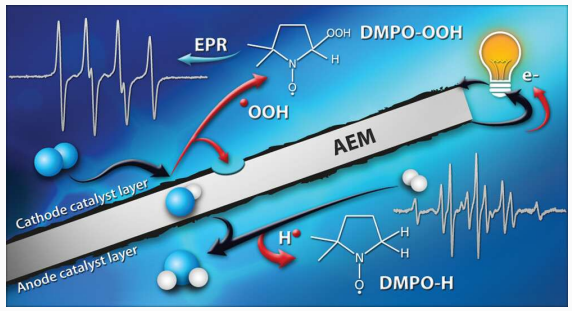
✓Contact: prof. Z. Sojka

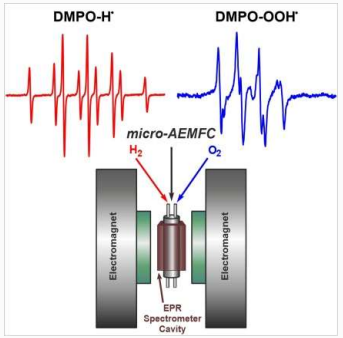
Spectroscopy, Electron Microscopy, Molecular Modelling and Nanochemistry Group

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EPR spectroscopy

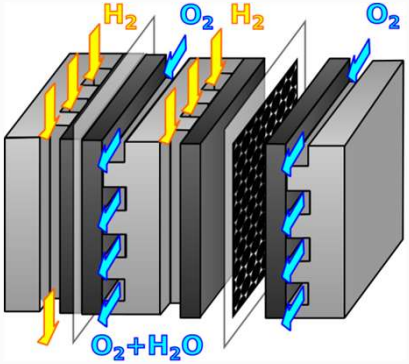
In situ detection of oxygen radical species formed in fuel cells

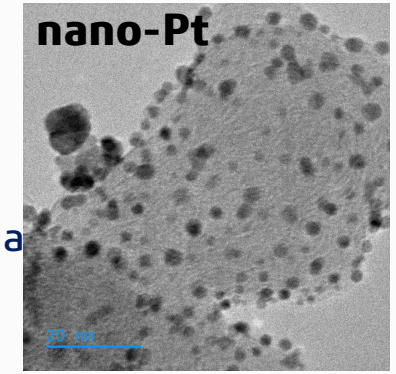


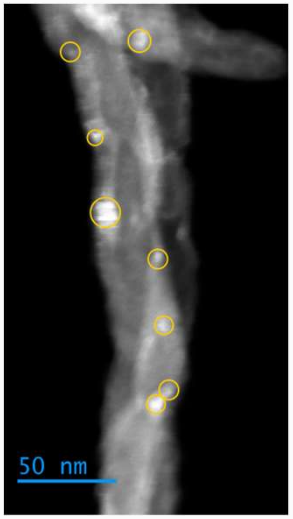


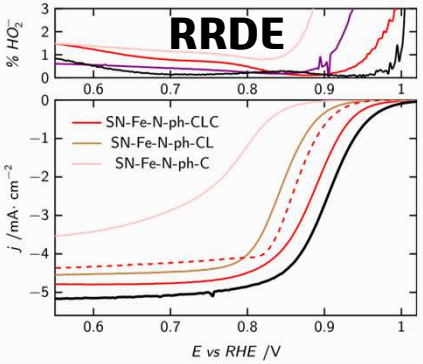
Electrocatalysis

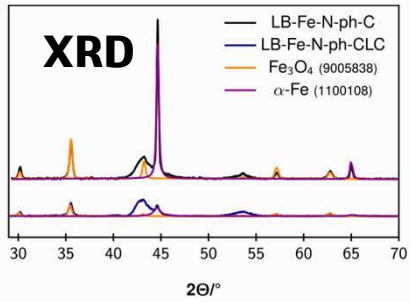
Development of oxygen reduction reaction catalysts for fuel-cell applications
Optimization of carbon supports
Synthesis of platinum nanoparticles
Fe–N–C composite materials











Fe-N-MWCNT

Conservation chemistry

Application of spectroscopic methods to assess degrada artworks made with synthetic and natural polymers



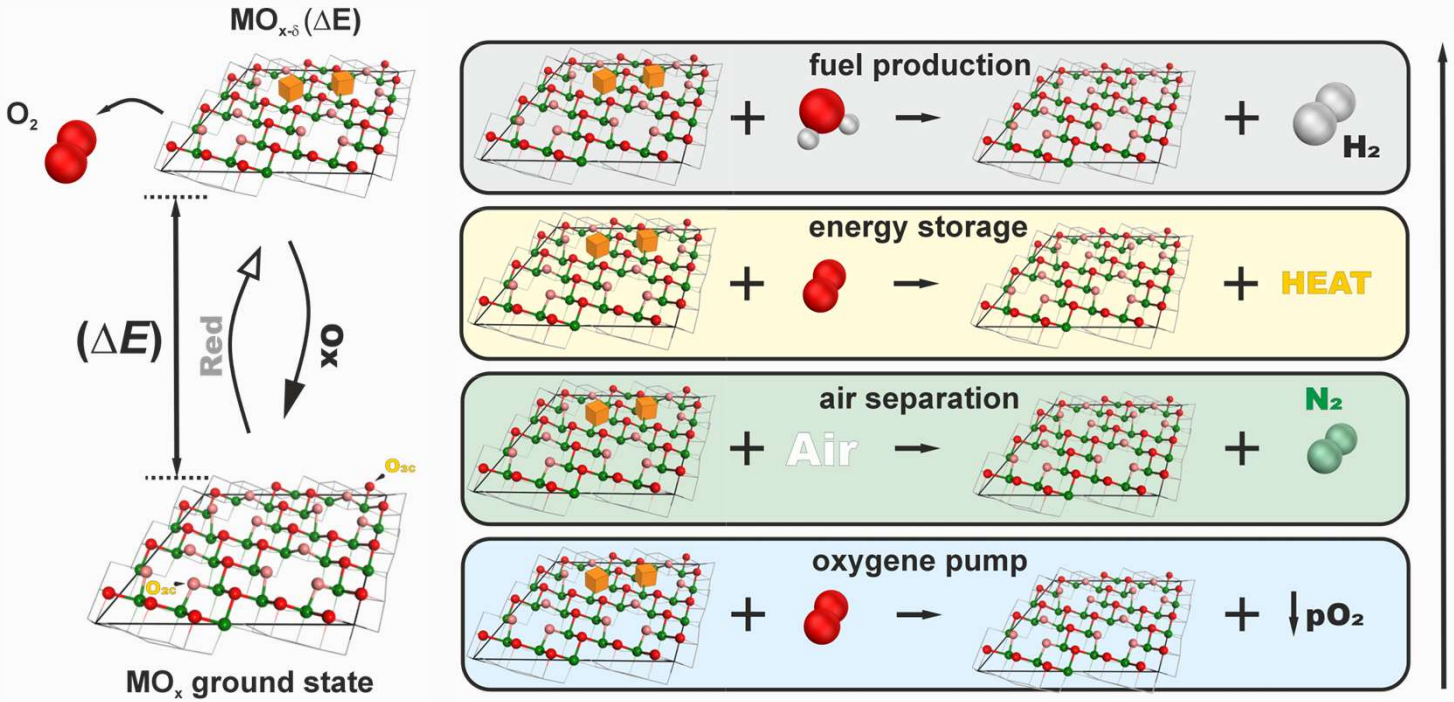


Contact: prof. dr hab. K. Kruczała

Spectroscopy, Electron Microscopy, Molecular Modelling and Nanochemistry Group

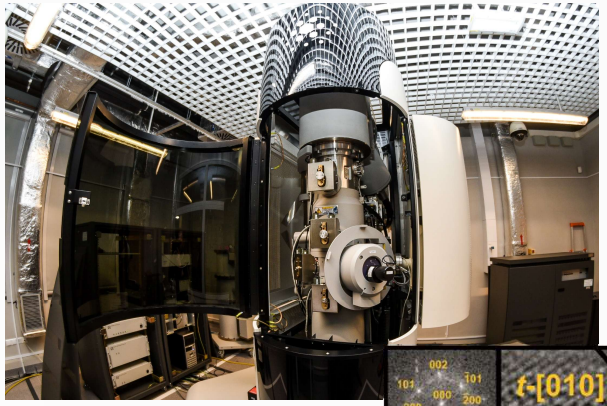
UNIWERSYTET JAGIELLOŃSKI W KRAKOWIE

Research and design of manganese-based catalysts with tailored redox properties for thermochemical cycles



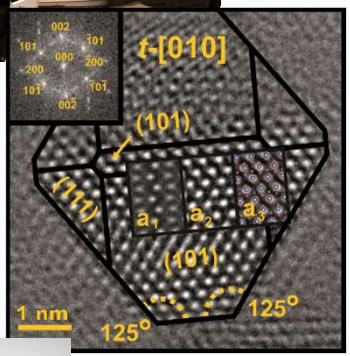
S/TEM

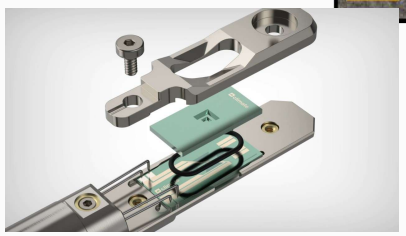
XAS



Synthesis

EELS





DFT

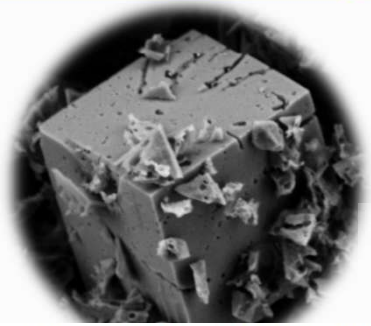
NCN project: “Computationally Assisted Microscopic and Spectroscopic Studies of Redox Reaction Mechanisms on Model Manganese Oxide Catalysts in the Context of Thermochemical Redox Cycles”

Contact: dr Joanna Gryboś

UNIWERSYTET JAGIELLOŃSKI
W KRAKOWIE

Zeolite Chemistry Group

prof. dr hab. Kinga Góra-Marek, dr inż. Karolina Tarach

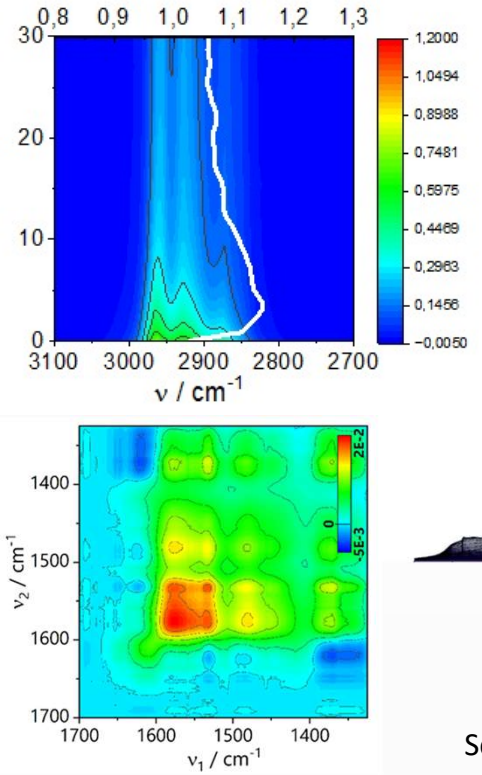


Research topics

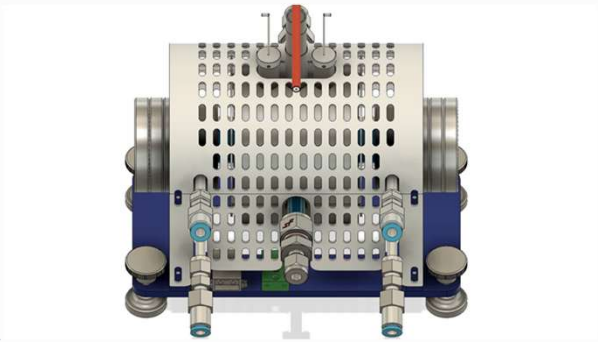
IR studies of reaction mechanisms

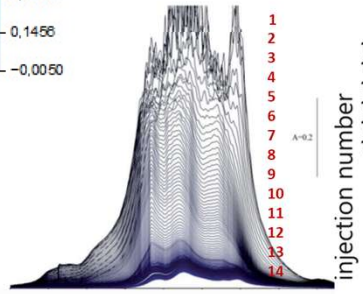
time-resolved methods

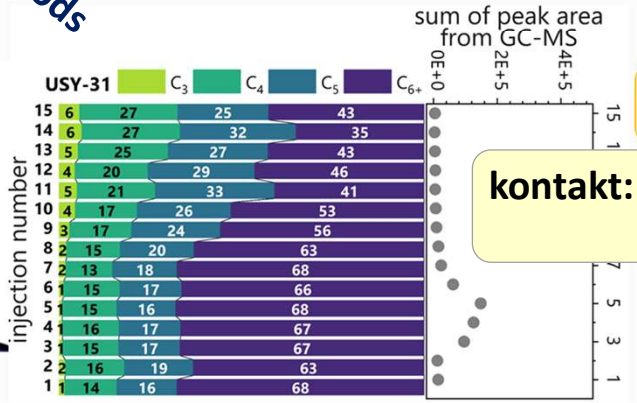
2D COS



Correlating IR spectroscopy with catalytic data







fuels from plastics
fuels from alcohols
catalyst deactivation



FT-IR analysis of effluent gases | thermogravimetric decomposition | sample storage | GC-MS analysis of stored samples

kontakt: prof. K. Góra-Marek
dr K. Tarach



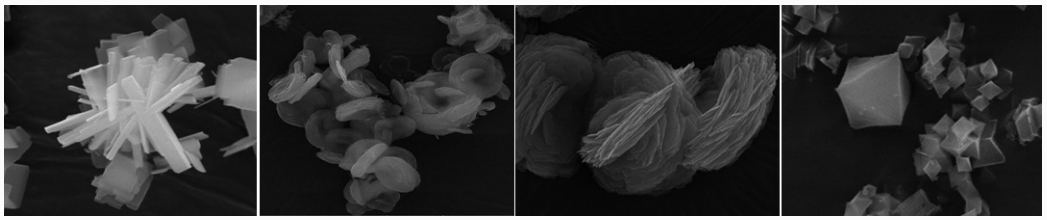
Scholarships available for MSc and PhD students under NCN-funded projects

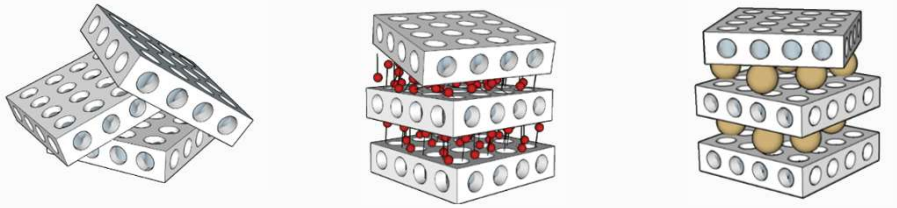
Zeolite Chemistry Group

UNIWERSYTET JAGIELLOŃSKI W KRAKOWIE

Prof. dr hab. Barbara Gil, prof. dr Wiesław Roth

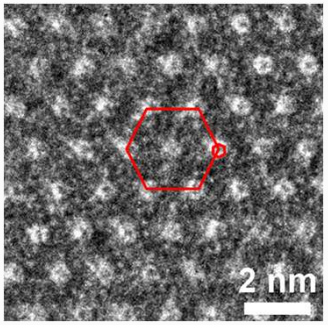
Investigation of nanoporous materials: conventional 3D zeolites, two-dimensional zeolite structures and metal–organic frameworks (MOFs)

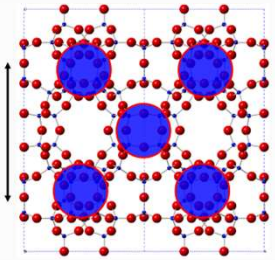


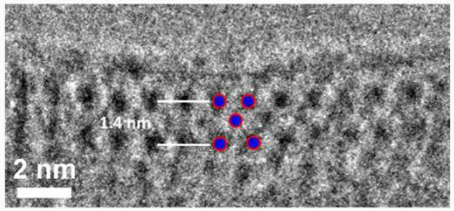


Synthesis of new two-dimensional hybrid zeolite materials

Studies of metal nanoparticle stabilization by silanol groups – NCN-funded research







Research methods
FTIR spectroscopy, UV–Vis DRS, hydrothermal synthesis, PXRD, porosity analysis and catalysis over 2D zeolites

Contact: prof. dr hab. B. Gil
https://zeochem.chemia.uj.edu.pl/ludzie

UNIWERSYTET JAGIELLOŃSKI
W KRAKOWIE

Zeolite Chemistry Group

MATERIALS
zeolites, MOFy

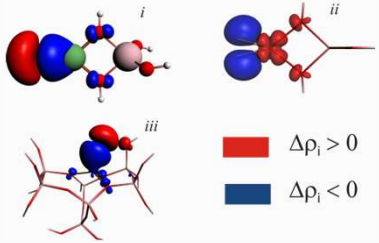
dr hab. Paweł Kozyra, prof. UJ
**Obliczeniowy charakter badań sprzyja pracy zdalnej*

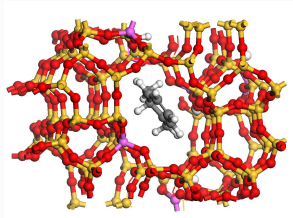
News

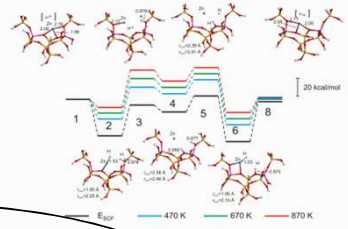
http://zeochem.chemia.uj.edu.pl/kozyra/

MODELLING*

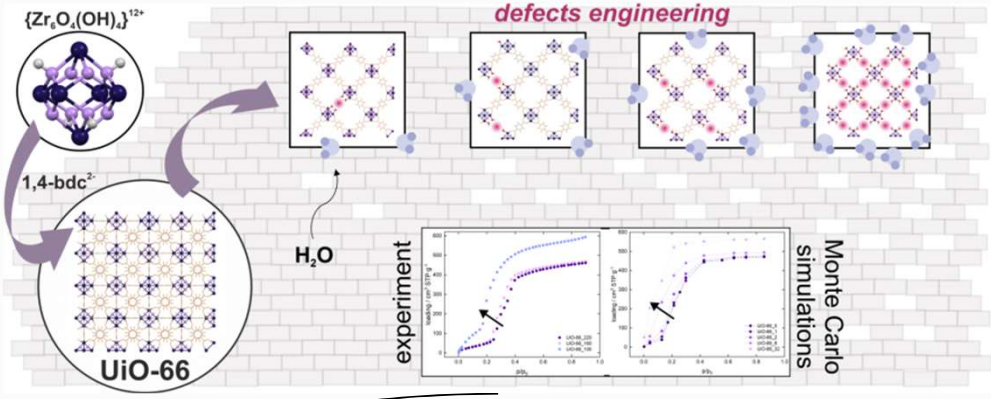
at the quantum level







at the classical level



PROPERTIES

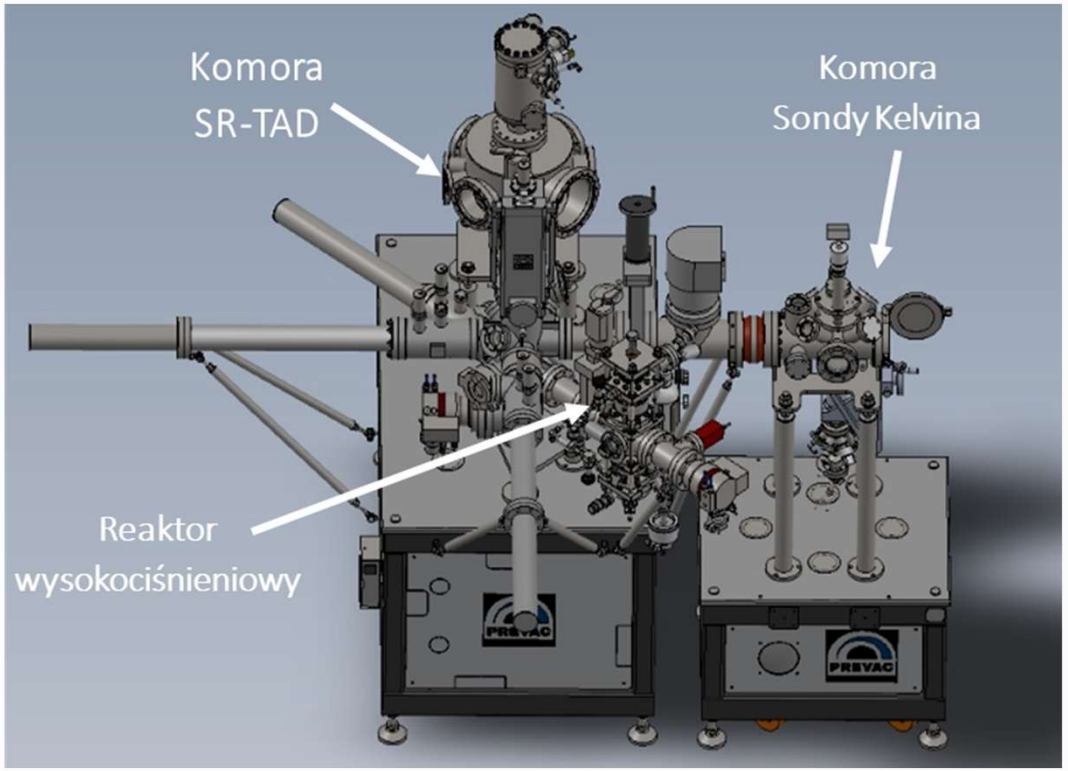
activation and reaction mechanisms

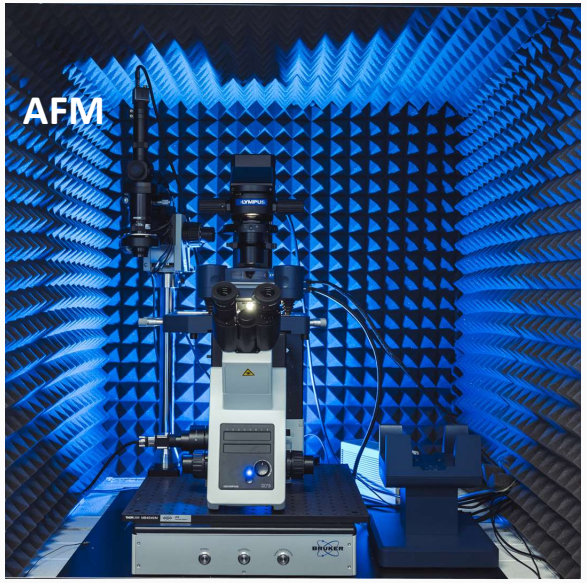
sorption properties

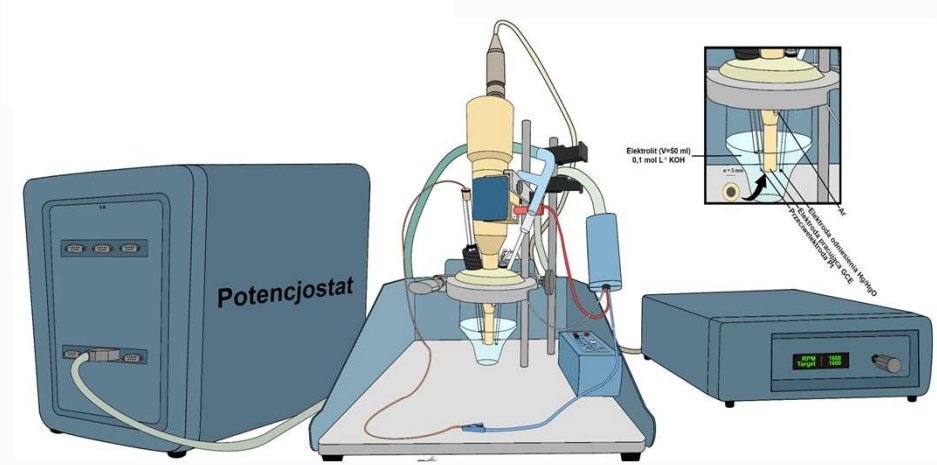
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specialized equipment for work function measurements and alkali metal desorption studies







Contact: prof. A. Kotarba
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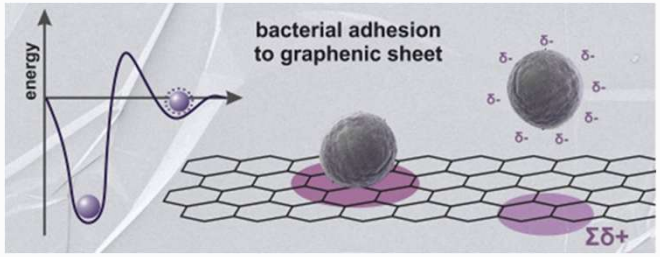
Prof. dr hab. Andrzej Kotarba, dr hab. Gabriela Grzybek, dr hab. Paweł Stelmachowski, prof. UJ

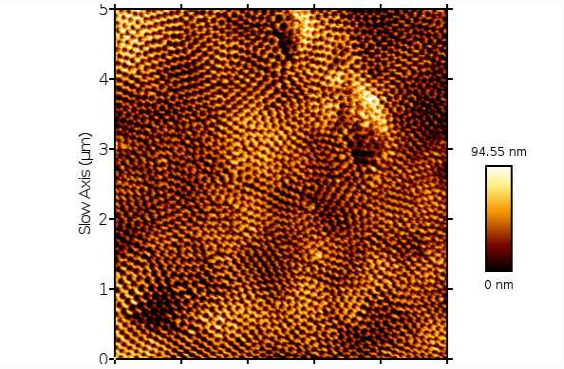
Surface functionalization of carbon materials

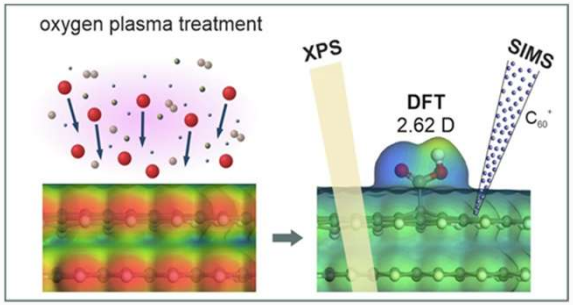
Functionalization of biomaterial surfaces with bioactive compounds: from fundamental to applied research (NCN Weave-UNISONO, 2022–2025)

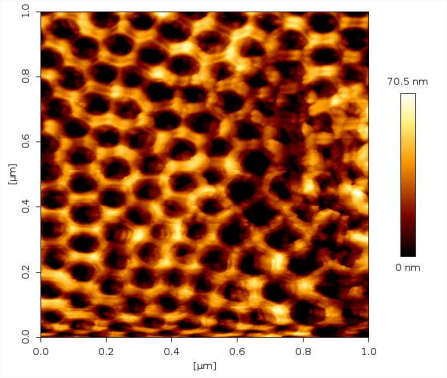
Collaboration: Czech Academy of Sciences, Prague (Czech Republic); University of Helsinki (Finland)

Plasma modification of carbon material surfaces: effects of introduced functional groups on biocompatibility and microbial adhesion (NCN OPUS-19, 2020–2024)









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Prof. Andrzej Kotarba, dr hab. Gabriela Grzybek, prof.UJ, dr hab. Paweł Stelmachowski, prof. UJ, dr Gabriela Jajko-Liberka

Synthesis and functionalization of oxide catalysts and MOF materials

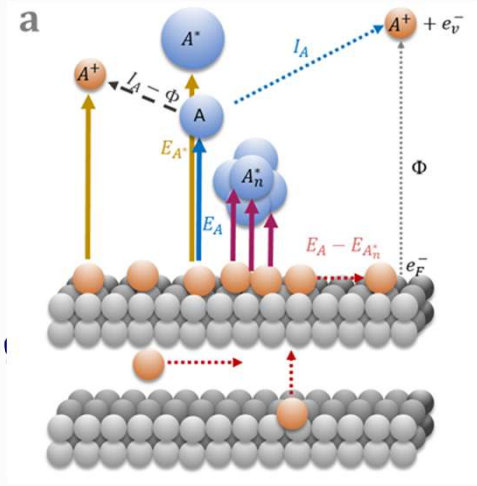
Comprehensive studies of the effect of alkali promotion on surface–structure–reactivity relationships in cobalt catalysts for ethanol steam reforming (NCN SONATA-17, 2022–2025)

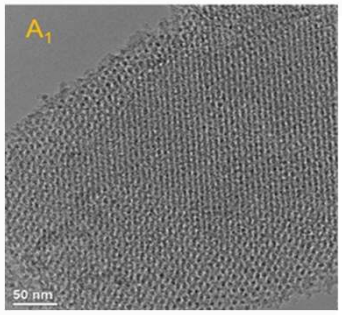
Collaboration: University of Alicante (Spain); Maria Curie-Skłodowska University, Lublin

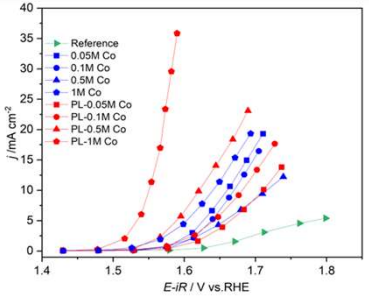
Electrocatalysis

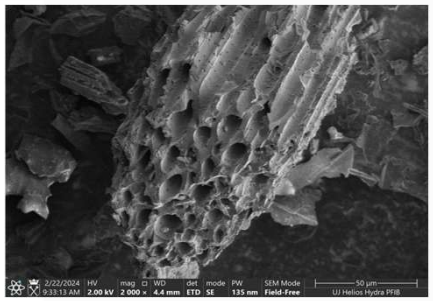
Composite materials for electrocatalytic water splitting: towards stable systems combining carbon materials and transition-metal compounds (NCN OPUS-19, 2020–2024)

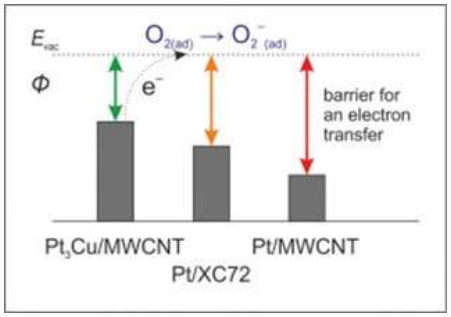
Collaboration: Spanish National Research Council (CSIC), Zaragoza (Spain); Adam Mickiewicz University, Poznań

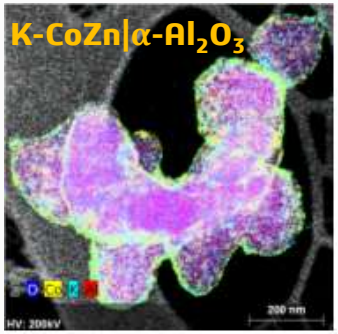












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Catalysis and Solid-State Physical Chemistry Team II

Application of equilibrium temperature-programmed desorption and adsorption in the study of porous materials

Research topics:

Development of new methods for determining pore volume and size

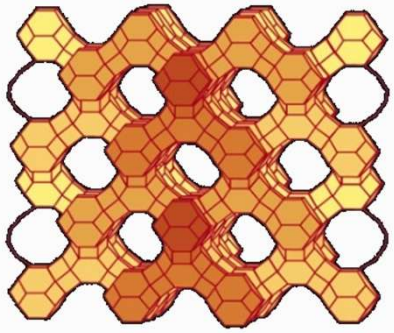
Investigation of interactions between adsorbed molecules and pore surfaces

Porosity characterization of new catalysts and adsorbents

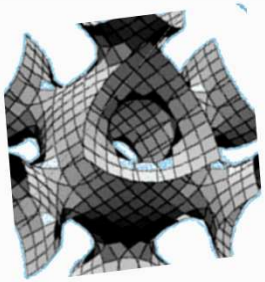
Contact: prof. dr hab. Wacław Makowski

Materials studied

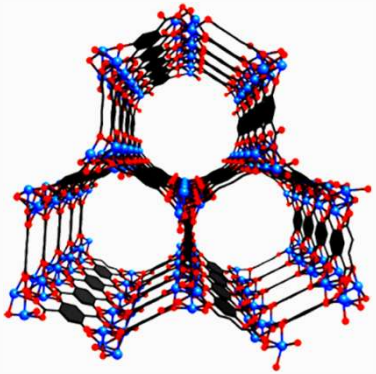
zeolites



krzemionkowe lub węglowe materials mezoporowate (pory o średnicy 2-50 nm)



porous coordination polymers (MOFs)

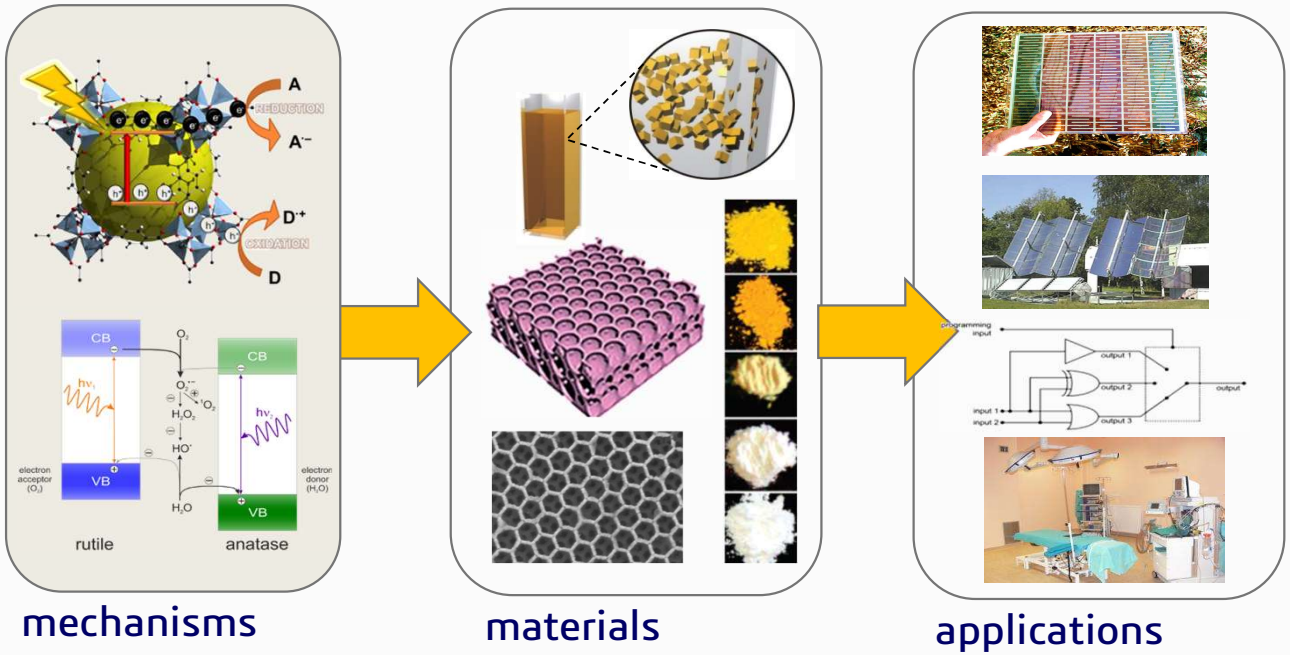


Coordination and Bioinorganic Physical Chemistry Team

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Photocatalysis Group

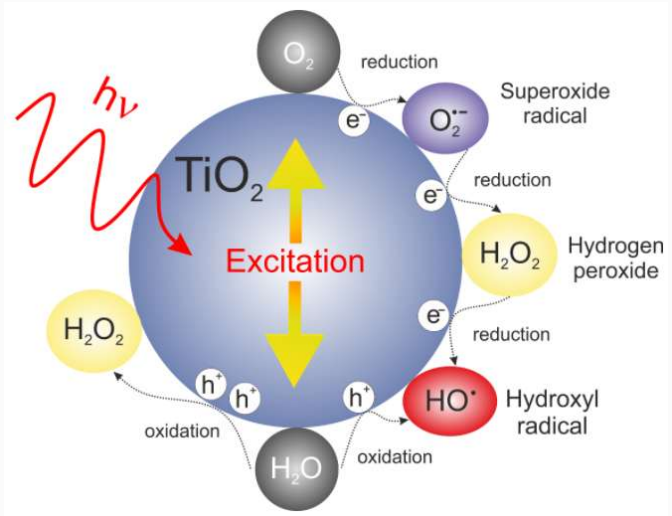
prof. Wojciech Macyk, dr Joanna Kuncewicz, dr Marcin Kobielusz, dr Przemysław Łabuz, dr Taymaz Tabari



mechanisms

materials

applications





photocatalysts, semiconductors, artificial photosynthesis, photoelectrochemistry

International collaborations: Germany, Finland, Japan, Canada, Australia, China and others

Implementation of FNP, NCN, NAWA, national and international projects; opportunities for international collaboration and scholarships

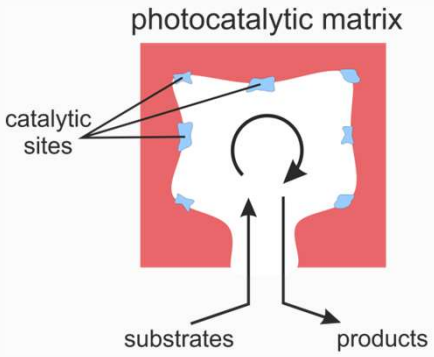
Contact: prof. W. Macyk
www.fotoCatalysis.pl

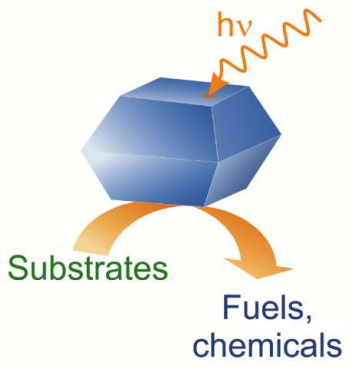
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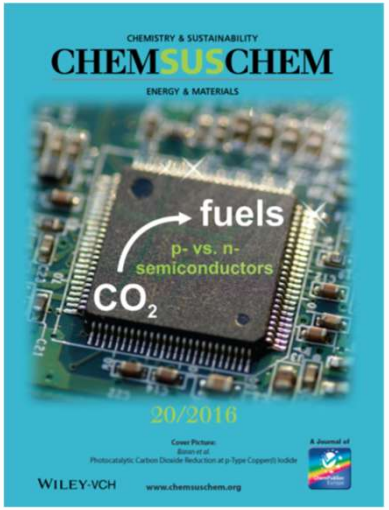
Coordination and Bioinorganic Physical Chemistry Team

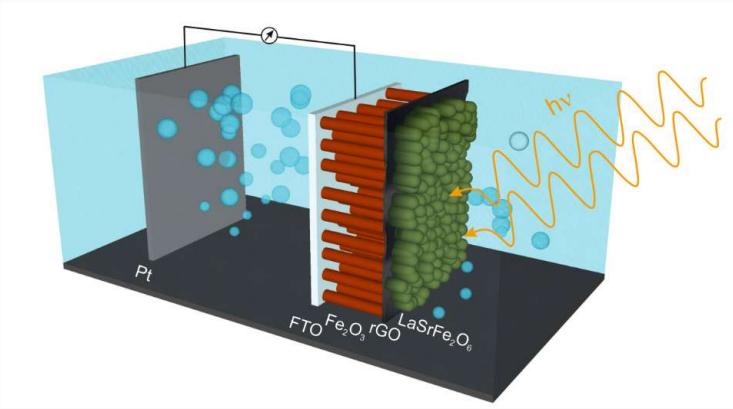
Photocatalysis Group

prof. Wojciech Macyk, dr Joanna Kuncewicz, dr Marcin Kobielusz, dr Przemysław Łabuz, dr Taymaz Tabari









Heterogeneous photocatalysis using semiconductor materials, primarily titanium(IV) oxide (TiO_2), with particular emphasis on:

- Photocatalytic reduction of carbon dioxide (CO_2)
- Photocatalytic synthesis of organic compounds
- Control of selectivity in photocatalytic reactions
- Photoelectrochemical water splitting
- Photoelectrochemistry and spectroelectrochemistry of semiconductors
- Photocatalytic oxidation reactions

Contact: prof. W. Macyk
www.fotoCatalysis.pl