



POLISH NATIONAL AGENCY  
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PROGRAMME

<p>name of the unit:</p> <p><b>DEPARTMENT OF MOLECULAR ENGINEERING</b></p> <p>Faculty of Process and Environmental Engineering, Lodz University of Technology</p>		<p>symbol:</p> <p><b>K-94</b></p> <p><a href="http://www.wipos.p.lodz.pl/en/Department_of_Molecular_Engineering,532">http://www.wipos.p.lodz.pl/en/Department_of_Molecular_Engineering,532</a></p>
<p>head of the unit:</p> <p><b>Prof. Jacek Tyczkowski, PhD, DSc</b></p>	<p>potential promoters:</p> <p>Prof. Jacek Tyczkowski, PhD, DSc Hanna Kierzkowska-Pawlak, PhD, DSc, TUL Prof. Marta Gmurek, PhD, DSc, TUL Prof.</p>	<p>contact person:</p> <p>H. Kierzkowska-Pawlak tel: 42- 631-37-74 <a href="mailto:hanna.kierzkowska-pawlak@p.lodz.pl">hanna.kierzkowska-pawlak@p.lodz.pl</a></p>
<p>scope of activities:</p> <p>The interests and fields of research are as follows:</p> <ul style="list-style-type: none"> <li>– technologies for the production of thin-film nanomaterials using the cold plasma (PECVD),</li> <li>– new plasma-prepared catalytic nanomaterials for advanced chemical technologies (e.g. combustion of volatile organic compounds, CO<sub>2</sub> hydrogenation, CO<sub>2</sub> capture),</li> <li>– molecular surface engineering – surfaces with special physicochemical properties (e.g. adhesion, adsorption, superhydrophobicity, oleophobicity),</li> <li>– new active plasma-prepared nanomaterials for electrochemistry (e.g. galvanic cells, fuel cells, water decomposition reactors),</li> <li>– non-equilibrium atmospheric plasma in biomedical applications or modification of agricultural products,</li> <li>– advanced oxidation processes in wastewater treatment (AOPs),</li> <li>– photoprocesses in the removal of impurities: photocatalysis, photosensitization, photocatalytic ozonation.</li> </ul>		<p><b>Cold plasma as a tool for molecular engineering</b></p>
<p>present activities:</p> <p>The main objective of the current research activities is to design at the molecular level and fabricate innovative nanomaterials with unique properties, such as catalytic, electronic, adhesive and others, using the plasma deposition technique (PECVD), for applications in the field of energy, advanced technologies based on heterogeneous catalysis and in surface engineering. Due to their thin-film form and high catalytic activity, the new generation of plasma-prepared nanocatalysts, offers significant prospects for their practical application in:</p> <ul style="list-style-type: none"> <li>– new technologies for CO<sub>2</sub> capture, conversion of CO<sub>2</sub> and nitrogen oxides,</li> <li>– combustion of volatile organic compounds, hydrogen production from catalytic water splitting,</li> <li>– water and wastewater treatment using new catalytic systems on structured supports.</li> </ul>		
<p>Future activities:</p> <p>Development of current and generation of new, hybrid catalytic nanomaterials by the cold plasma towards the desired properties for various energy and environmental applications; deeper understanding of the structure-properties relationship.</p>		



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**Publications/patents, awards, projects:**

- Kierzkowska-Pawlak, H., Kruszczyk, E., & Tyczkowski, J. (2022). Catalytic activity of plasma-deposited  $\text{Co}_3\text{O}_4$ -based thin films for  $\text{CO}_2$  hydration—A new approach to carbon capture applications. *Applied Catalysis B: Environmental*, 304, 120961.
- Bilińska, L., & Gmurek, M. (2021). Novel trends in AOPs for textile wastewater treatment. Enhanced dye by-products removal by catalytic and synergistic actions. *Water Resources and Industry*, 26, 100160.
- Tyczkowski, J., Kierzkowska-Pawlak, H., Kapica, R., Balcerzak, J., & Sielski, J. (2019). Cold plasma – A promising tool for the production of thin-film nanocatalysts. *Catalysis Today*, 337, 44-54.
  - Novel nanocatalytic structured packings for carbon dioxide hydrogenation, OPUS-NCN (2018-2021)
  - **Modern wastewater treatment with plasma-prepared catalyst for textile wastewater recycling (TEX-WATER-REC)**, Small Grant Scheme, NCBiR, 2021-2023
  - Investigation of the synergy between ozone and novel plasma-deposited catalysts in hybrid electrochemical ozonation of micropollutants, SONATA-NCN, 2021-2024

**Keywords:**

cold plasma, PECVD, thin films, catalysis, photocatalysis, surface engineering,  $\text{CO}_2$  capture,  $\text{CO}_2$  conversion, hydrogen production, advanced water and wastewater treatment processes (AOP's)

**List of internship proposal in this research team:**

- production of thin-film catalysts using the PECVD technique
- research on the catalytic activity of new materials in capture and conversion of  $\text{CO}_2$ , production of hydrogen from water decomposition, advanced oxidation processes