Application form for research topics in the field of engineering and technology for candidates to the Doctoral School in the academic year 2024/2025

Proposed subject matter of a doctorate
Processing and testing of properties of classical and biodegradable polymeric materials as well as composites. The subject matter covers processing and recycling and may also include foamed materials such as expanded polystyrene (EPS) and composites based on it
Scientific discipline *(delete as appropriate)*
~~AUTOMATION, ELECTRONICS, ELECTROTECHNICS AND SPACE TECHNOLOGIES~~ ~~CIVIL ENGINEERING, GEODESY AND TRANSPORT~~ MECHANICAL ENGINEERING
Proposed doctoral thesis supervisor
dr hab. inż. Tomasz Rydzkowski, profesor PK. Faculty: Faculty of Mechanical Engineering and Energetics; Department: Department of Food Processes and Engineering Street: Racławicka 15-17, 75-620 Koszalin, building: C; room: 225 e-mail: tomasz.rydzkowski@tu.koszalin.pl; phone: +48 94 34 78 424

Brief description of the research topics with an indication of the scientific issues (max. 350 words)
A dynamically evolving issue is the processing of plastics, with particular attention currently being paid to their recycling. Equally important is the separate stream of biodegradable plastics, their production, property testing, biodegradation, and search for applications. In the field of recycling, research on recycling and manufacturing of composites, especially biodegradable ones, and those containing various waste materials, is currently in vogue. Composites can be manufactured based on thermoplastic and thermosetting materials – most commonly chemically cross-linked resins. The proposed topics may include studying the influence of parameters in screw-disc extrusion (an extruder designed by T. Rydzkowski at the Koszalin University of Technology) or injection molding of polymer materials on their properties and susceptibility to degradation under selected conditions. The subject may encompass various techniques for processing thermoplastic or thermosetting materials and the addition of recyclates, nanoparticles, microspheres, or other reinforcements, such as carbon fibers, natural fibers, etc. This theme also includes the issue of producing hybrid insulation materials, innovative insulation boards. The topic may also involve the recycling of decommissioned wind turbine blades – a very current and attractive subject.
Justification of the purposefulness of taking up the research topics (max. 150 words)
The processing of polymer materials, especially their recycling, is not yet fully understood. These issues are particularly significant given the rising energy prices, requirements for the protection of

natural resources and the environment, and the circular economy goals. New legal regulations and limits set by the EU necessitate research on eco-friendly techniques and materials.

Proposed topics of doctoral theses within the proposed research subject matter (up to 3 topics)

• Researching the efficiency of recycling technological and post-consumer waste, such as multilayer packaging films, insulation materials like polystyrene or polyurethane.
• Investigating the properties and applications of polymer composites filled with functional waste materials (e.g., microballoons, nanoparticles) or natural materials (wood, tree needles or leaves, nutshells, hemp hurds, buckwheat husks, coffee and tea dregs, chaff, or others).
• Studying the influence of machining parameters (milling, CNC cutting) on the surface quality of mechanically processed elements made of polymer composites.

The sources of financing of the research topics (the subject matter of currently implemented research grants financed from external sources or as part of subsidies)

Internal grants at the Faculty of Mechanical Engineering and Energetics. Opportunity to submit an application for an NCBR grant.

Confirmation of the possibility of ensuring access to scientific apparatus and software necessary for the realization of the proposed research topics (*delete as appropriate*)

~~FULLY~~/ PARTIALLY/ ~~NONE~~

If the answer is PARTIALLY or NONE please indicate a type of missing scientific apparatus and/or software and the sources of financing an access to them

Absence of a frame for a small strength testing machine - there are transducers for small loads

List of the supervisor's scientific achievements in the field of indicated scientific problems

A list of up to 5 major supervisor’s publications related to the proposed research topics, published in journals indexed in the Web of Science or Scopus for the period of the last 3 years (taking into account the IF Impact Factor and the MNiSW score)

- ZUBAIR JAN A., RYDZKOWSI T., BURDUK A., KĘDZIA K., IQUBAL FALAK A.: Horizontal Axis Wind Turbine (HAWT) Life Cycle Assessment of 2.0 MW. Materiały i technologie XXI wieku, XXII Międzynarodowa Studencka Sesja Naukowa, Katowice, 28 maja 2021r. Wydawnictwo Politechniki Śląskiej, Gliwice 2021. ISSN 978-83-7880-776-6. (MNiSW - 20),
- ZIELIŃSKA D., RYDZKOWSKI T., THAKUR V.K, BORYSIAK S.: Enzymatic engineering of nanometric cellulose for sustainable polypropylene nanocomposites. Industrial Crops and Products. Volume 161, March 2021, 113188. https://doi.org/10.1016/j.indcrop.2020.113188. (MNiSW - 200, IF – 4,244),
- KUMAR RANA A., KUMARI THAKUR M., KUMAR SAINI A., KUMAR MOKHTA S., MORADI O., RYDZKOWSKI T., ALSANIE A.F., WANG Q., GRAMMATIKOS S., KUMAR THAKUR V.: Recent developments in microbial degradation of polypropylene: Integrated approaches towards a sustainable environment. Science of the Total Environment 826 (2022) 154056, 02/2022, doi.org/10.1016/j.scitotenv.2022.154056, (MNiSW – 200, IF – 10,753),
- ANDRZEJEWSKI J., BARCZEWSKI M., CZARNECKA-KOMOROWSKA D., RYDZKOWSKI T., GAWDZIŃSKA K., THAKUR V.K.: Manufacturing and characterization of sustainable and recyclable wood-polypropylene biocomposites: Multiprocessing-properties-structure relationships, Industrial Crops and Products. Volume 207, January 2024, 117710, https://doi.org/10.1016/j.indcrop.2023.117710. (MNiSW - 200, IF – 5,900).

A list of research grants financed by the National Science Centre, the National Centre of Research and Development and the European Research Council for the period of the last 5 years

- 3465/GG HORYZONT 2020/2016/0 – Politechnika Krakowska - Development of new composite materials for increase a durability, including corrosion protections for hydraulic infrastructures Granty na Granty, projekt Geo-Hydro-STR
- 3257/GG HORYZONT 2020/2015/0 – Politechnika Krakowska - Innovative and eco-friendly fibre based materials for constructions industry, ECO-BUS

A list of research services provided for industry related to the proposed research topics for the period of the last 5 years

- Analysis of thermodynamic properties of polymer samples to identify the cause of cracking in VC - AIC S.A. drainage trays. Address: 41 Rdestowa Street, 81-577 Gdynia, Manager.
- Research on the physical properties of weights for advertising banners. Company: Flag LINEA, Manager: Milena Trojanowska, Address: 38 Mieszka I Street, 75-132 Koszalin.
- Technical opinion regarding the possibility of replacing Hostalen PP H2150 polypropylene with PP Moplen EP540P for manufacturing condensate drain trays. Company: AIC S.A., Address: 41 Rdestowa Street, 81-577 Gdynia, Manager.
- Conducting microtomographic analysis of polymer composite samples based on expanded polystyrene EPS. Company: TERMEX Sp. z o.o., Address: 9 Lniana Street, 75-213 Koszalin, Manager.
- Opinion on the innovativeness of a form for expanded polystyrene with a system enabling compensation of zones with lower block density, planned for implementation at Arsanit factory in Ostróda; Company: ARSANIT Sp. z o.o., Address: 17 Obwodowa Street, 41-100 Siemianowice Śląskie, Manager.
- Opinion on the innovativeness of the EPS block production process planned for implementation in the newly built factory of Arsanit company; Company: ARSANIT Sp. z o.o., Address: 17 Obwodowa Street, 41-100 Siemianowice Śląskie, Manager.
- Opinion on the innovativeness of the technology for manufacturing metal-gypsum insulation panels; Company: BOMAT Sp. z o.o., Address: 9 Czeska Street, 20-424 Lublin, Manager.