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
Research on the production, properties, welding, and recycling of both conventional and biodegradable packaging films. The scope may include monolithic and multilayer films, modified films, as well as shrink films.
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 production of various packaging films and packaging techniques. Equally important is the separate stream of biodegradable films, their production, property testing, biodegradation, and exploration of applications. Currently, in packaging films, research on recycling and manufacturing of composite films, especially biodegradable ones, and those containing various waste materials, is in vogue. The proposed topics may also include research on the properties of shrink films - especially heat-shrinkable films. Shrink films are increasingly used in packaging technology, including vacuum packaging of food. These issues are significant both in terms of their impact on the packaged product and the influence of film transport and storage conditions on their shrinkage. For biodegradable films, not only their functional properties but also their susceptibility to biodegradation are important. An important issue is also the recycling and management of waste from multilayer laminates found, for example, in very popular milk or juice cartons.
Justification of the purposefulness of taking up the research topics (max. 150 words)
Packaging films are increasingly complex composites, yet environmental concerns and trends indicate a return towards monolithic films. Conducting research in both directions is justified, especially since various modifications of films are now commonly used, such as the addition or surface application of

nanoparticles to activate their surface.

Regarding shrink films, it's worth noting that packages in Europe are transported by trucks (TIRs), while outside of Europe (Australia, USA), they are transported in containers on ships. During transport, they are exposed to high temperatures, which affect their properties. This topic requires extensive exploration, especially in the face of emerging new, more environmentally friendly types of shrink films.

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

• The impact of composition and storage conditions on the properties of packaging films (e.g., shrinkability).

• Studying the properties and susceptibility to degradation of biodegradable packaging films.

• Researching the efficiency of recycling multilayer waste from packaging films.

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)

- 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),
- RYDZKOWSKI T, WRÓBLEWSKA-KREPSZTUL J., KUMAR THAKUR V., KRÓLIKOWSKI T.: Current trends of intelligent, smart packagings in new medical applications. 26th International Conference on Knowledge-Based and Intelligent Information & Engineering Systems (KES 2022). Procedia Computer Science Volume 207, 2022, Pages 1529-1538, doi.org/10.1016/j.procs.2022.09.210 (MNiSW - 70, CITESTORE – 3,6),
- CZAJKOWSKA A, LASKOWSKA D, RYDZKOWSKI T.: Wood-Based Composite Materials In The Aspect Of Structural New Generation Materials - Recognition Research. Bulletin of the Polish Academy of Sciences, Technical Sciences, PAN, vol. 71, 2023, s. 1-7, DOI:10.24425/bpasts.2023.146618 (MNiSW - 100, IF – 1,200),
- 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.