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
Investigations into the influence of pro-ecological methods of delivery cooling, lubricating and antiadhesive media to the machining zone on the course and results of the grinding process
Scientific discipline *(delete as appropriate)*
~~AUTOMATION, ELECTRONICS, ELECTROTECHNICS AND SPACE TECHNOLOGIES~~ ~~CIVIL ENGINEERING, GEODESY AND TRANSPORT~~ MECHANICAL ENGINEERING
Proposed doctoral thesis supervisor
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Brief description of the research topics with an indication of the scientific issues (max. 350 words)
The mechanical energy introduced into the grinding process as a result of the relative motion of the tool and workpiece is largely converted into heat. This leads to a significant increase in temperature in the tool-to-material contact zone caused by friction and deformation processes leading to chip formation and material removal. The long contact path between the grinding wheel and the ground surface makes the removal of heat from the grinding zone one of the most important factors in the grinding process. An excessive increase in temperature during the grinding process may lead to surface defects such as micro-cracks, grinding burns or unfavorable surface layer stresses. Moreover, the rising temperature in the grinding zone causes excessive wear of grinding wheel components (abrasive grains and bond). A high temperature leads to plasticization of the vertices of active abrasive grains. It may also cause thermal wear of the bond bridges and premature chipping of the abrasive grains from the grinding wheel active surface. In extreme cases, a rapidly changing temperature gradient in the abrasive tool can induce excessive thermal stresses, resulting in a drastic reduction in the strength of the entire tool and its breakage. In this context, the type, expenditure, and method of coolant supply has an extremely significant impact on the quality and stability of the grinding process and the repeatability of its results. However, in addition to the benefits of coolants, a number of economic and ecological problems arise. On the one hand, there are the costs of procurement, use and care, as well as the environmental impact of disposal. The total costs associated with the use of coolants are estimated, depending on the source, to be between 5% and 17% of the total production costs. Approximately 60% of all costs associated with

the use of coolants are related to maintenance and disposal.

Coolant components such as bacteriocides and fungicides, reaction products formed in coolant and containing foreign substances can become a primary cause of skin and respiratory illness for operators. Spills of harmful substances, emissions, or water used to clean cooling systems are sources of land, water, and air pollution. Coolants can be disposed of chemically (by re-refining as well as thermal cracking) or through biodegradation. They can also be incinerated and recovered through purification. These processes are costly and often significantly burden the environment with their products.

It follows from the above that research into environmentally friendly methods of delivery cooling, lubricating and antiadhesive agents to the machining zone is of great importance in the development of abrasive machining processes.

Justification of the purposefulness of taking up the research topics (max. 150 words)

The growing social awareness of natural resources protection results in an increasing emphasis on seeking methods of environmentally friendly machining, which in relation to grinding processes translates into a decisive reduction in the use of, commonly used today, water-based oil emulsions and oils for cooling and lubricating the machining zone. We can also expect the introduction of further legislative restrictions on the use of certain chemicals in manufacturing processes, which will accelerate the spread of hybrid methods of cooling and lubrication of the grinding zone. In this context, it is justified to conduct research on the development of innovative methods that are a viable alternative to flood cooling and allow their adaptation to the requirements of specific technological grinding operations in industrial conditions. In this context, the most important research directions include:

- searching for new types of cooling-lubricating fluids (e.g. as a result of dissemination of nanomaterials), which with the minimum expenditure ensure even more favorable grinding results in comparison to the substances used so far;
- integration of known techniques for the supply of cooling lubricants to the grinding zone in order to eliminate the disadvantages of existing systems in new hybrid methods;
- development of knowledge concerning heat transfer in complex systems with turbulent flows and with multiple coolants will be possible thanks to increasingly excellent computer modelling and simulation systems, mainly using the finite element method;
- searching for new solid substances used for impregnation of grinding wheels, which will efficiently perform the lubricating and antiadhesive function and at the same time will not be troublesome for the natural environment (e.g., biodegradable or recycled substances);
- searching for new ways of introducing to grinding wheels lubricating and antiadhesive substances in a solid state, e.g., as components of bonds or in the form of abrasive aggregates;
- implementation of known techniques to new types of grinding wheels, e.g., intended for machining integrating rough and finish grinding in one operation.

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

1. Investigations of the influence of cooling with compressed cooled air on the technological quality of technical blades formed in the process of peripheral grinding with cubic boron nitride grinding wheels
2. Investigations of the influence of the delivery of coolant doped with nanoparticles on the course and results of the surface grinding process
3. Investigations of the possibility of carrying out grinding process without the supply of liquid cooling lubricants to the grinding zone

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)
It is anticipated that the primary source of funding for the research will be the statutory research funds of the Department of Production Engineering. It is also possible to apply for external funding.
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
Not applicable.

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)
1. NADOLNY K., KIERAŚ S.: Experimental Studies on the Centrifugal MQL-CCA Method of Applying Coolant during the Internal Cylindrical Grinding Process. Materials, 2020, 13(10), 2383. DOI: 10.3390/ma13102383. 2. NADOLNY K., KIERAŚ S.: New approach for cooling and lubrication in dry machining on the example of internal cylindrical grinding of bearing rings. Sustainable Materials and Technologies, Volume 24, July 2020, e00166. DOI: 10.1016/j.susmat.2020.e00166. 3. NADOLNY K., KIERAŚ S., SUTOWSKI P.: Modern approach to delivery coolants, lubricants and antiadhesives in the environmentally friendly grinding processes. International Journal of Precision Engineering and Manufacturing-Green Technology, 8(2021)2, pp. 639-663. DOI: 10.1007/s40684-020-00270-y. 4. NADOLNY K., KAPŁONEK W., SUTOWSKA M., SUTOWSKI P., MYŚLIŃSKI P., GILEWICZ A., WARCHOLIŃSKI B.: Moving towards sustainable manufacturing by extending the tool life of the pine wood planing process using the AlCrBN coating. Sustainable Materials and Technologies, Volume 28, July 2021, e00259. DOI: 10.1016/j.susmat.2021.e00259. 5. ZIELIŃSKI B., NADOLNY K., ZAWADKA W., CHACIŃSKI T., STACHURSKI W., BATALHA G.F.: Effect of Pro-Ecological Cooling and Lubrication Methods on the Sharpening Process of Planar Blades Used in Food Processing. Materials 2022, 15(21), 7842. DOI: 10.3390/ma15217842.
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
1. "*Improving process and material efficiency in the sawmill industry*" - project financed from the funds of the National Centre for Research and Development under the program "*Environment, agriculture and forestry*" BIOSTRATEG, based on agreement no. BIOSTRATEG3 /344303/14/NCBR/2018; Project implemented from 22. 12.2017 until 31.12.2020 by a consortium led by the Poznań University of Life Sciences and co-executed by the Warsaw University of Life Sciences, Koszalin University of Technology and Koszalin Wood Industry Company KPPD Szczecinek SA.

A list of research services provided for industry related to the proposed research topics for the period of the last 5 years
2017-2018 – research project on behalf of Andre Abrasives Articles Sp. z o.o., Sp. k. from Koło, Poland concerning performance tests of small-size flat grinding wheels of dimensions 35×10×10 mm designed for internal cylindrical grinding processes.