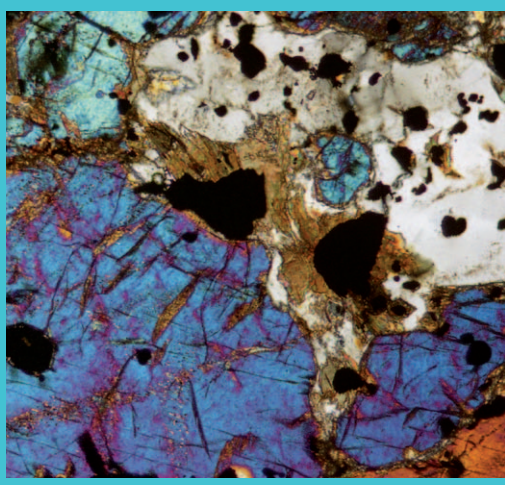
TAL TECH

RESEARCH AND DEVELOPMENT

SCHOOL OF ENGINEERING



2025

TALLINN UNIVERSITY OF TECHNOLOGY

CONTENTS

SCHOOL OF ENGINEERING

SCHOOL OF ENGINEERING

Dean: Tenured Associate Professor FJODOR SERGEJEV

e-mail: fjodor.sergejev@taltech.ee

Vice-Dean for Research: Tenured Full Professor ARGO ROSIN

e-mail: argo.rosin@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

496 Academic staff — Incl. 64 professors, 271 researchers

271 Doctoral students

33 Defended doctoral dissertations

491 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

DEPARTMENTS, COLLEGES

DEPARTMENT OF CIVIL ENGINEERING AND ARCHITECTURE
Director: Tenured Full Professor IRENE LILL, irene.lill@taltech.ee

DEPARTMENT OF ELECTRICAL POWER ENGINEERING AND MECHATRONICS
Director: Tenured Full Professor MART LANDSBERG, mart.landsberg@taltech.ee

DEPARTMENT OF ENERGY TECHNOLOGY
Director: Tenured Full Professor ALAR KONIST, alar.konist@taltech.ee

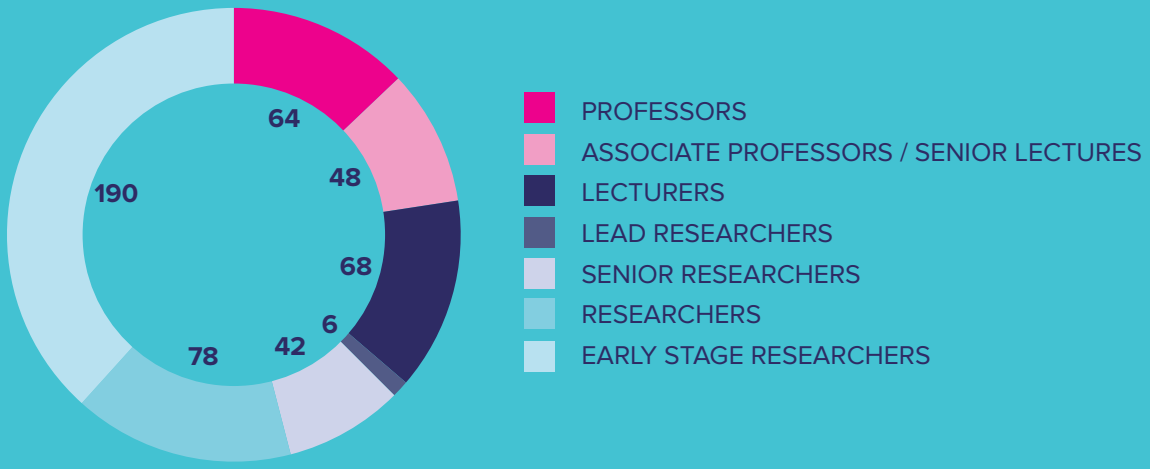
DEPARTMENT OF MATERIALS AND ENVIRONMENTAL TECHNOLOGY
Director: Tenured Full Professor MAARJA GROSSBERG-KUUSK, maarja.grossberg@taltech.ee

DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING
Director: Tenured Full Professor KRISTO KARJUST, kristo.karjust@taltech.ee

KURESSAARE COLLEGE
Director: MERIT KINDSIGO, merit.kindsigo@taltech.ee

TARTU COLLEGE
Director: Associate Professor AIME RUUS, aime.ruus@taltech.ee

VIRUMAA COLLEGE
Director: MARE ROOSILEHT, mare.roosileht@taltech.ee



DEPRATMENT OF CIVIL ENGINEERING AND ARCHITECTURE

Direktor: Tenured Full Professor IRENE LILL, irene.lill@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

141 Academic staff — Incl. 24 professors, 80 researchers

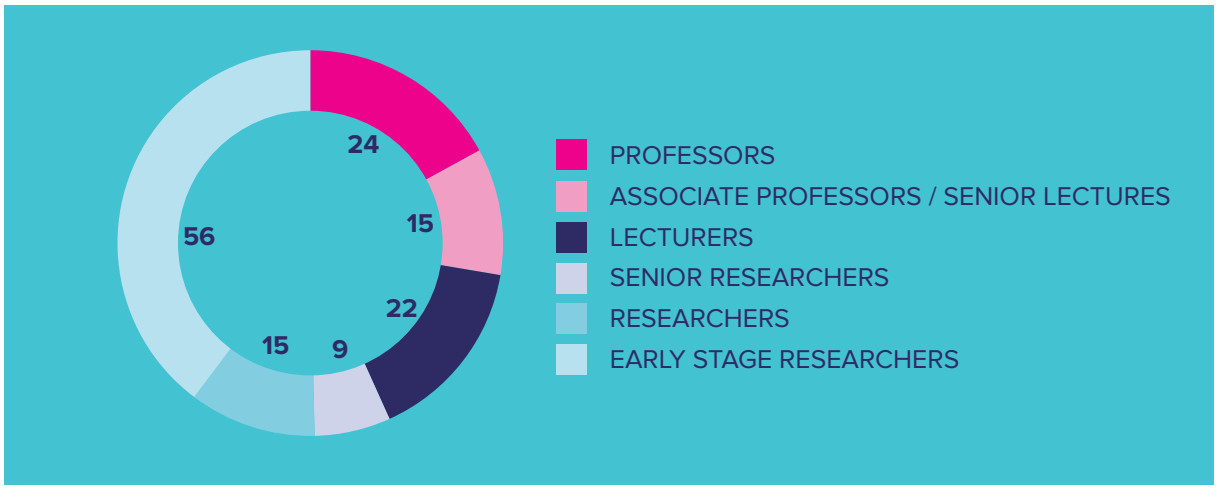
72 Doctoral students — 10 Defended doctoral dissertations

127 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 7 RESEARCH GROUPS:

- **ACADEMY OF ARCHITECTURE AND URBAN STUDIES.**
  Head: Tenured Full Professor KIMMO SAKARI LYLYKANGAS, kimmo.lylykangas@taltech.ee
- **BUILDING LIFECYCLE RESEARCH GROUP.**
  Head: Tenured Full Professor IRENE LILL, irene.lill@taltech.ee
- **NEARLY ZERO ENERGY BUILDINGS RESEARCH GROUP.**
  Head: Tenured Full Professor JAREK KURNITSKI, jarek.kurnitski@taltech.ee
- **ROAD ENGINEERING AND GEODESY RESEARCH GROUP.**
  Head: Tenured Full Professor ARTU ELLMANN, artu.ellmann@taltech.ee
- **STRUCTURAL AND FLUIDS MECHANICS RESEARCH GROUP.**
  Head: Tenured Full Professor ALEKSANDER KLAUSON, aleksander.klauson@taltech.ee
- **STRUCTURAL ENGINEERING RESEARCH GROUP.**
  Head: Associate Professor IVAR TALVIK, ivar.talvik@taltech.ee
- **WATER AND ENVIRONMENTAL ENGINEERING RESEARCH GROUP.**
  Head: Associate Professor KARIN PACHEL, karin.pachel@taltech.ee



ACADEMY OF ARCHITECTURE AND URBAN STUDIES

Head of the research group: Tenured Full Professor KIMMO SAKARI LYLYKANGAS, kimmo.lylykangas@taltech.ee

Members: Jaan Kuusemets, Jenni Vilhelmiina Partanen, Fabian Dembski, Luca Mora, Raoul Kurvits, Epi Tohvri, Anu Juurak, Sergei Letunovitš, Mark Kovalenko, Tiina Tuulik, Toivo Tammik, Emil Urbel, Üllar Ambos, Aurika Nõmm, Külli Meister, Francesco De Luca, Lill Sarv, Ioannis Lykouras

Post-doctoral researchers: Najmeh Mozaffaree Pour, Kaarel Sikk, Peter Robert Walke

Doctoral students: Sara Thabit Gonzalez, Dominik Beckers, Laura Mrosla, Hanna Matilda Vikberg, Mahdi Rasoulinezhad, Kadri-Ann Kertsmik, Olli Ilmari Jakonen, Kofoworola Modupe Osunkoya, Francesco Tonnarelli, Payam Madelat, Jelena Kazak, Helmi Marie Langsepp, Hawke Gihm, Hamidreza Zarrinkafsh, Farah Hisham Abdelfattah Elbehairy, Juha Matti Päätalo, Seungwon Eo, Kaidi Põldoja, Irena Atkovska, Grete Tiigiste, Hana Geara, Juulia Aliide Salulaid, Blaise Nkubiyaho

TOPICS AND COMPETENCES

KEYWORDS: green transition; urban design; urbanism; planning; building performance; daylighting; sustainability; Smart City; Future City; landscape architecture; participatory planning; digital urban twins; green transition; greenhouse gas quantification; history of architecture; life cycle assessment

The research work of the Academy comprises the practical and analytical cycle of architectural design and urban planning, integrating different fields of engineering and humanities, incl. social spheres related to the functioning of the society, real estate management, etc. The Academy's research topics are related to current issues related to cities, citizens, and the built environment.

The research team has top expertise in the following fields:

- Smart Cities/Urban transition processes (L. Mora, S. Thabit, D. Beckers, F. Tonnarelli, I. Lykouras);
- Greenhouse gas quantification (K. Lylykangas, K. Kertsmik);
- Performance analysis of built/urban environment (F. De Luca, K. Lylykangas, H. Vikberg, N. Eslamirad, A. Sepulveda Luque);
- Digital Urban Twins/Participatory planning (F. Dembski, V. Prilenska, K. Grišakov, T. Tuulik, M. Allik, L. Mrosla, H. Zarrinkafsh);
- Urban data analysis/Complexity research (J. Partanen, O. Jakonen, M. Rasoulinezhad, M. Osunkoya);
- History of architecture/Learning environments (E. Tohvri).

More information: *Academy of Architecture and Urban Studies*

IN 2025, two books were published:

- Epi Tohvri's monograph "Tallinna Tehnikaülikooli kampus Mustamäe luidetel" provides, for the first time, a comprehensive account of the search for a location and the architectural history of Estonia's own technical university, from the early twentieth century to the present day.
- Mora, L., Gerli, P., Beckers, D., Thabit, S., & Tonnarelli, F. (2025). *Smart City Code: Governance Handbook for Digital Transformation Managers in the Public Sector*. New York City, NY: Elsevier. This book synthesizes five years of intensive, globally-oriented research conducted through a collaboration between UN-Habitat and TalTech. Grounded in the first global survey on smart city governance practices and aligned with the UN's principles for people-centred smart cities, it establishes a comprehensive, evidence-based framework for governing the strategic, technical, and operational dimensions of urban digital transformation.

SELECTED PROJECTS

- VHE23035, *Renewable ENergy-based Positive Homes* (2023–2026)
- VHE24049, *Quantum Inspired Valuation of circular real estate* (2024–2028)
- VEU24026, *Demonstrating a model of collaborative pre-fabricated reinvention of modernist districts into cosy living environments* (2024–2027)

SELECTED ARTICLES

Lykouras, I.; Mora, L. (2025). Material matters: Recommendations for the analysis of relational spaces in sociotechnical transition studies. Technology in Society, 80, #102764. DOI: 10.1016/j.techsoc.2024.102764.

Wang, L.; De Luca, F.; Janssen, P.; Bui, D. P. T.; Chen, K. W.; Yuan, C. (2025). A cross-platform optimization system for comparative design exploration of competing concepts and strategies. Journal of Building Engineering, 115, #114413. DOI: 10.1016/j.jobe.2025.114413.

Haque, Md. N.; Beckers, D.; Costales, E.; Aad, S.; Sharifi, A.; Mora, L. (2025). A systematic review of research on just, equitable, responsible, and inclusive smart cities. Technology in Society, 83, #103050. DOI: 10.1016/j.techsoc.2025.103050.

BUILDING LIFECYCLE RESEARCH GROUP

Head of the research group: Tenured Full Professor IRENE LILL, irene.lill@taltech.ee

Members: Raido Puust, Ergo Pikas, Emlyn David Qivitoq Witt, Roode Liias, Lauri Jaakko Koskela, Tiina Nuuter, Tanel Tuisk, Erki Soekov, Lembi-Merike Raado, Tiina Hain, Virgo Sulakatko

Doctoral students: Mattias Põldaru, Christopher-Robin Raitviir, Fariha Harun, Alok Rawat, Muhammad Mubasher, Jürgen Tammepärg

TOPICS AND COMPETENCES

KEYWORDS: multiple criteria management strategies; building information modelling (BIM); construction economics; construction management; building life cycle; technical conditions of housing; disaster resilience of built environment; civil engineering education; construction regulations, normative materials, standards; utilization of oil shale ash in the production of building materials; energy saving materials for the renovation of buildings

The research group approaches the building lifecycle as a whole, integrating the construction process and its outcomes with management strategies, technologies, building materials, economics and facilities management.

Research involves the following studies:

- Main characteristics of binders or binder constituents based on oil shale ashes from electrostatic precipitator systems;
- Basics of new utilization processes for oil shale combustion solid wastes;
- Low strength backfilling concrete based on the residues of oil shale processing;
- Frost resistance of various concretes and comparison of their test methods;
- Building properties of chemically treated timber;
- Durability characteristics (vapour and water migration) of facade systems, thermal insulation and external facade coverings.

The Research and Testing Laboratory of Building Materials has certified testing personnel, standards, methods and equipment for the evaluation of conformity for various building products: cement, mortar, grout and concrete products and products from natural and artefact stones and insulation materials.

More information: *Building Lifecycle Research Group*

IN 2025: An important goal was to find solutions to reduce the climate impacts of the construction sector. Digitalization in both the broader and narrower sense is an important measure for evidence-based environmental impact reduction in the sector. The practical aspects of the unified construction classification and its further development were addressed both in cooperation with the Estonian construction sector and through international cooperation (participation in the CCIC consortium).

SELECTED PROJECTS

- LEAAE23043, *DIGITAL: Research for Tallinn Digital Twins platform services* (2023–2027)
- VEU24010, *Housing Decarbonisation Skills for Climate, Health and Jobs* (2024–2028)
- VERT23054, *FOUNTAIN: Fostering sustainable University-industry Techno-entrepreneurial Collaborations and innovations in Asian universities* (2023–2026)

SELECTED PUBLICATIONS

Pikas, E.; Tetik, M.; Seppänen, O.; Vendel, K.-R. (2025). Advancing AECO Education: A project-Based Lean IPD Design Process and Design Management Course. International Journal of Construction Education and Research, 1–33. DOI: 10.1080/15578771.2025.2534334.

Thomas, A.; Yörük, C. R.; Usta, M. C.; Pantšenko, N.-L.; Hain, T.; Uibu, M.; Trikkel, A. (2025). Developing Mineral Foam Blocks from Oil Shale Byproducts through Accelerated Carbonation. ACS Omega, 10 (40), 47051–47064. DOI: 10.1021/acsomega.5c05438.

Rawat, A.; Witt, E.; Lill, I. (2025). A Conceptual Framework for LLM-based Multi-agent System in Construction Management. Proceedings of the 2025 European Conference on Computing in Construction: 2025 European Conference on Computing in Construction, Porto, Portugal, July 14–17, 2025. European Conference on Computing in Construction. DOI: 10.35490/EC3.2025.218.

NEARLY ZERO ENERGY BUILDINGS RESEARCH GROUP

Head of the research group: Tenured Full Professor JAREK KURNITSKI, jarek.kurnitski@taltech.ee

Members: Martin Thalfeldt, Targo Kalamees, Hendrik Voll, Simo Ilomets, Peeter Parre, Dmitri Loginov, Marko Ründva, Martin Kiil, Endrik Arumägi, Kalle Kuusk, Raimo Simson, Andrea Ferrantelli, Tuule Mall Parts, Alo Mikola, Kaiser Ahmed, Paul Klõšeiko, Jaanus Hallik, Peep Pihelo, Anti Hamburg, Leena Paap, Üllar Alev, Edoardo Scalera, Georg-Mihkel Kodi

Post-doctoral researcher: Villu Kukk

Doctoral students: Karl-Villem Võsa, Ülar Palmiste, Qidi Jiang, Martin Talvik, Lauri Lihtmaa, Helena Kuivjõgi, Kristo Kalbe, Jevgeni Fadejev, Sofia Vasman, Kadri-Ann Kertsmik, Elisa Iliste, Siim Lomp, Hannes Praks, Henri Olak, Alois Andreas Põdra, Kätriin Onemar, Renate Jaanus, Hans Kristjan Aljas, Kädi-Riin Vendel, Jevgeni Lukaštšuk, Kristina Vilba

TOPICS AND COMPETENCES

KEYWORDS: building physics, HVAC, building service systems, ventilation, indoor climate, IAQ, radon, energy performance of buildings

Zero energy buildings theme consolidates research topics of energy performance, building physics, indoor climate, building services and of some architectural elements like massing and daylight. Key research initiatives are targeted to the development of technical solutions and calculation methods for highly energy performing and zero energy buildings within active cooperation with other research areas such as architecture, construction economics, building materials and energy production.

The main research topics have been focused on technical solutions and system integration for NZEB most urgently needed in Estonia, but also on NZEB development in Europe and worldwide. In addition to solutions for new buildings, the group has been extensively working on renovation and development of an energy calculation methodology.

Some examples of the research topics and outcomes:

- Measurement of heat emission efficiency and development of a simulation methodology for EN EN15306-2;
- Development of occupancy and internal heat gain schedules for prEN16798-1 and ISO 17772-1;
- Modeling of geothermal energy piles and ground source heat pump in a whole building simulation environment for heating and free cooling purposes;
- Development of overheating prevention solutions and a temperature simulation based compliance assessment methodology for residential buildings;
- Development and validation of a simplified energy performance compliance assessment method for Estonian regulation based on the specific heat loss correlation;
- Scenario analyses for energy savings and investment needs within the framework of the Estonian energy action plan ENMAK 2030+;
- Preparation of the Estonian regulation on minimum energy performance requirements, calculation methodology and the energy performance certificate;
- Preparation of the Estonian Long-term Renovation Strategy 2020–2050;
- Development of European REHVA COVID-19 ventilation guidance, Estonian COVID-19 ventilation regulation and guidance for ventilation systems operation and improvements.

More information: *Nearly Zero Energy Buildings Research Group*

IN 2025:

- Input into the European Commission's technical guidelines. The Centre of Excellence for Energy Efficiency contributed to the two most technical guidelines prepared by the European Commission for the implementation of the revised Energy Performance of Buildings Directive (EPBD), which were published as a Commission Notice (*Zero-emission buildings and technical systems and indoor climate quality parts*). The work was carried out by Jarek Kurnitski as the leader of the EPBD Concerted Action Calculation Methods Working Group, the leader of the REHVA Technology and Science Committee and a member of the Nordic Ventilation Group. As a result of this work, the zero-emission building calculation methodology was put on a scientific basis and the air quality management and monitoring requirement for non-residential buildings was equipped with reasonable and practically applicable indoor climate parameters. These guidelines have a great impact as they are used in all Member States.

- Developments in energy efficiency calculation methodology and regulation. As a result of the work carried out within the framework of the Energy Efficiency Centre of Excellence, updated regulations were prepared setting out minimum energy performance requirements for buildings, calculation methodology and energy labelling principles (entered into force on 01.03.2025). In cooperation with the Ministry of Climate, three new projects were launched to develop energy performance regulations for buildings, which are necessary for the transposition of the directive next year. They concern new requirements and limit values for zero-emission buildings, updating the weighting factors of energy carriers used in the calculation of primary energy consumption, and developing minimum thresholds for existing non-residential buildings.

SELECTED PROJECTS

- TF24019, *Centre of Excellence in Energy Efficiency* (2024–2030)
- TEM-TA78, *Data-driven assessment of the potential and impact of energy saving flexibility technologies in buildings* (2024–2028)

SELECTED PUBLICATIONS

Seyed Salehi, S.S.; Kalamees, T.; Kurnitski, J.; Thalfeldt, M. (2024). New typical meteorological year generation method based on long-term building energy simulations. Building and Environment, 256, #111504. DOI: 10.1016/j.buildenv.2024.111504.

Simson, R.; Thomsen, K.E.; Wittchen, K.B.; Kurnitski, J. (2025). Benchmarking Danish, Estonian and Finnish NZEB requirements with European Commission recommendations in residential and office buildings. Energy and Buildings, 345, #116086. DOI: 10.1016/j.enbuild.2025.116086.

ROAD ENGINEERING AND GEODESY RESEARCH GROUP

Head of the research group: Tenured Full Professor ARTU ELLMANN, artu.ellmann@taltech.ee
Members: Kristjan Lill, Arto Lille, Kalev Julge, Luule Kaal, Ain Kendra, Nelli Ustinova, Harri Rõuk, Tiit Metsvahi, Sven Sillamäe, Kait Värat, Rainis Eksi, Julia Kutsõn, Urmo Pappel
Post-doctoral researcher: Sander Varbla
Doctoral students: Karli Kontson, Vahidreza Jahanmard, Saeed Rajabi Kiasari, Aleksei Kupavõh, Yu Yan

TOPICS AND COMPETENCES

KEYWORDS: roads, bridges, geodesy, geoinformatics

The main research topics of the Road Engineering and Geodesy research group are as follows:

- Research on stabilized pavement layers;
- Development of methodology for elastic pavement design;
- Calculation and optimization of the environmental footprint of road construction processes;
- Calculation of the CO_2 footprint of the Estonian asphalt industry and proposals to reduce it;
- Research on the road construction materials (bitumen, fillers, asphalt mixes, etc.);
- Analysis of increase in traffic and its impact, traffic safety (road safety auditing and inspection, road network impact analysis, safety analysis, etc.);
- Development of the calculation method for steel tube bridges based on the interaction between arc and soil;
- Development of bridge managing systems and life cycle calculation for bridges;
- Specification of the load bearing capacity for Soviet era standard reinforced concrete bridges according loadings based on Eurocode;
- Geoid modelling research with emphasis on the Nordic-Baltic region;
- Development of geodetic infrastructure (e.g. establishment/validation of gravity databases, geoid modelling computations, mean sea surface modelling, studies of shipborne GNSS to evaluate geoid models at sea) for finalizing hydrographic surveys in the Baltic Sea;
- Development of technological solutions for combining different spatial data acquisition sensors in a mobile platform and corresponding data processing;
- Geodetic SAR for Baltic Height System Unification and studies for marine processes.

More information: *Road Engineering and Geodesy Research Group*

IN 2025 a study was conducted to develop asphalt mixtures suitable for Estonian conditions, while replacing as much bitumen as possible with bio-based lignin. In 2025, a test section of the Randvere road in Viimsi municipality was paved. In addition to the reference mixtures, three mixtures containing lignin were paved. The proportion of lignin in the mixtures was 26–28% of the bitumen-lignin mixture.

SELECTED PROJECTS

- PRG1785, *Development of continuous DYNAmic vertical REFerence for maritime and offshore engineering by applying machine learning strategies / DYNAREF/* (2023–2027)
- TARISTU24-TK11 E*stonian Environmental Observatory* (2025–2029)
- VA24019, *Baltic Sea Dynamics through 4D Modelling and Integrated Earth Observation* (2024–2026)

SELECTED PUBLICATIONS

Rajabi Kiasari, S.; Ellmann, A.; Delpeche-Ellmann, N. (2025). Sea level Forecasting using Deep Recur-rent Neural Networks with High-Resolution Hydrodynamic Model. Applied Ocean Research, 1–32 [in print].

Jahanmard, V.; Ellmann, A.; Delpeche-Ellmann, N. (2025). Quantification of Baltic Sea Water Budget Components Using Dynamic Topography. Ocean Science [in print].

Kontson, K.; Lill, K.; Aavik, A. (2024). Statistical-empirical pavement temperature prediction models based on data from road weather stations in Estonia. Road Materials and Pavement Design, 1. DOI: 10.1080/14680629.2024.2415347.

MECHANICS OF FLUIDS AND STRUCTURES RESEARCH GROUP

Head of the research group: Tenured Full Professor ALEKSANDER KLAUSON, aleksander.klauson@taltech.ee

Members: Kristjan Tabri, Ivar Annus, Andrus Räämet, Andres Braunbrück, Anatoli Vassiljev, Madis Ratassepp, Hendrik Naar, Nils Kändler, Katrin Kaur, Mirko Mustonen, Peeter Tikerpe, Medhat Hussainov, Murel Truu

Doctoral students: Mikk-Markus Imala, Carlos Omar Rasgado Moreno, Lauri Hass, Kristjan Suits, Mikloš Lakatoš, Kerta Kõiv, Chengxiang Peng

TOPICS AND COMPETENCES

KEYWORDS: smart and resilient urban water systems including drinking water, stormwater and sewage networks, hydrodynamics, flow in pipes, climate change mitigation and adaptation, risk analysis; anthropogenic underwater noise, monitoring and analysis of underwater ambient sound; nondestructive testing, modeling ultrasound propagation in various materials; fluid structure interaction of deformable structures; ultimate limit strength of marine structures; analysis and simulation of maritime accidents; simulation and assessment of ships seakeeping performance.

The research team works in four main research fields:

1. *Modelling, planning, management and risk analysis of urban water systems.* Urban water system studies are focused on optimization, planning, development, management, risk assessment and mitigation of hydraulic systems (primarily urban drainage and drinking water systems). Research on stormwater systems focuses on implementation and improvement of digital twins of the systems in order to decrease the pluvial flooding risks in urban areas.
2. *Research on ship and marine structures*. The research focuses on the analysis of the behavior of marine structures under ultimate and accidental loads; on the analysis of the seakeeping performance of midsize fast ships and on the analysis interaction between fluid and deformable metallic structures.
3. *Underwater acoustics research*. The research focuses on the analysis of the ambient underwater sound in the Baltic Sea to assess the contribution of anthropogenic noise and its harmful effects on marine life.
4. *Non-destructive testing studies:* development of experimental and numerical methods for the development of innovative technologies for the inspection and monitoring of modern structures (aircraft, wind turbines) and materials (composite, layered additives). Current focus is on the development of guided wave tomography for the structural health monitoring of pipelines and composite structures.

More information: *Mechanics of Fluids and Structures Research Group*

IN 2025:

- A methodology was developed to assess the multiple benefits of nature-based solutions for stormwater management, taking into account flood risk mitigation, water quality improvement, heat island mitigation and changes in population well-being. The methodology was validated in five cities along the Baltic Sea. In addition, a framework for assessing small and medium-sized water companies was developed to analyze the potential for digitalizing their stormwater management.
- Ultrasonic non-destructive testing methods were developed, improving measurement efficiency and quantitative defect detection in complex geometries. A new BMOGCC-type coded excitation was developed, which increases the signal-to-noise ratio and measurement speed.

SELECTED PUBLICATIONS

Kõiv, K.; Annus, I.; Kändler, N.; Kaur, K.; Suits, K.; Truu, M. (2025). Methodology for multi-benefit analysis of nature-based solutions. Blue-Green Systems, 7 (2), 287–304. DOI: 10.2166/bgs.2025.102.

Rasgado-Moreno, C.-O.; Rist, M.; Land, R.; Ratassepp, M. (2025). Guided wave tomography of pipe bends based on full waveform inversion. Ultrasonics, 148, #107560. DOI: 10.1016/j.ultras.2024.107560.

Tabri, K.; Naar, H.; Heinvee, M.; Soo, A.; Hosseinzadeh, S.; Roosipuu, T. (2025). MV Estonia: Numerical modelling of bow arrangement collapse sequence. In: Trends in Collision and Grounding of Ships and Offshore Structures. (299–308). CRC Press. DOI: 10.1201/9781003684404-38.

STRUCTURAL ENGINEERING RESEARCH GROUP

Head of the research group: Associate Professor IVAR TALVIK, ivar.talvik@taltech.ee

Members: Alar Just, Aldur Parts, Ahti Lääne, Eero Tuhkanen, Johannes Pello, Priit Luhakooder, Mattia Tiso

Doctoral students: Katrin Nele Mäger, Johanna Liblik, Kristo Paalandi, Jane Liise Nurk

TOPICS AND COMPETENCES

KEYWORDS: structural engineering, fire resistance, Eurocode, steel structures, engineered wood

The studies of the group are related to the analysis of various building structures and foundations.

Resent research is focused on studying the performance of timber and steel structures at ambient and elevated temperatures. Design methods are developed regarding the effect of the charring layer on resistance of timber elements in fire. Interaction of timber structures with different insulation materi-als and claddings is also studied. The European test method for determining the fire resistance of ad-hesives used in engineered wood structures is under development. The research results have direct connection with the revision process of Eurocode 5.

Other topics of research cover connections and stiffness properties of cross laminated timber elements and development of probabilistic models of steel elements in fire.

The members of the group provide their expertise in industrial research and development projects of the construction sector.

The research group cooperates with other technical universities and research institutes (ETH, RISE, TUM, MPA Stuttgart).

More information: *Structural Engineering Research Group*

IN 2025: The European test method for determining the fire resistance of engineered wood adhesives was further developed. European calculation model was presented to calculate the load-bearing capacity of wooden I-beams in a fire situation. Methods for calculating the fire resistance of steel elements were supplemented.

The research group continued previously initiated studies:

- fire resistance of structures;
- assessment of strength and stiffness properties of wood in wood recycling;
- effect of adhesives on fire resistance of engineered wood;
- studies of the condition of reinforced concrete panels of existing apartment buildings for the implementation of factory renovation;
- studies to standardize the calculation values of temperature-dependent strength and stiffness properties of glulam in Europe. The results of the studies were used to supplement the new version of the European standard for the design of timber structures (Eurocode 5).

SELECTED PROJECTS

- TEM-TA80 *Development of methods for the valorization of underutilized wood and wood material in construction* (2024–2028)
- PRG2213, *Development of Wood-bio-adhesive Systems in Sustainable and Safe Engineered Wood Products in Construction* (2024–2028)
- VHE23055 *Demonstrating Real and Affordable Sustainable Building Solutions with Top-level whole life-cycle performance and Improved Circularity* (2023–2027)

SELECTED PUBLICATIONS

Vihmann, J. L.; Just, A.; Sterley, M.; Mäger, K. N.; Kers, J. (2025). The Performance of Bond Lines of Engineered Wood in Cone Heater Testing. Fire and Materials. DOI: 10.1002/fam.3295.

Mager, K. N.; Just, A. (2025). Charring design model for light timber frame assemblies with load-bearing I-joists. Fire Safety Journal, 153, ARTN 104369. DOI: 10.1016/j.firesaf.2025.104369.

Liblik, J.; Just, A. (2023). Small-scale assessment method for the fire resistance of historic plaster system and timber structures. Fire and Materials, 47 (1), 62–74. DOI: 10.1002/fam.3069.

WATER AND ENVIRONMENTAL ENGINEERING RESEARCH GROUP

Head of the research group: Associate Professor KARIN PACHEL, karin.pachel@taltech.ee

Members: Arvo Iital, Janek Laanearu, Alvina Reihan, Viktoria Voronova, Kristjan Piirimäe, Argo Kuusik, Erki Lember

Doctoral students: Yaroslav Kobets, Pavlo Lyshtva, Rene Reisner, Hanna-Lii Kupri, Susmita Banerjee, Ayankoya Yemi Ayankunle, Mark-Andrian Skljarov, Marija Klõga

TOPICS AND COMPETENCES

KEYWORDS: water quality, water resources, climate changes, hydrology, pollution load, water supply, sewerage, water monitoring, nutrients, wastewater, stormwater, sewage, sludge, waste

This is an interdisciplinary research group, where engineers, hydrologists, water chemists and other specialists from both water and environmental engineering participate. Research is developed in the following directions:

- Sustainable management of water resources and water quality. Hydrological studies of rivers from engineering viewpoint. Climate change and its impact on the quantity and quality of water. Floods and draughts.
- Studies of pressure factors affecting water quality. Regularities in water quality formation in both natural conditions as well as under various anthropogenic impacts.
- Studies in the field of riverine pollution loads. Water protection measures. Innovative methods of water monitoring (automatic systems for water monitoring). Studies on diffuse pollution and mitigation thereof.
- Urban water supply (domestic water) and sewage systems (sewerage, wastewater, stormwater), including pipelines outside buildings, internal pipelines in buildings, treatment facilities, engineering solutions and technologies, studies for improving design and construction. Pharmaceutical residues and heavy metals in municipal wastewater and sludge, as well as elaboration of relevant treatment technologies.
- Waste management. Waste utilisation. Treatment technologies for landfill leachate water, engineering solutions. Investigation of the possibilities of production of biogas from biodegradable waste and by-products of the processing industry.

More information: *Water and Environmental Engineering Research Group*

For scientific and experimental research, the group uses its own internationally accredited water quality laboratory (*https://taltech.ee/en/water-quality-research-laboratory*).

IN 2025: Within the framework of the project "Engineering tools for stratified flow processes in the built environment", large-scale sewer air-water stratified flow numerical modelling solution was developed for an urban area to perform an odor study. The modelling results give insight into the complexity of airflow dynamics in a poorly vented pipeline.

The BIO-PLASTICS EUROPE project created the Policy Framework to illustrate how the project will contribute to the EU policy recommendations for bio-based plastics systems of toys, cutlery, packaging, agricultural mulch film, and aquatic equipment.

Baltiplast project "Baltic Approaches to Handling Plastic Pollution under a Circular Economy Context" was ended. The project's main objective was to identify, test and deploy concrete solutions to handle and reduce the flow of plastic waste to the Baltic Sea, under the lenses of a circular economy.

SELECTED PROJECTS

- VEU23019EA, *Implementation of national climate change adaptation activities in Estonia* (2023–2032)
- VEU19017 *Development of an integrated water management and its modern tools in Estonia – strategic choices for future* (2019–2028).
- PRG1487 *Engineering Tools of Stratified-Flow Processes in the Built Environment* (2022–2026).

SELECTED ARTICLES

Lyshtva, P.; Voronova, V.; Kuusik, A.; Kobets, Y. (2025). Assessing the Biodegradation Characteristics of Poly(Butylene Succinate) and Poly(Lactic Acid) Formulations Under Controlled Composting Conditions. AppliedChem, 5, 3, #17. DOI: 10.3390/appliedchem5030017.

Ayankunle, A. Y.; Buhhalko, N.; Pachel, K.; Lember, E.; Drenkova-Tuhtan, A.; Heinlaan, M. (2025). Microplastics in Estonian wastewater treatment plants: First evaluation of baseline concentrations and stage-wise removal efficiency. Aquatic Toxicology, 281, 107305. DOI: 10.1016/j.aquatox.2025.107305.

Laanearu, J.; Cuthbertson, A. (2023). Hydraulics of stratified sill flows within varying channel geometries: investigating energy loss and mixing of maximal two-layer exchange. Environmental Fluid Mechanics, 1–40. DOI: 10.1007/s10652-022-09899-6.

DEPARTMENT OF ELECTRICAL POWER ENGINEERING AND MECHATRONICS

Director: MART LANDSBERG,
mart.landsberg@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

73 Academic staff — Incl. 6 professors, 65 researchers

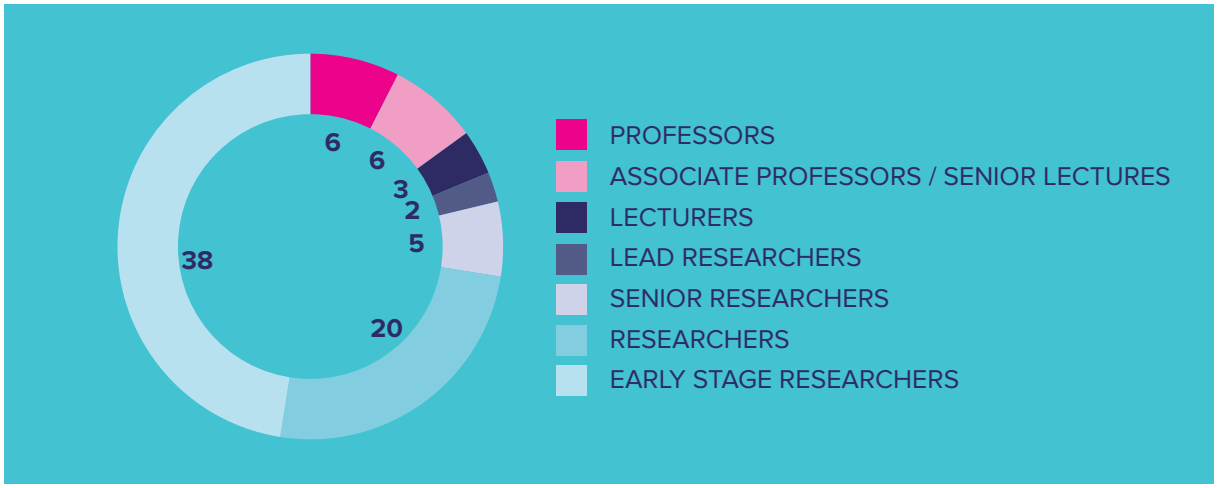
55 Doctoral students — 13 Defended doctoral dissertations

147 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 7 RESEARCH GROUPS:

- **ELECTRICAL MACHINES.**
  Head: Tenured Associate Professor ANTS KALLASTE, ants.kallaste@taltech.ee
- **ENERGY ECONOMICS AND HIGH VOLTAGE ENGINEERING RESEARCH GROUP.**
  Head: Tenured Full Professor IVO PALU, ivo.palu@taltech.ee
- **FUNDAMENTALS OF ELECTRICAL ENGINEERING.**
  Head: Tenured Associate Professor LAURI KÜTT, lauri.kutt@taltech.ee
- **MECHATRONICS AND AUTONOMOUS SYSTEMS RESEARCH GROUP.**
  Head: Tenured Associate Professor ANTON RASSÕLKIN, anton.rassolkin@taltech.ee
- **MICROGRIDS AND METROLOGY, INCL. LABORATORY OF LIGHTNING TECHNOLOGY.**
  Head: Tenured Full Professor ARGO ROSIN, argo.rosin@taltech.ee
- **POWER ELECTRONICS RESEARCH GROUP.**
  Head: Lead Research Scientist DMITRI VINNIKOV, dmitri.vinnikov@taltech.ee
- **POWER SYSTEMS RESEARCH GROUP.**
  Head: Tenured Associate Professor JAKO KILTER, jako.kilter@taltech.ee



ELECTRICAL MACHINES RESEARCH GROUP

Head of the research group: Tenured Associate Professor ANTS KALLASTE, ants.kallaste@taltech.ee

Members: Toomas Vaimann, Bilal Asad, Hadi Ashraf Raja, Hans Tiismus, Maia-Liisa Veldi, Kerdo Kruberg

Doctoral students: Siarhei Autsou, Muhammad Usman Naseer, Martin Sarap, Shahid Hussain, Muhammad Usman Sardar, Zahoor Ahmad, Suleman Saeed, Khizra Arif, Mehroz Fatima, Sumeet Khalid, Waqas Ahmed Sarwar

TOPICS AND COMPETENCES

KEYWORDS: electrical machines, generators, electrical drives, fault diagnostics, condition monitoring, artificial intelligence

The Electrical Machines Research Group is mainly involved in analysis, design, testing, development etc. of electrical machines, including wind generators. Additionally, the research group deals with electrical machine diagnostics, developing of permanent magnet materials for the use in electrical machines, novel methodologies for design and optimization of electrical machines and drives.

The main research topics of the last years have been the investigation of additive manufacturing possibilities of electrical machines and the development of this technology. Active research is going on in the field of intelligent methods for electrical machines and drive systems condition monitoring and diagnostics, involving Artificial Intelligence methods, possibilities provided by Internet of Things and Industry 4.0 technologies.

More information:
https://taltech.ee/en/electrical-machine-group

IN 2025

The project "Additivly Manufactured Electrical Machines" was continued. The project addresses questions related to defining machine types suitable for 3D printing and optimizing them according to the possibilities of 3D printing. A key consideration is the application of the electrical machine, as 3D printing is particularly suitable for specialized machines.

The project "Advanced recycled permanent Magnets for New Energy and Mobility Applications (MagNEO)" was continued in cooperation with National Institute of Chemical Physics and Biophysics (coordinator) and Tartu University. The project focuses on the development of recycling of sintered NdFeB. The recycling of NdFeB would reduce the EU´s dependence on China being more economical and cheaper compared to mining.

The project "Development of Risk- and Condition-Based Asset Management Principles" aims to understand the usability of assets managed by an electrical grid operator and develop methodologies for determining and analyzing the actual technical condition of equipment. A significant outcome is the development and potential implementation of maintenance methodologies based on a real substation provided by the client.

SELECTED PROJECTS

- PRG1827 "*Additivly Manufactured Electrical Machines*" (2023–2027)
- VERT23001 "*Capacity Enhancement in Electrical Equipment Condition Monitoring and Fault Diagnostics*" (2023–2025)
- LEEEE21116 "*Development of risk and condition based asset management principles*" (2021–2025)

SELECTED PUBLICATIONS

Plopeanu, T.; Kalda, J.; Tiismus, H.; Virro, I.; Vaimann, T.; Kallaste, A. (2025). Optimal shape of additively manufactured magnetic cores. Scientific Reports, 15, art. 42501. DOI: 10.1038/s41598-025-26678-7.

Sardar, M. U.; Vaimann, T.; Kütt, L.; Asad, B.; Kallaste, A.; Rassõlkin, A. (2025). Modeling Cable-Fed Induction Motor Drives with Optimized Impedance Characterization Across a Low to High-Frequency Spectrum. IEEE Transactions on Energy Conversion, 1–14. DOI: 10.1109/TEC.2025.3630465.

Sarap, M.; Singh, S.; Kallaste, A.; Qureshi, A. J.; Tiismus, H.; Vaimann, T.; Ghahfarokhi, P. S. (2025). Comparative Study of Advanced Heatsink Structures for Improved Thermal Performance in Axial Flux Motors. IEEE Access, 13, 100850–100860. DOI: 10.1109/ACCESS.2025.3577289.

ENERGY ECONOMICS AND HIGH VOLTAGE ENGINEERING RESEARCH GROUP

Head of the research group: Tenured Full Professor IVO PALU, ivo.palu@taltech.ee

Members: Reeli Kuhi-Thalfeldt, Jelena Šuvalova, Paul Taklaja, Victor Astapov, Ivar Kiitam, Sambeet Mishra, Hannes Agabus, Sten Buldas, Lisete Laine, Rasmus Tammis, Vladislav Musakko

Doctoral students: Maninder Choudhary, Praveen Prakash Singh, Ahto Pärl, Heiki Jakson, Alexander Varushchenkov, Johan Felix Blumfeldt, Kristopher Raik

TOPICS AND COMPETENCES

KEYWORDS: green energy economy, technology applicability and investment profitability analyses, economic and technical modelling of power system and electricity market, high voltage, insulators, partial discharges

The research team specializes in analyzing the components and challenges of the energy market to gain insight and create models using software such as EnergyPro, DigSilent, Windpro. The models consider future technologies and trends to evaluate the economic aspects of new power plants and their competitiveness. Broader models are used to analyze the energy system's impact on policies and regulations, allowing the government and policymakers to create better long-term development plans and aid economic growth. The team has international expertise in technology applicability and investment profitability analysis.

The High Voltage research laboratory activities are focused on the studies of the high voltage insulation and applications Associate with the high voltages and strong electrical fields. Most research is related to the insulators and insulation used in power lines, both overhead and cable lines are studied. Another scope of research is the effects of high loading, nonlinear loads and power quality to high voltage equipment (transformers, cable power lines etc.).

More information:
https://taltech.ee/en/energy-economics-research-group

SELECTED PROJECTS

- LEEEE24081 "*Expertise to assess the development of the frequency reserve market by Elering in accordance with (EU) 2017/2195 and the Agreement governing the operation of the Continental European Synchronous Area and its annexes (SAFA)*" (2024–2024)
- LEEEE24062 "*Partial Discharge measurements of Tootsi-Sopi wind park medium voltage underground cables*" (2024–2024)
- LEEEE25061 "*Safety in Electrical Grid Containing Distributed Generation: Practical Experiments*" (2025–2025)

SELECTED PUBLICATIONS

Choudhary, M.; Shafiq, M.; Bhattarai, A.; Kiitam, I.; Taklaja, P.; Palu, I. (2025). A Comprehensive Study of Partial Discharge Based Extrinsic Aging in Nomex Insulation Films: Modeling, Simulation and Measurement. Electric Power Systems Research, 245, #111663. DOI: 10.1016/j.epsr.2025.111663.

Pärl, A.; Singh, P. P.; Palu, I.; Sachan, S. (2025). Cost Analysis and Optimization of Modern Power System Operations. Applied Sciences, 15 (15), #8481. DOI: 10.3390/app15158481.

Maask, V.; Agabus, H.; Tiismus, H.; Astapov, V.; Ahmadiahangar, R.; Korõtko, T.; Rosin, A. (2025). Exploring the Landscape of End User Energy Flexibility: A Systematic Review of Technologies, Challenges, and Opportunities. IEEE Access, 13, 146579–146602. DOI: 10.1109/ACCESS.2025.3599989.

FUNDAMENTALS OF ELECTRICAL ENGINEERING

Head of the research group: Tenured Associate Professor LAURI KÜTT, lauri.kutt@taltech.ee

Members: Martin Jaanus, Heigo Mõlder, Kamran Daniel, Aleksander Kilk, Marek Jarkovoi, Tarmo Rosman, Toomas Vinnal, Henri Liivrand, Karl Leego, Laur Valgur, Martin Mikk Kõiv, Oliver Niin

Doctoral students: Martin Parker, Rana Muhammad Arslan Qadar, Taavi Salum

TOPICS AND COMPETENCES

KEYWORDS: electromagnetic compatibility, electric power quality, electromagnetic research, electrical engineering, circuit analysis

The main research activities are related to electric power supply quality (voltage quality, including voltage level and voltage waveform parameters, their influences and optimization; alternating voltage/current measurements and measurement data processing; investigation for influence of the voltage quality on the operation of devices and systems, etc.) and electromagnetic compatibility (EMC) (mutual electromagnetic influence of devices and systems, electromagnetic emission and immunity; wideband EM-field measurement and evaluation; influence of EM-noise on the operation of devices and systems, etc.).

In the field of electric power quality, challenges arise from the upcoming EU energy regulations, laying down requirements that can be achieved through higher amount of power electric converters related to small-power generation units including photovoltaic panels, small-power wind and other renewable producers. In order to achieve this, an investigation has to be carried out for the limits and capabilities of a public distribution network for operation without inadvertent violations of the voltage quality. The topics are closely related to both the fields of power quality (requirements to voltage quality and overload avoidance) and of EMC (requirements for devices and/or enforcement of the network against voltage degradation).

In the topics of EMC the research is targeted at conditions on how to combine different technologies in the same power supply grid (for example, power line communication and devices in the network), how to guarantee the compliance of specific electric and electronic products to the EU EMC and low voltage directives. The research group has equipment in the EMC laboratory, which also provides capabilities to test the products prior to their market release. The EMC laboratory can also provide services to the innovative electric and electronic industry, supporting faster development and market entry of their products.

More information: *https://taltech.ee/en/fundamental-electrical-engineering-group*

IN 2025: The research carried out focused on issues of electromagnetic compatibility related to power semiconductor converters. The research on DC converters addressed the mapping of electromagnetic interference generation mechanisms in partial-power converter class devices, including monitoring of converter components through refined analysis of high-frequency disturbances.

To enable more comprehensive monitoring of power supply systems, an initial prototype solution for a measurement platform was developed to support the creation and implementation of novel pre-analysis algorithm.

In the field of electromagnetic compatibility, work continued on developing measurement capability for conducted disturbances related to the operation of renewable energy sources and power semiconductor converters in distribution networks. The tools required for comprehensive measurement of renewable energy producers' electrical installations were further developed.

SELECTED PROJECTS

- TFA25100 "*Development of a base system for monitoring the status data of the electricity distribution networks to support flexibility services, to increase the use of renewable energy resources and improve reliability of the grid*" (2025–2026)
- LEEEV25081 "*Solar power plant EMF/EMC analysis*" (2025–2025)
- PRG2055 "*Tõhusad, töökindlad ja turvalised osavõimsusega elektroonilised süsteemid*" (2024–2028)

SELECTED PUBLICATIONS

Daniel, K.; Kutt, L.; Iqbal, M.N; Shabbir, N.; Raja, H.A,; Sardar, M.U.; (2024). A Review of Harmonic Detection, Suppression, Aggregation and Estimation Techniques. Applied Sciences, 14 (23), #10966. DOI: 10.3390/app142310966.

Iqbal, M. N.; Kütt, L.; Daniel, K.; Shabbir, N.; Amjad, A.; Awan, A. W.; Ali, M. (2024). Inaccuracies and Uncertainties for Harmonic Estimation in Distribution Networks. Sustainability, 16 (15), #6523. DOI: 10.3390/su16156523.

Sardar, M. U.; Vaimann, T.; Kütt, L.; Asad, B.; Kallaste, A.; Land, R. (2025). Wideband Frequency Response Analysis for Sensitive Condition Estimation of Machine's Turn Insulation Degradation Faults. 2025 IEEE Workshop on Electrical Machines Design, Control and Diagnosis (WEMDCD): Valletta, Malta, 9–10 April 2025. IEEE, 1–6. DOI: 10.1109/WEMDCD61816.2025.11014207.

MECHATRONICS AND AUTONOMOUS SYSTEMS RESEARCH GROUP

Head of the research group: Tenured Associate Professor ANTON RASSÕLKIN, anton.rassolkin@taltech.ee

Members: Tiia Tammaru, Even Sekhri, Leo Teder, Andres Kiitam, Andres Aleksander Kase, Kenari Koonik, Martin Võip, Karl Aleksander Leoste, Aure Vainu-Konnapere, Kevin Lindlaan, Margus Tõnissaar, Sven Rosenberg

Doctoral students: Mahmoud Ibrahim, Daniil Valme, Rolando Antonio Gilbert Zequera, Diana Belolipetskaja, Johannes Muru, Assem Reda Abdelhafez Fahim Meghawer

TOPICS AND COMPETENCES

KEYWORDS: design and control of mechatronic systems, propulsion drive, Digital Twins, UGV and UAV simulations, machine vision applications

The research activities of the Mechatronics and Autonomous Systems Centre are focused on the further development of mechatronics and autonomous systems. Modern vehicles (including various electric vehicles, e.g. electric cars, unmanned land and aircraft) also require energy efficiency optimization. The research team is developing several test platforms and digital twins to achieve this goal. The possibilities of combining real and virtual sensors with artificial intelligence are being explored to prolong the working life of vehicles and reduce the risk of failure.

Additionally, the main focus of R&D is the development of hardware and related software based on artificial intelligence for robotics and automation control systems and the development of user interfaces for systems, sensing, and especially new machine vision applications. The emphasis is on industrial robotics and the development of unmanned ground vehicle (UGV) and unmanned aerial vehicle (UAV) systems, as well as hardware-in-the-loop simulation and test systems.

More information: *https://taltech.ee/en/mechatronics-and-autonomous-systems*

IN 2025: Two new research projects were launched:

1. The project "Advanced Digital Tools to Accelerate the Development of Software-Defined Electric Vehicles" aims to further advance the digital twin technology of the electric powertrain in the development of software-controlled electric vehicles. The project targets the evolution of digital twins toward adaptive and intelligent levels, addressing the growing demand for efficient testing, validation, and optimization of electric propulsion systems in alignment with the EU clean energy transition objectives. Key research challenges include lifecycle management of digital twins, large-scale data processing, and reliable real-time communication. Through system integration, optimization, and technology demonstration, the project aims to make a significant contribution to the development of next-generation software-defined electric vehicle platforms.
2. "Artificial Intelligence-Based Adaptive Drive Control System". The project focuses on the development of a smart and adaptive electric drive system aimed at improving the energy efficiency and reliability of electric vehicles. The proposed solution integrates artificial intelligence-based control algorithms with advanced sensor technologies, enabling real-time adaptation to varying traffic and road conditions.

SELECTED PUBLICATIONS

- PRG2532 "*Advanced Digital Tools to Accelerate the Development of Software-Defined Electric Vehicles*" (2025–2029)
- TFA25099 "*Artificial intelligence-based adaptive drive control system*" (2025–2026)

SELECTED PUBLICATIONS

Ibrahim, M.; Järg, O.; Seppago, R.; Rassõlkin, A. (2025). Performance Optimization of a High-Speed Permanent Magnet Synchronous Motor Drive System for Formula Electric Vehicle Application. Sensors, 25, 10, #3156. DOI: 10.3390/s25103156.

Ibrahim, M.; Rassõlkin, A. (2025). Hybrid-Driven Digital Twin Modelling Framework for an EV Propulsion Drive System. IET Intelligent Transport Systems, 19, 1, #e70099. DOI: 10.1049/itr2.70099.

Gilbert Zequera, R. A.; Rjabtšikov, V.; Rassõlkin, A.; Vaimann, T.; Kallaste, A. (2024). Deep Learning methodology for charging management applications in battery cells based on Neural Networks. IEEE Transactions on Intelligent Vehicles, 1–15. DOI: 10.1109/TIV.2024.3417216.

MICROGRIDS AND METROLOGY

Head of the research group: Tenured Full Professor ARGO ROSIN, argo.rosin@taltech.ee

Members: Roya Ahmadiahangar, Tarmo Korõtko, Freddy Plaum, Vahur Maask, Madis Lehtla, Tobias Häring, Arvo Oorn, Toivo Varjas, Marti Laidre, Jaakob Lambot, Trevor Uuna, Julius Välja, Aiko Liisa Olek, Eva Tallo, Imre Drovtar, Indrek Möldre, Ketlin Tölp, Kevin Räpo, Meeli Maria Viikmaa

Doctoral students: Arqum Shahid, Martin Parker, Mitra Nabian Dehaghani Furqan Amjad, Merilin Metsik, Zeeshan Ali Shah

TOPICS AND COMPETENCES

KEYWORDS: microgrids, power system digitalization; energy communities; artificial intelligence applications in power system; energy flexibility; demand side management; energy storages; automation and diagnostic systems; electrical lighting

The research activities are focused on the development of two key research areas: electrical power supply systems (microgrids) and metrology.

Research in the field of electricity supply is focused on the research of models for predicting and characterizing the flexibility of the electricity system on demand side; on increasing the flexibility of energy communities by applying the artificial intelligence for control and optimization of energy flows, and on the development of innovative flexibility services and products. The application of the street lighting infrastructure is also being studied for a wider integration of green technologies (EVs, renewables, etc.) into the electricity system.

Research in the field of metrology is mainly focused on the development of measurement methods important in electric lighting and diagnostics of industrial equipment. In electric lighting, the impact of new lighting technologies on humans and the environment (including road safety) is studied, new lighting measurement methods are developed, e.g. for evaluating the effects of LED screens and lighting pollution. Measurement methods and algorithms suitable for diagnostics of industrial equipment are also studied in order to prevent economically costly failures and malfunctions.

More information: *https://taltech.ee/en/microgrids-and-metrology-group*

IN 2025:

The research group distinguished itself at the international level primarily through R&D results that shifted the focus from the development of individual technologies toward a systemic, data-driven, and artificial intelligence–enabled energy system. A key novelty was the treatment of renewable energy sources, energy storage systems, and end-user flexibility as a single, controllable resource rather than as isolated components.

A particularly novel international contribution was the methodology for quantifying aggregated energy flexibility, which integrates flexible capacity, activation duration, and rebound effects into a single metric. This enables a more realistic assessment of the value of flexibility across different energy markets and reduces risks for system operators and aggregators.

The analysis of the role of artificial intelligence and language models in the management of power grids proved to be particularly promising. The research

team showed that distributed AI and specialized language models enable more accurate power quality predictions, faster operational responses, and more efficient handling of complex regulatory frameworks. The systematic use of digital twins and high-quality data brought a new level of testing of energy technologies and validation of business models.

SELECTED PROJECTS

- ÕÜF3 "*Research and Development of Novel Renewable Energy and Flexibility Technologies*" (2023–2029)
- ÕÜF4 "*Research and development of novel applications for community and small-scale energy systems*" (2023–2029)
- VHE24065 "*Art of Darkness as Cultural Heritage of Urban Landscape*" (2025–2027)

SELECTED PUBLICATIONS

Shahid, A.; Ahmadiahangar, R.; Kilter, J.; Rosin, A. (2025). Data-driven quantification and aggregation of demand-side flexibility for symmetrical bidding in energy balancing markets. Electric Power Systems Research, 247, #111823. DOI: 10.1016/j.epsr.2025.111823.

Maask, V.; Rosin, A.; Korotko, T.; Thalfeldt, M.; Syri, S.; Ahmadiahangar, R. (2023). Aggregation ready flexibility management methods for mechanical ventilation systems in buildings. Energy and Buildings, 296, #113369. DOI: 10.1016/j.enbuild.2023.113369.

Plaum, F.; Rosin, A.; Ahmadiahangar, R. (2024). Novel Quantification Method of Aggregated Energy Flexibility Based on Power-Duration Curves. IEEE Access, 12, 132825–132837. DOI: 10.1109/ACCESS.2024.3461151.

POWER ELECTRONICS RESEARCH GROUP

Head of the research group: Lead Research Scientist DMITRI VINNIKOV, dmitri.vinnikov@taltech.ee

Members: Tanel Jalakas, Andrii Chub, Andrei Blinov, Indrek Roasto, Oleksandr Matiushkin, Edivan Laercio Carvalho, Vinod Kumar Yadav, Abualkasim Ahmed Ali Bakeer, Alexander Rink, Artem Fesenko, Artur Lavrov, Kristjan Uus, Siim-Erik Viiding

Postdoctoral researcher: Edivan Laercio Carvalho da Silva, Ievgen Verbytskyi, Neelesh Yadav, Sachin Chauhan Doctoral students: Hossein Afshari, Parham Mohseni Dash Agholi, Salman Khan, Sayeed Hasan, Hossein Nourollahi Hokmabad, Tofopefun Nifise Olayiwola, Salamat Ali, Hetal Sharma, Tuhin Mitra, Abdul Majid Bhat, Hans Anniste, Saqib Ali, Zeeshan Haider

TOPICS AND COMPETENCES

KEYWORDS: power converters for renewables, energy systems for near-zero energy buildings, power converters for energy storages, reliability of power electronic systems

Research in the group is focused on the development and experimental validation of advanced power electronic converters for such demanding applications as renewable energy systems, rolling stock, automotive and telecom. The key research directions include synthesis of new converter topologies, development of special control and protection algorithms, implementation of advanced components and materials, and elaboration of design guidelines for enhancing the efficiency, power density and reliability of the on-market power electronic systems.

Since 2010 the Power Electronic Group is a member of ECPE – European Center for Power Electronics e.V., which is an industry-driven research network promoting education, innovation, science, research and technology transfer in the area of Power Electronics in Europe. Moreover, the group is a part of Estonian Centre of Excellence for zero energy and resource efficient smart buildings and districts (ZEBE). The core activities in ZEBE are related to the advancing of the residential DC microgrid technology and acceleration of the transition towards highly energy-efficient and decarbonized buildings.

More information: *https://taltech.ee/en/power-electronics-research-group*

IN 2025 the research group members have participated in more than 10 different national and international R&D projects, from which the following can be highlighted:

- "*Future-Proof Power Electronic Systems for Residential Microgrids*". The main objective of this project is to make a breakthrough in the applied design of power electronic systems for residential DC microgrids (RDCμG) by the acquisition of cutting-edge knowledge in topologies, control, optimization, reliability and lifetime extension methods. It is highly expected that key competences obtained during the project will help to advance the emerging RDCμG technology by enabling novel versatile cost-effective power electronic systems, which will push forward the innovation and accelerate the transition towards highly energy-efficient and decarbonized buildings.
- "*Centre of Excellence in Energy Efficiency*" (CoE ENER). CoE aims to contribute to Estonian societal and economic challenge to transform 75% of existing building stock with poor energy performance to zero emission buildings (ZEB) with maximized co-benefits and improved life quality by 2050.
- "*SHIFT to Direct Current*" project aims to propose and implement a top-down application-agnostic approach for the design, simulation, test, validation, and application of both medium and low voltage direct current solutions.

SELECTED PROJECTS

- PRG1086 "*Future-Proof Power Electronic Systems for Residential Microgrids*" (2021–2025)
- TF24019EE "*Centre of Excellence in Energy Efficiency*" (2024–2030)
- TTK12 "*Energiatõhususe ja taastuvenergeetika tuumiktaristu*" (2025–2029)

SELECTED PUBLICATIONS

Yadav, N.; Chub, A.; Hassanpour, N.; Blinov, A.; Vinnikov, D. (2025). Protection and Control Implementation for Bidirectional Step-Up/Down Partial Power Converter for Droop-Controlled DC Microgrids. IEEE Transactions on Industry Applications, 61 (5), 7470–7480. DOI: 10.1109/TIA.2025.3561767.

Carvalho, E. L.; Mandrioli, R.; Vinnikov, D. (2025). Universal Interlinking Converter for DC-Powered Prosumer Buildings. IEEE Open Journal of Power Electronics, 6, 1967–1979. DOI: 10.1109/OJPEL.2025.3629539.

Yadav, N.; Chub, A.; Hassanpour, N.; Blinov, A.; Vinnikov, D.; Galkin, I. (2025). A Hybrid Modulation Approach for Step-Up/ Down Partial Power Converter with Improved MPPT Efficiency Around Zero Partiality. IEEE Transactions on Industry Applications, 1–10. DOI: 10.1109/TIA.2025.3525607.

POWER SYSTEMS RESEARCH GROUP

Head of the research group: Tenured Associate Professor JAKO KILTER, jako.kilter@taltech.ee

Members: Hamid Khoshkhoo, Madis Leinakse, Henri Manninen, Kaur Tuttelberg, Ülo Treufeldt, Tanel Sarnet, Marko Tealane, Brenda Pent, Eliise Kaha, Elis Vedom, Uku Sau

Doctoral students: Guido Andreesen, Pradeep Kumar Gupta, Sajjad Asefi, Ahmed Bassiouny Abdelfattah Bassiouny Faioud

TOPICS AND COMPETENCES

KEYWORDS: power system stability, wind and solar power copower system stability, wind and solar power connections, power quality, HVDC and FACTS, load modelling, relay protection, wide-area monitoring and control

Research activities in the group are focused on the development of control and protection algorithms and applications, and performing system analysis considering the challenges in modern and future power systems.

Key research areas: power system real-time control protection and analysis based on wide-area information with respect to HVDC and FACTS control, wind power integration, power quality and load modelling. Emphasis is on modern power systems where the level of generation through converters is increasing and consequently the level of system inertia is decreasing.

Other research activities are concentrated on the development and assessment of power quality mitigation methods in transmission and distribution systems considering the availability of modern compensation devices and wide-area information.

More information: *https://taltech.ee/en/power-systems-group*

IN 2025

- Algorithms for reducing the volume of power grid models were defined and developed, taking into account the addition of converter-based production units to the power systems.
- A framework for assessing the reserve market volumes of the Estonian and Baltic electricity systems was created.

- A novel approach and control algorithms were created for cooperation between industrial consumers and the power system within the framework of system services.
- A methodology for assessing and comparing the assets of network companies was further developed and mathematical approaches were developed for determining the actual state of the power switch.
- Principles for the operational control of the Estonian power system in disturbance operation were compiled.
- A methodology for cooperation between DC connections and synchronous machines in low-inertia power grid conditions was analyzed and developed.
- The challenges associated with large-scale connection of wind and solar energy and possible improvement solutions in the framework of the Estonian power system were analyzed and defined.

SELECTED PROJECTS

- TEM-TA134 "*Optimal and reliable control of power systems in the framework of large-scale renewable energy*" (2024–2028)
- LEEEE20087 "*Principles of risk-based asset management in future electricity systems*" (2020–2021)
- LEEEE25056 "*Modeling, testing and grid analysis of a Purtse energy storage system*" (2025–2026)

SELECTED PUBLICATIONS

Gupta, P.K.; Tuttelberg, K.; Kilter, J. (2025). Forecasting Corona Losses on High Voltage Transmission Lines Using Machine Learning. IEEE Transactions on Power Delivery, 40, 5, 2696–2705. DOI: 10.1109/TPWRD.2025.3593923.

Asefi, S.; Asefi, S.; Afshari, H.; Kilter, J.; Shayesteh, E.; Hilber, P.; Lindquist, T. (2025). Machine Learning-Based High-Voltage Circuit Breaker Defect Classification Utilizing Savitzky-Golay Filter. IEEE Transactions on Instrumentation and Measurement, 74, #3557009. DOI: 10.1109/TIM.2025.3604980.

Campos, N. M. D.; Sarnet, T.; Kilter, J. (2023). Novel Gramian-based Structure-preserving Model Order Reduction for Power Systems with High Penetration of Power Converters. IEEE Transactions on Power Systems, 38 (6), 5381–5391. DOI: 10.1109/TPWRS.2022.3228458.

DEPARTMENT OF ENERGY TECHNOLOGY

Director: Tenured Full Professor
ALAR KONIST,
alar.konist@taltech.ee

MAIN FIGURES 2025

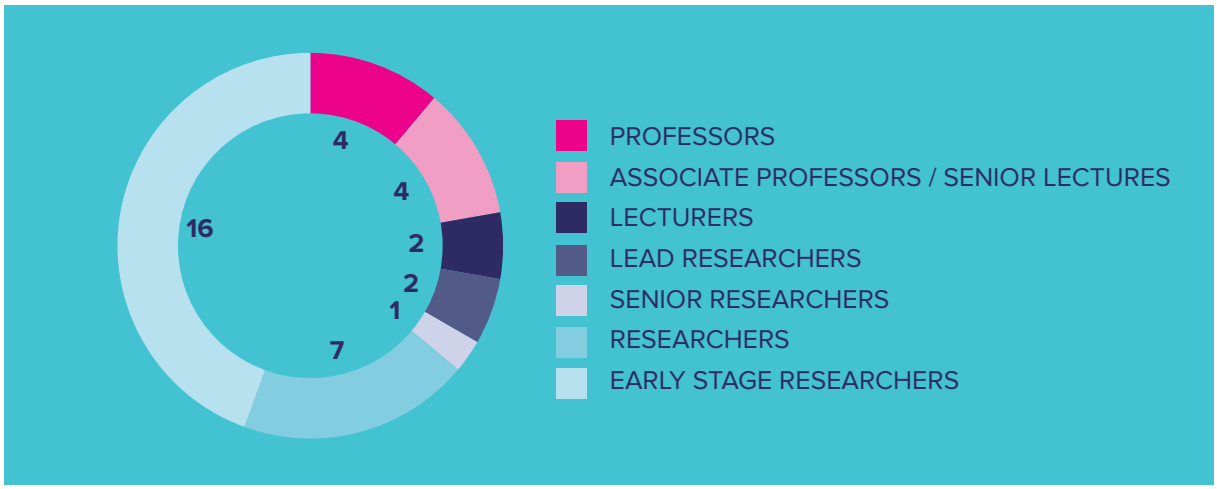
(as of Dec. 31, 2025)

32	Academic staff	Incl. 4 26	professors researchers
17	Doctoral students	1	Defended doctoral dissertations
22	Scientific publications*		

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 3 RESEARCH GROUPS:

- **LABORATORY OF FUEL AND AIR EMISSION ANALYSIS.**
  Head: Tenured Associate Professor OLIVER JÄRVIK, oliver.jarvik@taltech.ee
- **RESEARCH GROUP OF SUSTAINABLE ENERGY AND FUELS.**
  Head: Tenured Full Professor ALAR KONIST, alar.konist@taltech.ee
- **SMART DISTRICT HEATING SYSTEMS AND INTEGRATED ASSESSMENT ANALYSIS OF GREENHOUSE GASES EMISSIONS.**
  Head: Tenured Full Professor ANNA VOLKOVA, anna.volkova@taltech.ee



LABORATORY OF FUEL AND AIR EMISSION ANALYSIS

Head of the research group: Tenured Associate Professor OLIVER JÄRVIK, oliver.jarvik@taltech.ee

Members: Inna Kamenev, Jelena Veressinina, Mihkel Koel, Kristel Tanilas, Kadriann Tamm, Sven Kamenev, Liisi Blank

Doctoral students: Kati Roosalu, Nouman Rafique, Laura Kiolein

TOPICS AND COMPETENCES

KEYWORDS: thermodynamic properties, multicomponent mixtures, vapor pressure, correlations, pyrolysis, machine learning, fuel and ash analyses, environmental technologies

The group's work is focused on the studies of pyrolysis processes and the characterization of pyrolysis process inlet and outlet streams. This includes the measurement of composition and thermodynamic properties of pure organic compounds, mixtures, and pyrolysis oils (shale oil and bio-oil).

Additionally, there is a strong expertise in the studies of thermal behavior of solids and liquids (calorimetry and thermogravimetriy) and the parameters (molar mass distribution, rheological properties) and thermal stability of various mixtures of organic substances (oils, resins, polymers).

The group's activities are closely intertwined with the work of the Sustainable Energy and Fuels Research Group. There is also a strong collaboration with Virumaa College.

The group's recent research activities are related to the following topics:

- Determination and prediction of properties of ionic liquids and deep eutectic mixtures;
- Studies on CO_2 utilization;
- Studies on improving the quality of wastewater;
- Studies of pyrolysis and co-pyrolysis and gasification

SELECTED PROJECTS

- VEU25048 "*High-temperature thermal energy storage enabling a second life for existing fluidized bed boilers with a high efficiency*" (2025–2029)
- PRG1784 "*Sustainable and Effective Materials for Latent Heat Thermal Energy Storage Based on Amine Ionic Liquids*" (2023–2027)
- LEIEE23071 "*Determining the species composition and properties of the waste incinerated at the Iru power plant, as well as the CO2 emission*" (2023–2024)

SELECTED ARTICLES

Kaljusmaa, L.-M.; Tubli, D.; Adamson, J.; Konist, A.; Järvik, O. (2025). Thermal stability of amine and carboxylic acid based protic ionic liquids from the perspective of thermal energy storage. Journal of Molecular Liquids, 427, #127396. DOI: 10.1016/j.molliq.2025.127396.

Yang, D.; Tanilas, K.; Järvik, O.; Konist, A. (2025). Trace element quantification in solid fuel wastes by LA-ICP-MS: a review. Talanta, #128951. DOI: 10.1016/j.talanta.2025.128951.

Roosalu, K.; Kamenev, I.; Tanilas, K.; Reinik, J.; Jarvik, O. (2025). Trace elements in oil shale ashes and waste wood ashes and their leachability with a focus on chromium. Oil Shale, 42 (3), 273–290. DOI: 10.3176/oil.2025.3.02.

RESEARCH GROUP OF SUSTAINABLE ENERGY AND FUELS

Head of the research group: Tenured Full Professor ALAR KONIST, alar.konist@taltech.ee

Members: Dmitri Nešumajev, Tõnu Pihu, Janek Reinik, Alejandro Lyons Cerón, Mais Hanna Suleiman Baqain

Doctoral students: Mari Sinisalu-Sulg, Mari-Liis Ummik, Liisa-Maria Kaljusmaa, Fanfan Xu, Hannela Artus, Dan Yang

TOPICS AND COMPETENCES

KEYWORDS: fuels, combustion, pyrolysis, gasification, ash, activation energies, CO_2 emissions, CCS and CCU (inc. Oxyfuel)

Moving toward zero carbon emissions is an ultimate goal for energy technology. The group intends to tackle the problem by studying the possibilities of oxy-fuel co-combustion of oil shale (OS) and biomass in circulating fluidized bed (CFB) boiler. The proposed process will allow for the reduction of hazardous waste ash products, in addition to emissions, which have so far been generated annually in the amount of approximately six million tons. One of the most important topics the research group is dealing with is the investigation of the possibilities of using carbon capture and storage or utilization, or so-called CCUS technologies. The main goal is to investigate whether, by applying the conditions of oxygen and CO_2 combustion, it is possible to achieve a CO_2 flow of sufficient purity that could be removed from the energy production cycle in order to achieve climate neutrality.

In addition, the group deals with better characterization of fly ash, in order to enable more effective use of the ash that is formed under oxyfuel combustion conditions. The "organic and in-organic" (carbon) portion of the ash is the key to success in many new utilization schemes.

A broad-based scientific investigation of the form, sorptive properties and behaviour of the inorganic/organic material in ash samples is carried out in order to help identify new commercial opportunities.

The accredited laboratory group provides accredited sample analyses for various customers.

SELECTED PROJECTS

- TEM-TA73 "*Refinement of oil shale into raw materials for industries*" (2024–2028)
- VEU23060 "*Cyber-Physical systems and digital twins for the decarbonisation of energy-intensive industries*" (2023–2027)
- LEIEE23037 "*Ambient air emissions measurements at production units located on the territory of Enefit Power AS*" (2023–2025)

SELECTED PUBLICATIONS

Xu, F.; Neshumayev, D.; Konist, A.; (2025). Synthesis strategies and hydrogen storage performance of porous carbon materials derived from bio-oil. Chemical Engineering Journal, 505, #159381. DOI: 10.1016/j.cej.2025.159381.

Yang, D.; Tanilas, K.; Konist, A.; Järvik, O. (2025). Evaluating LA-ICP-MS and digestion-based ICP-MS methods for trace elements determination in oil shale and its solid wastes. Talanta, 295, #128319. DOI: 10.1016/j.talanta.2025.128319.

Xu, F.; Nešumajev, D.; Konist, A.; (2025). Thermal decomposition behaviors and kinetic parameter calculations during common reed and its components pyrolysis. Renewable Energy, 248, #123130. DOI: 10.1016/j.renene.2025.123130.

SMART DISTRICT HEATING SYSTEMS AND INTEGRATED ASSESSMENT ANALYSIS OF GREENHOUSE GASES EMISSIONS

Head of the research group: Tenured Full Professor ANNA VOLKOVA, anna.volkova@taltech.ee

Members: Eduard Latõšov, Andrei Dedov, Igor Krupenski, Aleksandr Hlebnikov, Srenath Sukumaran, Kertu Lepiksaar, Inge Roos

Postdoctoral Researcher: Sylvester Ikenna Ofili

Doctoral student: Hesham Ali, Janika Laht, Mohd Basit Wani, Siim Erik Pugal, Dabrel Prits, Tanel Kirs, Janita Andrijevskaja

TOPICS AND COMPETENCES

KEYWORDS: 4th generation district heating, district cooling low temperature district heating, primary energy factors, CO_2 emissions, thermal energy storage, CHP, (cogeneration of heat and power), large heat pumps, LCA, carbon footprint, cold storage

The group deals with: (1) the development of new technical solutions for the transition of district heating (DH) systems towards an intelligent, highly efficient and regenerative energy supply concept and (2) integrated assessment analysis of greenhouse gas emissions.

The group's recent research activities are connected with the analysis of:

- The heat supply option of a low temperature district heating network from the return line of a well-established high temperature district heating system.
- The impact of return temperature reduction on a high temperature district heating system.
- Monitoring the Energy Efficiency Pillar for Climate Neutrality.

- Existing large-scale DH system transition towards 4th generation DH.
- 5th generation district heating.
- Seawater based district cooling.
- Use of solar energy in district heating.
- Integration of large heat pumps into DH systems.
- Use of residual heat in district heating and cooling.
- CO_2 emissions from district heating.

SELECTED PROJECTS

- PRG2701 "*Next-Generation District Heating: Enhancing Sustainability through Multi-Level Energy Cascades and Decentralised Renewable Energy Sources*" (2025–2029)
- VIR25004 "*Local Heat Planning – Achieving the heat transition in BSR municipalities*" (2025–2028)
- VERT24071 "*Green and Digital Skills for Smart District Heating and Cooling Networks*" (2025–2028)

SELECTED PUBLICATIONS

Ali, H.; Hlebnikov, A.; Pakere, I.; Volkova, A. (2024). An evaluation and innovative coupling of seawater heat pumps in district heating networks. Energy, 312, #133461. DOI: 10.1016/j.energy.2024.133461.

Lepiksaar, K.; Kajandi, G.-M.; Sukumaran, S.; Krupenski, I.; Kirs, T.; Volkova, A. (2024). Optimizing Solar Energy Integration in Tallinn's District Heating and Cooling Systems. Smart Energy, #100166. DOI: 10.1016/j.segy.2024.100166.

Ali, H.; Dedov, A.; Volkova, A. (2024). Exploring Heat Demand Forecasting in District Heating Networks Using Random Parameter Linear Regression Model. Environmental and Climate Technologies, 28, 1, 670–685. DOI: 10.2478/rtuect-2024-0052.

DEPARTMENT OF MATERIALS AND ENVIRONMENTAL TECHNOLOGY

Director: Tenured Full Professor
MAARJA GROSSBERG-KUUSK,
maarja.grossberg@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

86 Academic staff — Incl. 12 professors, 67 researchers

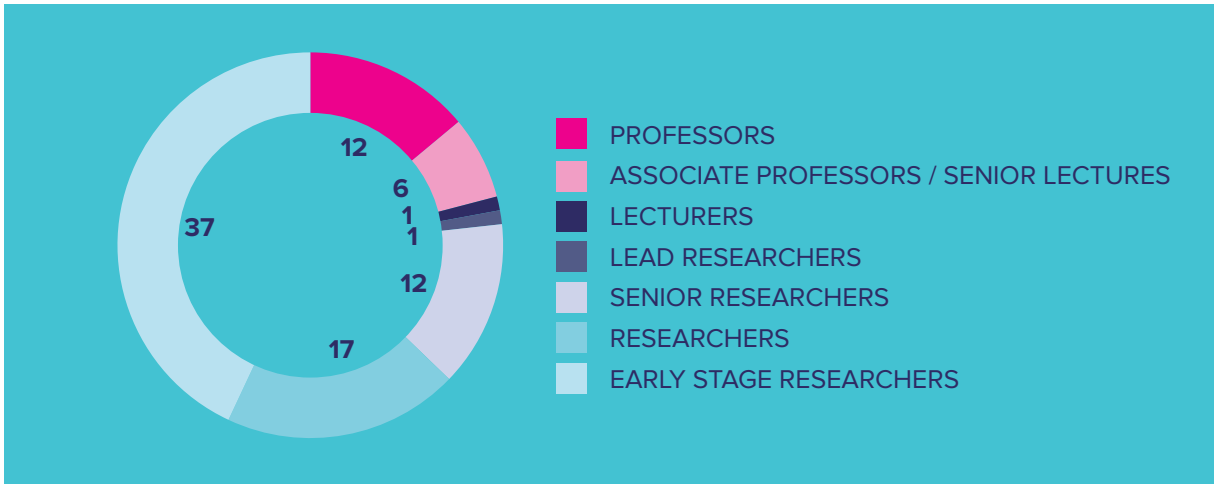
45 Doctoral students — 6 Defended doctoral dissertations

50 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 8 RESEARCH GROUPS:

- **LABORATORY OF BIOFUNCTIONAL MATERIALS.**
  Head: Lead Research Scientist VITALI SÕRITSKI, vitali.syritski@taltech.ee
- **LABORATORY OF BIOPOLYMER TECHNOLOGY.**
  Head: Researcher-Professor ANDRES KRUMME, andres.krumme@taltech.ee
- **LABORATORY OF ENVIRONMENTAL TECHNOLOGY.**
  Head: Tenured Full Professor SERGEI PREIS, sergei.preis@taltech.ee
- **LABORATORY OF INORGANIC MATERIALS.**
  Head: Tenured Full Professor ANDRES TRIKKEL, andres.trikkel@taltech.ee
- **LABORATORY OF PHOTOVOLTAIC MATERIALS.**
  Head: Tenured Associate Professor MARIT KAUK-KUUSIK, marit.kauk-kuusik@taltech.ee
- **LABORATORY OF TEXTILE TECHNOLOGY.**
  Head: Associate Professor TIIA PLAMUS, tiia.plamus@taltech.ee
- **LABORATORY FOR THIN FILM ENERGY MATERIALS.**
  Head: Tenured Full Professor ILONA OJA ACIK, ilona.oja@taltech.ee
- **LABORATORY OF WOOD TECHNOLOGY.**
  Head: Tenured Associate Professor JAAN KERS, jaan.kers@taltech.ee



LABORATORY OF BIOFUNCTIONAL MATERIALS

Head of the Laboratory: Lead Research Scientist VITALI SÕRITSKI, vitali.syritski@taltech.ee

Members: Jekaterina Reut, Roman Borozņjak, Akinrinade George Ayankojo, Anna Kidakova

Doctoral students: Vu Bao Chau Nguyen, Prachi Madan Garade

TOPICS AND COMPETENCES

KEYWORDS: Molecularly Imprinted Polymers, synthetic receptors, chemical sensors, medical diagnostics, PoCT, environmental monitoring, COVID-19 express test

The group develops smart biosensing functional materials to propose solutions with considerable potential impact on essential areas of human life such as environmental protection and medical diagnostics. By employing the molecular imprinting technology, the group designs and synthesizes polymeric materials so called Molecularly Imprinted Polymers (MIP). The main benefits of MIPs is related to their synthetic nature, i.e. excellent chemical and thermal stability associated with reproducible, cost-effective fabrication. MIPs can be easily integrated with a variety of sensor platforms including piezogravimetric, optical and electrochemical transducers and allowing label-free detection of a target analyte with high sensitivity and selectivity. The group has successfully developed sensors targeting clinically relevant analytes, including immunoglobulin G; neurotrophic factors (BDNF, CDNF); viral and disease-related proteins (SARS-CoV-2 nucleocapsid and spike proteins, hepatitis C antigen); hormones (cortisol); as well as environmental water pollutants such as antibiotics and fungicides (sulfamethizole, amoxicillin, erythromycin, azoxystrobin).

IN 2025

Electrochemical sensors employing molecularly imprinted polymers (MIPs) as selective recognition layers and ruthenium oxide (RuO_2) electrodes as transducers were successfully developed for the detection of protein and hormone biomarkers in biological samples:

- A cortisol-selective sensor was demonstrated to reliably detect cortisol in real human saliva within physiologically relevant concentration ranges, confirming the applicability of the sensing platform for non-invasive biomarker analysis. The obtained results are currently being prepared for submission as a patent application.
- Using an epitope imprinting strategy, a peptide-imprinted polymer (peptide-MIP) was developed for the selective recognition of growth differentiation factor-15 (GDF-15), a clinically relevant prognostic biomarker. The peptide-MIP was successfully integrated onto a RuO_2 electrode to form an electrochemical sensor and was validated in real biological matrices, including mouse and human serum. This study was conducted in close cooperation with the Institute of Biotechnology, University of Helsinki.

Overall, the developed sensing systems enable fast, simple, and cost-effective biomarker detection in complex biological samples, while demonstrating robust and reproducible performance with strong potential for point-of-care applications.

More information: *https://taltech.ee/en/laboratory-biofunctional-materials*

SELECTED PROJECTS

- PRG2113 "*Biomimetic Polymeric Receptors Integrated with Multi-sensor Systems for Low-cost and Fast Analysis of Complex Environments*" (2024–2028)
- TK218 "*Estonian Center of Excellence of Well-Being Science*" (2024–2030)

SELECTED PUBLICATIONS

Chau Nguyen, V. B.; Reut, J.; Ayankojo, A. G.; Syritski, V. (2025). Direct electrochemical sensing of ampicillin in aqueous media by a ruthenium oxide electrode decorated with a molecularly imprinted polymer. Talanta, 287, #127580. DOI: 10.1016/j.talanta.2025.127580.

Ayankojo, A. G.; Reut, J.; Borozņjak, R.; Syritski, V. (2025). Ruthenium oxide electrode integrated with molecularly imprinted polymer for direct electrochemical sensing of a neurotrophic factor protein. Sensors and Actuators B: Chemical, 429, 137301. DOI: 10.1016/j.snb.2025.137301.

Ayankojo, A. G.; Borozņjak, R.; Reut, J.; Tuvikene, J.; Timmusk, T.; Syritski, V. (2023). Electrochemical sensor based on molecularly imprinted polymer for rapid quantitative detection of brain-derived neurotrophic factor. Sensors and Actuators B: Chemical, 397, #134656. DOI: 10.1016/j.snb.2023.134656.

LABORATORY OF BIOPOLYMER TECHNOLOGY

Head of the Laboratory: Researcher-Professor ANDRES KRUMME, andres.krumme@taltech.ee

Members: Elvira Tarasova, Natalja Savest, Illia Krasnou, Omar Parve, Jaan Parve

Doctoral students: Anna Ilnitskaja, Gretel Brus, Aysha Siddika

TOPICS AND COMPETENCES

KEYWORDS: polymers, biopolymers, derivatives of cellulose, polymer technology, polymeric composites, reactive extrusion, textile, electrospinning, nanofibres, conductive polymers, supercapacitors, filtering materials

The main focus of the research of the laboratory is valorization of environmental resources and development of new energy storage methods for energy efficient environments. The goal is to find sustainable alternatives for fossil resources based polymeric materials by more efficient utilisation of biopolymers and recycled materials in commodity products and in specific fields.

Innovative options for the sustainable recovery of cellulose are being sought through the use of new, reusable solvent media, bio-based chemical modification reagents and energy-saving technologies. New, distillable ionic liquids are used as solvents. The use of plant oils for cellulose esterification is being studied and reactive extrusion technology is being developed. The laboratory is the only one in Estonia capable of pilot production by electrospinning technology.

The electrospinning technology is also applied for developing filter materials based on cellulose derivatives and containing antiviral agents, which prolong their life and make them carbon neutral.

The laboratory has a unique pilot production capability in Estonia in such important areas of polymer / plastics technology as compounding, extrusion and injection molding. Composites of thermoplastic and thermosetting polymers with inorganic or bio-based additives are being developed for the efficient use of secondary raw materials in the circular economy.

Properties of textile fibres obtained by different recycling methods are being explored and their suitability for manufacturing different types of (textile) materials is being studied. Producing nonwoven materials with recycled textile fibres and thermoplastic virgin fibres is the main method explored. The laboratory also develops durable and sustainable textile and clothing materials.

More information:
https://biopolymer.taltech.ee/en/

IN 2025: Development of the reactive extrusion process: Initial modeling of the process was carried out using the special software "Ludovic". The optimal cellulose concentrations in the reaction mixtures and the rheological properties of the reaction mixtures were clarified.

Possibilities for developing solvent environments were studied.

Development of separation processes was continued. A significant part of the work focused on investigating the recycling of ionic liquids specifically designed for dissolving cellulose.

Applied research on new cellulose-based bioplastics was initiated, testing the suitability of these materials for paper lamination and electrospinning.

SELECTED PROJECT

- TEM-TA103 "*New biomaterials made by reactive extrusion from cellulose and by-products of vegetable oil production*" (2024–2028)

LABORATORY OF ENVIRONMENTAL TECHNOLOGY

Head of the Laboratory: Tenured Full Professor SERGEI PREIS, sergei.preis@taltech.ee

Members: Niina Dulova, Marina Kritševskaja, Juri Bolobajev, Eneliis Kattel, Priit Tikker

Doctoral students: Kristen Altof, Irina Petrotšenko, Daniel Anselm Teittinen

TOPICS AND COMPETENCES

KEYWORDS: environmental technology, water treatment, air cleaning, soil cleaning, advanced oxidation processes, pulsed corona discharge plasma, catalytic and photocatalytic processes

The research group is competent in solving environmental technology problems, including water treatment, air and soil cleaning by using advanced oxidation processes, pulsed corona discharge plasma, catalytic and photocatalytic processes. The processes under investigation have great potential for the removal of persistent pollutants and micropollutants from water, contaminated soils and exhaust gases. Air treatment with corona pulsed electric discharge plasma as a highly energy-efficient cleaning process is applied to destroy microorgan-isms, including viruses, and to degrade volatile organic compounds.

More information: *https://taltech.ee/en/laboratory-environmental-technology*

IN 2025

The group considers one of its major achievements to be the development of a method for applying pulsed electrical corona discharge to the selective oxidation of pharmaceutical substances in human urine, with the aim of using it in the production of fertilizer for agricultural applications. To date, no similar technologies exist anywhere in the world. The results of the work have been published.

SELECTED PROJECT

- ETAG22018 "*Utilization of Aluminium-Bearing Raw Materials for the Production of Aluminium Metal, Other Metals and Compounds*" (2022–2025)
- VIR23025 "*Stormwater purification with construction and demolition waste*" (2023–2026)
- TF24021EK2 "*Centre of Excellence in Circular Economy for Strategic Mineral and Carbon Resources*" (2024–2030)

SELECTED PUBLICATIONS

Altof, K.; Krichevskaja, M.; Preis, S.; Bolobajev, J. (2025). Advanced oxidation of airborne m-xylene in combination of pulsed corona discharge and post-plasma photocatalysis. Journal of Electrostatics, 138, #104104. DOI: 10.1016/j.elstat.2025.104184.

Teittinen, D. A.; Preis, S.; Bolobajev, J. (2025). Upscaling of Toluene Oxidation Using Water-Sprinkled Pulsed Corona Discharge and Photocatalysis. Processes, 13 (9), #2982. DOI: 10.3390/pr13092982.

Tan, Z.; Chen, W.; Wei, X.; Qiu, Z.; Zhuang, W.; Zhang, B.; Xie, J.; Lin, Y.; Ren, Y.; Preis, S.; Wei, C.; Zhu, S. (2025). Virus-bacterium interaction involved in element cycles in biological treatment of coking wastewater. Bioresource Technology, 416, #131839. DOI: 10.1016/j.biortech.2024.131839.

LABORATORY OF INORGANIC MATERIALS

Head of the Laboratory: Tenured Full Professor ANDRES TRIKKEL, andres.trikkel@taltech.ee

Members: Tiit Kaljuvee, Kaia Tõnsuaadu, Mai Uibu, Can Rüstü Yörük, Mustafa Cem Usta, Marve Einard

Doctoral students: Ruhany Sheherazad Azeez, Eliise-Koidula Kivimäe, Adheena Thomas, Ademola Michael Adegbile, Krevon Alet-Märtson

TOPICS AND COMPETENCES

KEYWORDS: phosphorite, graptolite-argillite, oil shale ash, precipitated calcium carbonate, GHG, thermal analysis

The activities of the laboratory are focused on three priority directions:

- Expanding the resource base of critical raw materials with basic and applied research for the development of new sustainable methods for the valorisation of Estonian phosphorite and as-sociated minerals (graptoliteargillite) – for the selective separation of valuable components such as phosphorus, vanadium and rare earths;
- Reducing greenhouse gas emissions which is one of the key objectives of the green turn, in-cluding development of chemical-technological bases of accelerated carbonation processes for alkaline industrial wastes (oil shale ash, clinker dust) as well as oxy-fuel combustion of fuels as a promising method for CO_2 capture. The possible applications are aimed to make construction materials together with simultaneous binding of CO_2;
- Applied research to reuse oil shale ash for the production of a valuable product – precipitated calcium carbonate – on an industrial scale with the possibly complete utilization of the generated residues.

The research group is part of the *Centre of Excellence in Circular Economy for Strategic Mineral and Carbon Resources* and leads the sub-theme of strategic minerals. The aim of the research is to consolidate Estonia's research potential for the development and implementation of new innovative solutions for the valorization of secondary and primary mineral resources and to train the next generation of highly qualified researchers in this field. The main objectives are to increase resource efficiency, maximize the use of local resources, promote safe material circulation and recycling, and minimize the demand for new natural resources.

More information: *https://taltech.ee/en/laboratory-inorganic-materials*

SELECTED PROJECTS

- PRG1779 "*Phosphorus Fertilisers and Rare Metals from Estonian Phosphorite in a Waste-Free Way*" (2023–2027)
- TEM-TA87 "*Complex recovery of mineral mining and industrial waste as secondary raw material in the context of eco-conscious building materials and hydrometallurgy*" (2024–2028)
- TEM-TA100 "*Variability of Properties of Associated Resources of Shelly Phosphorite and Opportunities for Beneficiation*" (2024–2028)

SELECTED PUBLICATIONS

Thomas, A.; Yörük, C. R.; Usta, M. C.; Pantšenko, N.-L.; Hain, T.; Uibu, M.; Trikkel, A. (2025). Developing Mineral Foam Blocks from Oil Shale Byproducts through Accelerated Carbonation. ACS Omega, 10 (40), 47051−47064. DOI: 10.1021/acsomega.5c05438.

Azeez, R. S.; Tõnsuaadu, K.; Einard, M.; Kaljuvee, T.; Trikkel, A. (2025). Dissolution kinetics of rare earth elements from Estonian phosphate rock using hydrochloric acid treatment. Minerals Engineering, 233, #109641. DOI: 10.1016/j.mineng.2025.109641.

Kivimäe, E.-K.; Tõnsuaadu, K.; Kaljuvee, T.; Kallaste, T.; Trikkel, A. (2025). Effect of calcination of Estonian black shale on the solubility of metallic elements in sulfuric acid environment. Journal of Thermal Analysis and Calorimetry. DOI: 10.1007/s10973-025-15121-8.

LABORATORY OF PHOTOVOLTAIC MATERIALS

Head of the Laboratory: Tenured Associate Professor MARIT KAUK-KUUSIK, marit.kauk-kuusik@taltech.ee

Members: Sergei Bereznev, Mati Danilson, Maarja Grossberg-Kuusk, Reelika Kaupmees, Jüri Krustok, Valdek-Mikli, Katri Muska, Maris Pilvet, Taavi Raadik, Kristi Timmo, Mare Altosaar, Jaan Raudoja

Doctoral students: Marc Dolcet Sadurni, Katriin Reedo, Idil Mengü, Elizaveta Shmagina, Nafiseh Abbasi, Marc Vincent Heemskerk, Achmad Nasyori, Liisa Kumar, Mia-Maria Meldorf

TOPICS AND COMPETENCES

KEYWORDS: Environmentally friendly energy materials, solar energy and photovoltaic device technologies, semiconductor materials and thin films, optical and electrical characterization of materials and devices

The research activities of the Laboratory are focused on the development of solar energy and photovoltaic device technologies based on environmentally friendly inorganic semiconductor materials, including the development of various integrated solutions (BIPV, PIPV). The group possesses world-class technological competence in the synthesis of multicomponent absorber materials, targeted control of chemical composition and defect structure, and the development of scalable technological processes, including those applicable under ambient air conditions. The research group has strong and long-standing experience in the fabrication of nano- and microscale metal, metal oxide, and chalcogenide thin-film coatings using both physical and chemical deposition methods. In addition, the group has high-level expertise in the investigation of the fundamental optical and electrical properties of optoelectronic materials and devices (including solar cells, light-emitting diodes, lasers, and sensors), encompassing the analysis of defects, electronic transitions, and phase transitions.

IN 2025, the research activities of the group resulted in several internationally outstanding achievements in the fields of semiconductor materials and photovoltaics:Luminescence studies demonstrated that cadmium doping of Sb_2Se_3 thin films and single crystals creates a shallow acceptor defect with an ionization energy of 22 meV, enabling a significant increase in hole concentration and improved electrical properties of the material.

A major breakthrough was achieved in understanding and implementing the phosphorus doping mechanism in FeS_2 (pyrite). Scalable p-type doping was demonstrated via incorporation of the FeP_4 compound into the pyrite crystal structure during growth.

A comprehensive photoluminescence analysis of Cu_2GeS_3 microcrystals was carried out under pulsed and continuous-wave excitation to investigate the optical properties and defect structure of this promising material for indoor PV applications.

High-quality $Sb_{1-x}Bi_xSeI$ microcrystals covering the full compositional range were successfully synthesized using a solid-state method. For the first time, the bandgap evolution across the entire series was determined and an experimental band diagram was constructed, revealing a significant shift of the valence band maximum and a composition-driven conductivity type transition from p-type to n-type. These results are highly relevant for the design of optoelectronic and photovoltaic interfaces and highlight the potential of specific compositions for both single-junction and multi-junction solar cell applications.

More information: *https://taltech.ee/en/laboratory-photovoltaic-materials*

SELECTED PROJECTS

- PRG1815 "*Next Generation Microcrystalline Pyrite Solar Cell for Terrestrial and Extraterrestrial Applications*" (2023–2027)
- TF24020 "*GREENTECH*" (2024–2030)
- PRG1023 "*Sustainable, cost-efficient, flexible, lightweight and semitransparent multinary chalcogenide based solar cells for building integrated photovoltaics*" (2021–2025)

SELECTED PUBLICATIONS

Nasyori, A.; Pilvet, M.; Saar, A.; Krustok, J.; Danilson, M.; Kaupmees, R.; Mikli, V.; Gong, Y.; Josepson, R.; Saucedo, E.; Grossberg, M.; Kauk-Kuusik, M. (2025). In Ambient Air Processed Cu2ZnSnS4 Absorber Layers from DMSO-Based Precursors: Enhanced Efficiency via Device Post-annealing. Journal of Materials Chemistry A, 13, 30167. DOI: 10.1039/d5ta04554a.

Reedo, K.; Raadik, T.; Altosaar, M.; Pilvet, M.; Gutjuma, A.; Krustok, J.; Paaver, P. (2025). Scalable Phosphorus Doping of p-Type FeS₂ Microcrystals for Photovoltaic Applications. ACS Omega, 10 (48), 58869–58876. DOI: 10.1021/acsomega.5c07455.

Dolcet Sadurni, M.; Timmo, K.; Mikli, V.; Krustok, J.; Danilson, M.; Suchodolskis, A.; Radu, C.; Bocirnea, A.E.; Galca, A.C.; Grossberg-Kuusk, M.; Kauk-Kuusik, M. (2025). Effects of cationic substitution on the properties of Sb1-xBixSeI (x = 0–1) compounds. Journal of Alloys and Compounds, 1037, #182292. DOI: 10.1016/j.jallcom.2025.182292.

LABORATORY OF TEXTILE TECHNOLOGY

Head of the Laboratory: Associate Professor TIIA PLAMUS, tiia.plamus@taltech.ee

Member: Laura Kuningas

Doctoral students: Md Toufiqur Rahman, Katre Worth, Diana Tuulik, Md Arifur Rahman

TOPICS AND COMPETENCES

KEYWORDS: textile materials; recycling of textile materials; circular economy; reuse; technical design of apparel and textile products

The group's scientific activities are related with the following fields:

- circular economy in textile and clothing field;
- developing composite and textile materials from mechanically recycled textile fibres;
- exploring physico-mechanical properties of textile and clothing materials;
- developing textile products, apparel and protective clothing;
- exploring novel processing methods of textile materials (laser cutting, digital printing etc.).

More information: *https://taltech.ee/en/laboratory-of-textile-technology*

SELECTED PROJECTS

- TF24021EK2 "*Centre of Excellence in Circular Economy for Strategic Mineral and Carbon Resources*" (2024–2030)
- LITEE24096 "*Development of a measurement methodology of LWIR range shielding efectiveness and a shielding material prototype*" (2024–2025)

SELECTED PUBLICATIONS

Mäe, T.; Plamus,T.; Majak, J.; Karunanidhi, R.; Rahman, M. T. (2023). Application of HOHWM Based Function Approximation Algorithms in Engineering Design. International Conference on Numerical Analysis and Applied Mathematics 2021: ICNAAM-2021, Rhodes, Greece, 20–26 September 2021. AIP Publishing, 250003. (AIP Conference Proceedings; 2849/1). DOI: 10.1063/5.0162255.

Mandre, N.; Plamus, T.; Linder, A.; Varjas, T.; Majak, J.; Krumme, A. (2023). Design of Performance Characteristics on Laser Treated Denim Fabric. Materials Science, 29 (4), 515–524. DOI: 10.5755/j02.ms.33259.

Mandre, N.; Plamus, T.; Linder, A.; Krumme A.; Rohumaa, A. (2023). Impact of laser fading on physico-mechanical properties and fibre morphology of multicomponent denim fabrics. Proceedings of the Estonian Academy of Sciences, 72 (2), 145–153. DOI: 10.3176/proc.2023.2.05.

LABORATORY FOR THIN FILM ENERGY MATERIALS

Head of the research group: Tenured Full Professor ILONA OJA ACIK, ilona.oja@taltech.ee

Members: Malle Krunks, Tatjana Dedova, Maciej Sibiński, Nicolae Spalatu, Atanas Katerski, Merike Kriisa, Robert Krautmann, Jekaterina Sydorenko, Arvo Mere

Postdoctoral Researchers: Daria Miliaieva, Christopher Howard Don, Dumitru Untila, Omoboyede Femi Igbari, Thanh Tai Nguyen

Doctoral students: Sajeesh Vadakkedath Gopi, Mykhailo Koltsov, Ernest Adiyiah Asare, Hadeer Hussien Ahmed Hussien Saleh, Athulya Babu Suseela, Paula Eda Stoicescu

TOPICS AND COMPETENCES

KEYWORDS: solar cells, thin films, photocatalytic coatings

The key competences of the Laboratory for Thin Film Energy Materials are:

- Development of metal oxide and chalcogenide thin films and nanostructures by cost-effective chemical and vacuum based technologies.
- Development of solar cells.
- Development of photocatalytic coatings.

IN 2025

- As an innovation, an ultrathin ZnO interfacial layer was introduced into the FTO/TiO_2-ETL/Sb_2S_3/P3HT-HTL/Au solar cell structure to modify the TiO_2/Sb_2S_3 interface. As a result, the grain size of the absorber layer increased and recombination losses at the interface were reduced. The efficiency of devices incorporating the ZnO interfacial layer under standard illumination conditions (AM 1.5G, 100 W/cm²) increased to 7.5%, and under low light intensities to 18%, while using an ultrathin 150 nm thick absorber layer. The measured efficiencies are higher than those previously reported for comparable devices based on Sb_2S_3 absorbers.
- Within the physical vapour deposition (PVD) platform, we developed a processing methodology for vapor transport deposition (VTD) that enables compact and uniform Sb_2Se_3 absorber layers and high-quality CdS/Sb_2Se_3 heterojunctions. By controlling growth kinetics and interface chemistry, solar cell efficiencies of up to 5% were achieved, accompanied by reduced recombination losses. The results provide scalable process and materials design guidelines for next-generation chalcogenide thin-film photovoltaics.

More information: *https://taltech.ee/en/laboratory-thin-film-energy-materials*

SELECTED PROJECTS

- VFP20035 "*ERA chair of emerging next-generation photovoltaics*" (2020–2026)
- PRG627 "*Antimony chalcogenide thin films for next-generation semi-transparent solar cells applicable in electricity producing windows*" (2020–2024)
- TF24020EK "*GREENTECH*" (2024–2030)

SELECTED PUBLICATIONS

Gopi, S. V.; Krautmann, R.; Katerski, A.; Josepson, R.; Untila, D.; Hiie, J.; Krunks, M.; Acik, I.; Spalatu, N. (2025). Optimization of VTD Sb₂Se₃ absorber growth rate in CdS/Sb₂Se₃ thin film solar cells: A defect perspective on chloride vs non-chloride based devices. Solar Energy Materials and Solar Cells, 293, #113856. DOI: 10.1016/j.solmat.2025.113856.

Asare, E. A.; Katerski, A.; Kriisa, M.; Josepson, R.; Rotaru, V.; Guc, M.; Payno Zarceño, D.; Navarro-Güell, A.; Grzibovskis, R.; Vembris, A.; Pérez-Rodríguez, A.; Saucedo, E.; Spalatu, N.; Krunks, M.; Oja Acik, I. (2025). Influence of Sulfur Source on Growth of In-Air Sprayed Ultrathin Film Sb2S3 for Enhanced Solar Cell Performance. ACS Applied Materials & Interfaces, 17, 47, 64753−64770. DOI: 10.1021/acsami.5c17869.

Dedova, T.; Krautmann, R.; Rusu, M.; Katerski, A.; Krunks, M.; Unold, T.; Spalatu, N.; Mere, A.; Sydorenko, J.; Sibiński, M.; Acik, I. Oja (2025). Sb2S3 solar cells with TiO2 electron transporting layers synthesized by ALD and USP methods. Solar Energy Materials and Solar Cells, 280, #113279. DOI: 10.1016/j.solmat.2024.113279.

LABORATORY OF WOOD TECHNOLOGY

Head of the Laboratory: Tenured Associate Professor JAAN KERS, jaan.kers@taltech.ee

Members: Triinu Poltimäe, Heikko Kallakas, Karmo Kiiman, Anti Rohumaa, Percy Festus Alao, Margus Kangur, Loretta Kalju, Joonas Lauri Hakonen. Tolgay Akkurt

Doctoral students: Catherine Kilumets, Tanuj Kattamanchi, Paula Eda Stoicescu, Laura Kaljula, Eldwin Maidiono, Ignatius Kristia Adikurnia, Jie Li, Maarja Mirjam Rajasaar, Sandra Rose Biby, Silvi Treial

TOPICS AND COMPETENCES

KEYWORDS: veneer, plywood, wood-polymer composites, agro-crop and natural fibre composites, fire resitance, bio-based adhesives testing, furniture and upholstery furniture products development and testing

The Laboratory of Wood Technology investigates the possibilities for using the low-quality hardwood species in veneer and veneer based products by evaluating the impact of surface properties, quality to the bond strength development.

In collaboration with nearly zero energy buildings research group, hygrothermal criteria were developed for using cross-laminated timber (CLT) panels in the design and construction of wooden buildings (PhD thesis of Villu Kukk). Within the framework of the *WoodLCC* project, the impact of moisture content and temperature to crack formation in CLT panels is investigated.

Development of biocomposites and green composites from natural fiber and agro-crop (hemp fibres and reed) is also an important part of the research work of the laboratory.

Due to the areas of use, it is important to increase the fire-safety properties of biocomposite materials, which is being studied in collaboration with the Structural Engineering Research Group.

In collaboration with the Laboratory of Polymer and Textile Technology, novel thermoplastic cellulose materials for further packaging applications are developed.

IN 2025: Research results demonstrated that aspen and black alder are viable alternatives to birch in multilayer wood composites. High quality plywood can be produced from lower grade hardwoods by optimizing veneer densification parameters.

In parallel, studies addressed two key challenges in plywood production: flammability and formaldehyde emissions.

More information: *https://taltech.ee/en/laboratory-wood-technology*

SELECTED PROJECT

- TEM-TA139 "*Bio-based sustainable and fire-resistant composite materials developed from secondary raw materials*" (2024–2028)
- MNKE22048 "*The possibilities of using Estonian underutilized wood species in new veneer-based products*" (2022–2024)
- MNKE22024 "*WoodLCC – Enhanced Life-Cycle-Costing in wood construction by novel methods for service life planning*" (2022–2025)

SELECTED PUBLICATIONS

Alao, P.; Rohumaa, A.; Dembovski, K.H.; Ruponen, J.; Kallakas, H.; Kers, J. (2025). Effect of Aspen Face Veneer Thickness on the Fire Performance of Post-Manufacture Fire-Retardant Treated Birch Plywood. Proceedings of the 11th European Conference on Wood Modification: (ECWM 2024). Firenze, Italy, April 15-16, 2024. Cham: Springer, 165–172. (Springer Proceedings in Materials; 86). DOI: 10.1007/978-3-031-99418-0_21.

Kilumets, C.; Kallakas, H.; Ralph, S.; Zhu, J.Y.; Hunt, C.G.; Rohumaa, A.; Kers, J. (2024). Effect of lignin on veneer densification and set-recovery. Construction and Building Materials, 451, #138795. DOI: 10.1016/j.conbuildmat.2024.138795.

Akkurt, T.; Rohumaa, A.; Kers, J. (2025). Effective Wood Veneer Densification by Optimizing Key Parameters: Temperature, Equilibrium Moisture Content, and Pressure. Forests, 16 (6), #969. DOI: 10.3390/f16060969.

DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

Director: Tenured Full Professor
KRISTO KARJUST,
kristo.karjust@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

74 Academic staff — Incl. 13 professors, 47 researchers

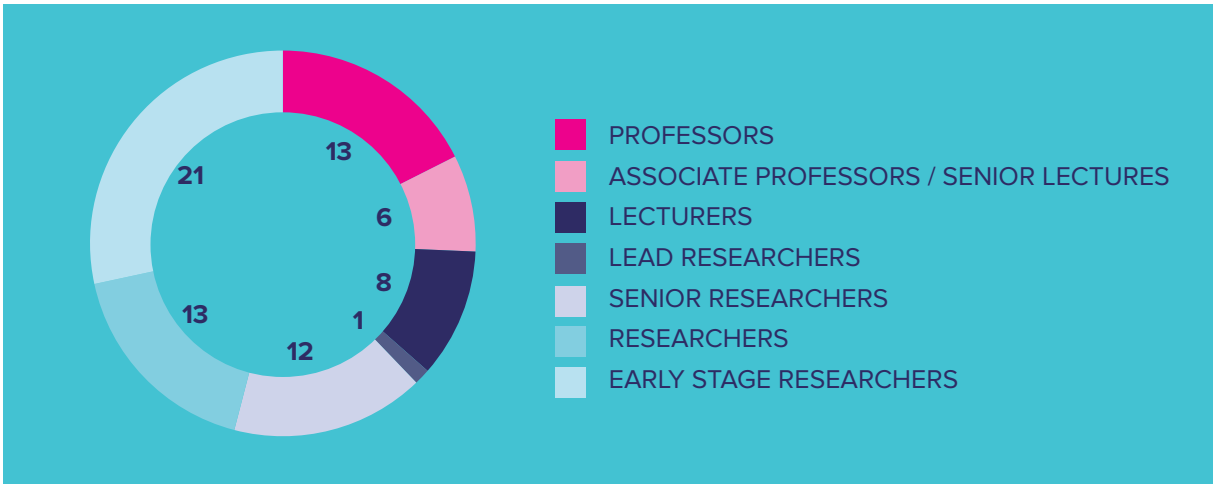
39 Doctoral students — 3 Defended doctoral dissertations

127 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN 8 RESEARCH GROUPS:

- **ADDITIVE MANUFACTURING TECHNOLOGIES.**
  Head: Tenured Full Professor PRASHANTH KONDA GOKULDOSS, prashanth.konda@taltech.ee
- **ADVANCED STRUCTURES AND PRODUCTS.**
  Head: Tenured Full Professor JÜRI MAJAK, juri.majak@taltech.ee
- **AUTOMATED PRODUCTION SYSTEMS AND REAL-TIME MONITORING AND AI MODELS.**
  Head: Tenured Full Professor KRISTO KARJUST, kristo.karjust@taltech.ee
- **ROBOTICS AND AUTONOMOUS VEHICLES.**
  Head: Tenured Associate Professor RAIVO SELL, raivo.sell@taltech.ee
- **INNOVATIVE SYSTEMS FOR INDUSTRIAL APPLICATIONS.**
  Head: Tenured Full Professor IRINA HUSSAINOVA, irina.hussainova@taltech.ee
- **LOGISTICS AND TRANSPORT.**
  Head: Senior Researcher DAGO ANTOV, dago.antov@taltech.ee
- **SMART INDUSTRY.**
  Head: Tenured Full Professor TAUNO OTTO, tauno.otto@taltech.ee
- **WEAR RESISTANT COMPOSITES AND COATINGS.**
  Head: Senior Researcher JAKOB KÜBARSEPP, jakob.kubarsepp@taltech.ee



ADDITIVE MANUFACTURING TECHNOLOGIES

Head of the research group: Tenured Full Professor PRASHANTH KONDA GOKULDOSS, prashanth.konda@taltech.ee

Members: Lauri Kollo, Sokkalingam Rathinavelu, Ramin Rahmani Ahranjani

Doctoral students: Javad Karimi, Navid Alinejadian

TOPICS AND COMPETENCES

KEYWORDS: aadditive manufacturing, powder metallurgy, solidification, meta-stable materials, amorphous alloys, high entropy alloys, high temperature materials, light metals, biomaterials and mechanical properties

The research topics of the group are:

(1) Alloy design for additive manufacturing;

(2) Pre-mature failure in additively manufactured materials;

(3) Powder metallurgy of high entropy alloys for extreme environments;

(4) Processing of functional materials by additive manufacturing.

More information: *https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29781*

SELECTED PROJECT

- ETAG21021 "*Waste-to-resource: eggshells as a source for next generation biomaterials for bone regeneration*" (2021–2024)

SELECTED PUBLICATIONS

Ye, Z.; Zhao, K.; Yu, Z.; Prashanth, K. G.; Zhang, F.; He, Y.; Peng, Y.; Wu, W.; Tan, H. (2024). Understanding the solute segregation and redistribution behavior in rapidly solidified binary Ti-X alloys fabricated through non-equilibrium laser processing. Additive Manufacturing, 96, #104561. DOI: 10.1016/j.addma.2024.104561.

Yang, H.; Ma, P.; Zhang, Z.; Xie, X.; Yang, P.; Zhang, H.; Jia, Y.; Prashanth, K. G. (2024). Microstructure and mechanical performances of NiCoFeAlTi high-entropy intermetallic reinforced CoCrFeMnNi high-entropy alloy composites manufactured by selective laser melting. Journal of Materials Research and Technology, 33, 6275–6287. DOI: 10.1016/j.jmrt.2024.11.022.

Baskaran, J.; Muthukannan, D.; Shukla, R.; Konda Gokuldoss, P. (2024). Manufacturability and deformation studies on a novel metallic lattice structure fabricated by Selective Laser Melting. Vacuum, 222, #113065. DOI: 10.1016/j.vacuum.2024.113065.

ADVANCED STRUCTURES AND PRODUCTS

Head of the research group: Tenured Full Professor JÜRI MAJAK, juri.majak@taltech.ee

Members: Martin Eerme, Jüri Lavrentjev, Martin Pärn, Meelis Pohlak, Fabio Auriemma, Hans Rämmal, Maarjus Kirs, Janno Nõu

Doctoral students: Katre Worth, Tõnis Raamets, Marvar Mehrparvar, Margus Villau, Lenart Kivistik, Tiina Lelumees

TOPICS AND COMPETENCES

KEYWORDS: structural analysis and design optimization, artificial intelligence, acoustics, numerical methods, composite materials

The competencies of the workgroup cover development and application of the AI based optimization algorithms, procedures and tools for design of products and production processes. One of the main directions of recent years is the implementation of Evolutionary (EA) methods and tools in engineering design. Current issues include the development of hybrid methods and the combined use of artificial intelligence tools in algorithms (ANN + EA). One subtopic is the development and adaption of new numerical methods with focus on Haar wavelet based discretization methods.

Competencies also include structural analysis of the structures and composite materials, development of higher order Haar wavelet method for solving corresponding differential equations; high speed deformations.

The research team has a long experience in wave propagation research in channels and more generally in a limited space. Various test methods for sound field decomposition have been developed. The developed applications have been used for experimental determination of acoustic properties of different materials and products, as well as for the collection of energy harvesting from acoustic noise.

Artificial intelligence is increasingly being used to solve a wide range of societal problems. The research group's work is related to several *AIRE sub-projects*.

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29843

IN 2025, research activities in the field of artificial intelligence were continued. Development of product quality assessment algorithms based on convolutional neural networks (a subtype of deep neural networks) was further pursued. More specifically, algorithms for the detection of delamination and cracks were developed. The AI domain additionally includes the development and application of multicriteria decision-making methods. Due to the dominance of AI-related topics, the development and application of numerical methods based on Haar wavelets received slightly less attention this year.

SELECTED PROJECTS

- ÕÜF9 "*Development of robot-human co-creation in industry*" (2023–2029)
- AR20013 "*Smart City Center of Excellence*" (2020–2023)
- VEU25028 "*Reusable Easy to Breath and Use Masks – Elastomeric half-mask (Easy2reUse)*" (2025–2029)

SELECTED PUBLICATIONS

Paat, A.; Majak, J.; Karu, V.; Hitch, M. (2024). Fuzzy analytical hierarchy process based environmental, social and governance risks assessment for the future phosphorite mining in Estonia. The Extractive Industries and Society, 17 (101438), 1–8. DOI: 10.1016/j.exis.2024.101438.

Arda, M.; Majak, J.; Mehrparvar, M. (2024). Longitudinal Wave Propagation in Axially Graded Raylegh-Bishop Nanorods. Mechanics of Composite Materials, 59 (6), 1109–1128. DOI: 10.1007/s11029-023-10160-4.

Karjust, K.; Mehrparvar, M.; Kaganski, S.; Raamets, T. (2025). Development of a Sustainability-Oriented KPI Selection Model for Manufacturing Processes. Sustainability, 17 (14), #6374. DOI: 10.3390/su17146374.

AUTOMATED PRODUCTION SYSTEMS AND REAL-TIME MONITORING AND AI MODELS

Head of the research group: Tenured Full Professor KRISTO KARJUST, kristo.karjust@taltech.ee

Members: Jüri Riives, Martinš Šarkans, Aigar Hermaste, Kashif Mahmood, Margus Müür, Riho Uusjärv, Heiko Pikner

Doctoral student: Tõnis Raamets

TOPICS AND COMPETENCES

KEYWORDS: manufacturing execution system (MES), production monitoring, production optimisation, real time information, wireless sensor network, predictive mainenance, artificial intelligent in production

The main objective of the research is to study and develop Automated Production Monitoring System using AI models. The research group developed Production Monitoring System DIMUSA with predictive functionality that operates in near real time, focusing on SMEs.

The advanced Production Monitoring and Prediction System detects, measures and monitors the variables, events and situations which affect the performance and reliability of manufacturing systems and processes. Efficient, real-time feed of information for production control and monitoring includes data acquisition about the state of equipment, production orders, flow of materials, quality of products, process data and other necessary data which are used for making proper and optimised decisions regarding manufacturing planning, improved use of available resources, planning of equipment maintenance, etc.

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29844

IN 2025, the main research focus was on artificial intelligence-based production optimization, digital twins, and autonomous systems. Research into autonomous mobile robots and production logistics, both through theoretical models and applied research, was of great importance. Contributions were also made to the development of methodologies for sustainable production and environmental impact assessment.

SELECTED PROJECTS

- TT2 "*Smart Industry Centre*" (2021–2024)
- VEU22048 "*Master of Science in Smart, Secure and Interconnected Systems*" (2022–2026)
- VEU22026 "*AI & ROBOTICS ESTONIA (EDIH)*" (2022–2025)
- VEU25028 "*Reusable Easy to Breath and Use Masks – Elastomeric half-mask (Easy2reUse)*" (2025–2029)

SELECTED PUBLICATIONS

Karjust, K.; Mehrparvar, M.; Kaganski, S.; Raamets, T. (2025). Development of a Sustainability-Oriented KPI Selection Model for Manufacturing Processes. Sustainability, 17 (14), #6374. DOI: 10.3390/su17146374.

Raamets, T.; Karjust, K.; Hermaste, A.; Kelpman, K. (2025). Virtual factory model development for AI-driven optimization in manufacturing. Proceedings of the Estonian Academy of Sciences, 74 (2), 228–233. DOI: 10.3176/proc.2025.2.26.

Kelpman, K.; Karjust, K.; Majak, J. (2025). An overview of smart workplace solutions and potential imp-rovement areas. Proceedings of the Estonian Academy of Sciences, 74, 2, 155–159. DOI: 10.3176/proc.2025.2.13.

ROBOTICS AND AUTONOMOUS VEHICLES

Head of the research group: Tenured Associate Professor RAIVO SELL, raivo.sell@taltech.ee

Members: Andres Petritšenko, Martinš Šarkans, Margus Müür, Vladimir Kuts, Kaimo Sonk, Mauro Bellone, Mohsen Malayjerdi, Heiko Pikner, Rahul Razdan

Doctoral students: Krister Kalda, Andrew James Roberts, Toomas Tahves

TOPICS AND COMPETENCES

KEYWORDS: robotics, self-driving vehicles, artificial intelligence, autonomous systems, smart city

The research group is working on the development and research on complex autonomous systems, including localization, navigation, mission planning, sensorics, artificial intelligence, electro-mechanics, control, simulation and machine vision.

The topics are applied to a full range of autonomous systems, in particular to self-driving vehicles, mobile robots, industrial logistics robots and drones.

The research group's activities are aimed at future mobility and are directly related to the green transition and reducing emissions in the transport sector.

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29845

IN 2025 the research group has achieved internationally visible R&D results in the fields of autonomous mobility, cybersecurity of connected transport systems, and smart city experimentation. The group has advanced validation and verification methodologies for autonomous vehicles, integrating digital twin environments with real-world pilot operations to improve safety assessment and corner-case analysis. Significant progress has also been made in zero-trust security architectures for next-generation (6G-ready) mobility ecosystems, strengthening the resilience and trustworthiness of cyber-physical trans-port infrastructures. In addition, the group has contributed to the development of scalable toolkits and implementation frameworks that support cities and industry partners in deploying autonomous and multimodal mobility solutions. These outcomes demonstrate a strong combination of experimental research, applied engineering, and international collaboration, reinforcing the group's position as a credible partner in European research and innovation networks.

SELECTED PROJECTS

- VHE24058 "*Extended zero-trust and intelligent security for resilient and quantum-safe 6G networks and services*" (2025–2027)

- LEMEE23083 "*Study for the development of a passive-adaptive autonomous navigation system for unmanned ground vehicles*" (2023–2026)
- TFA25109 "*Isejuhtivate sõidukite turvalisuse valideerimise ja verifitseerimise platvorm*" (2025–2026)

SELECTED PUBLICATIONS

Razdan, R.; Sell, R.; Akbas, M. I.; Menase, M. (2025). Perspectives on Safety for Autonomous Vehi-cles. Electronics, 14 (22), art. 4500. DOI: 10.3390/electronics14224500.

Sell, R.; Razdan, R.; Kase, K.; Rüütmann, T. (2025). The Role of AI Chatbots in Engineering Education: Experimental Findings and Implementation Strategies. International Journal of Engineering Pedagogy (iJEP), 15 (5), 4–19. DOI: 10.3991/ijep.v15i5.56681.

Gu, J.; Bellone, M.; Pivoňka, T.; Sell, R. (2024). CLFT: Camera-LiDAR Fusion Transformer for Semantic Segmentation in Autonomous Driving. IEEE Transactions on Intelligent Vehicles, 1–12. DOI: 10.1109/TIV.2024.3454971.

INNOVATIVE SYSTEMS FOR INDUSTRIAL APPLICATIONS

Head of the research group: Tenured Full Professor IRINA HUSSAINOVA, irina.hussainova@taltech.ee

Members: Fjodor Sergejev, Maksim Antonov, Mart Viljus, Sofiya Aydinyan, Rocío Estefania Rojas Hernandez, Dmitri Goljandin, Roman Ivanov, Rainer Traksmaa, Hans Vallner, Heinar Vagiström, Rahul Kumar

Doctoral students: Mansoureh Rezapourian, Arash Kariminejad

TOPICS AND COMPETENCES

KEYWORDS: ceramics; composites; multifunctional structures; bio-inspired materials; tribology; recycling; high temperature materials; chemical vapour deposition; self-propagating high temperature synthesis; microstructural analysis; mechanical testing; additive manufacturing; spark plasma sintering

The research is broadly subdivided into three main interconnected and highly interdisciplinary directions focused on (a) hierarchically structured bio-inspired multi-functional composites including but not limited to electroconductive ceramics, functionally graded and anisotropic ceramic-based composites, mesoporous ceramics, nanofibers, graphene added bulks, ceramic membranes; (b) tribology and high-temperature damage-tolerant composites for tribo-applications; (c) selective laser melting and powders for SLM/S of ceramic-metal composites and AM of complex-shaped ceramic-matrix composites.

The team has several inventions keeping research at a high international level. The most influential are (i) a self-aligned fibrous scaffold for highly anisotropic cell cultures; (ii) a method for producing nanofibers composites by combustion techniques and products comprising thereof; (iii) fibrous ceramic networks and preparation thereof by selective laser melting; and (iv) ceramic complex structures by SLS.

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29846

SELECTED PROJECTS

- PRG643 "*Bio-replicating Engineering Structures for Tribo-applications (BEST)*" (2020–2024)
- MNHA23020 "*New generation of bioactive laser textured Ti/HAp implants*" (2023–2026)
- MNHA22057 "*Circular product design for automotive components made from recycled and sustain-able composite material*" (2022–2024)

SELECTED ARTICLES

Sadlik, J.; Kosińska, E.; Tomala, A.; Bańkosz, M.; Polajnar, M.; Kumar, R.; Kalin, M.; Kravanja, G.; Hribar, L.; Hussainova, I.; Nykiel, M.; Sobczak-Kupiec, A.; Jampilek, J. (2025). Effect of Laser Sur-face Texturing and Fabrication Methods on Tribological Properties of Ti6Al4V/HAp Biocompo-sites. Materials, 18, 11, #2468. DOI: 10.3390/ma18112468.

Necib, J.; Feldbach, E.; Romet, I.; Nagirnyi, V.; Hussainova, I.; Rojas-Hernandez, R. E. (2025). In-vestigation of deep UV emission of rare-earth-free Zn2SiO4 micropowders: the correla-tion of structural and luminescence properties. Journal of Luminescence, 280, #121070. DOI: 10.1016/j.jlumin.2025.121070.

Melkonyan, S.; Zakaryan, M.; Grigoryan, Y.; Kharatyan, S. Hussainova, I.; Chabanais, F.; Sham-shirgar, A. S.; Persson, P. O.Å.; Rosen, J.; Aydinyan, S. (2025). Phase and Microstructure Evolu-tion Patterns at Combustion Synthesis of High-Entropy M2AlC (M=Ti/Ta/V/Nb/Cr) MAX Phase. Journal of Materials Research and Technology, 39, 5800–5807. DOI: 10.1016/j.jmrt.2025.10.186.

RESEARCH GROUP OF LOGISTICS AND TRANSPORT

Head of the research group: Senior Researcher DAGO ANTOV, dago.antov@taltech.ee

Members: Jüri Lavrentjev, Kati Kõrbe Kaare, Hans Rämmal, Ott Koppel, Jelizaveta Janno, Anton Pashkevich

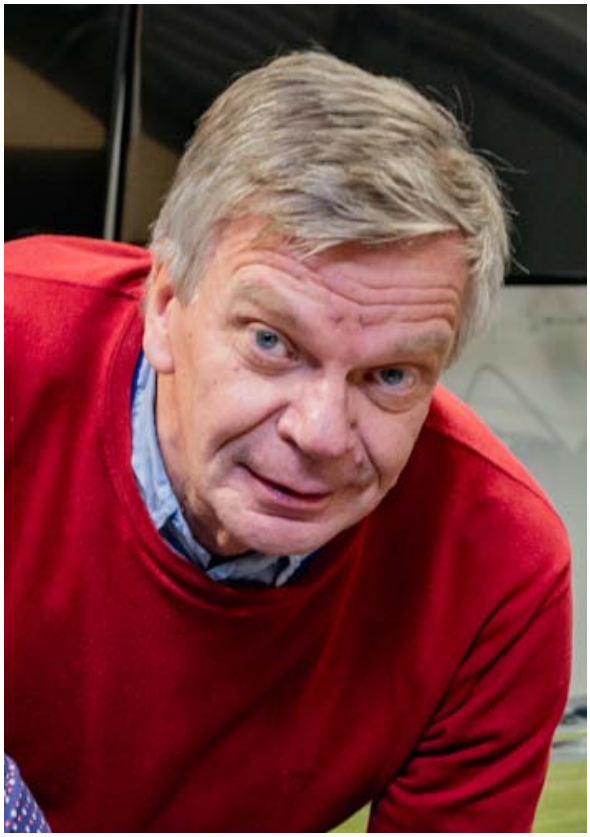
Doctoral students: Kaur Sarv, Raul Markus

TOPICS AND COMPETENCES

KEYWORDS: sustainable solutions in transport and logistics, digitization of logistics solutions, transport demand analysis

The activities of the research group are largely related and focused on the following main topics:

- sustainable solutions in transport and logistics (including achieving carbon neutrality, elements of the green turn in the transport system, safe solutions, etc.);
- optimization of the logistics system, for example the possibilities of implementing digital solutions in logistics solutions
- transport demand analysis, in particular assessments of transport demand today and in the future, which factors affect it and which solutions are feasible for its realization.



The activities of the research group are focused namely on these topics using the most modern methods for their research, starting with data collection and analysis and ending with system simulation.

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29847

SELECTED PROJECTS

- VHE25032 "*Co-creation and experimentation for road-users' co-existence, empathy and behaviour, building a holistic model for traffic safety culture*" (2025–2028)
- TF24022EM2 "*Development and provision of IC modules for higher education and vocational schools: Course "Data in Supply Chains and Mobility" in the field of transport/logistics*" (2023–2024)

SELECTED PUBLICATIONS

Jairus, T.; Sadam, A.; Kõrbe Kaare, K.; Pilvik, R. (2025). Economic Feasibility of Drone-Based Traf-fic Measurement Concept for Urban Environments. Future Transportation, 5 (4), #163. DOI: 10.3390/futuretransp5040163.

Pilvik, R.; Jairus, T.; Sadam, A.; Nõmmela, K.; Kõrbe Kaare, K.; Scholliers, J. (2025). Exploitability of Maritime Fleet-Based 5G Network Extension. Electronics, 14 (11), #2210. DOI: 10.3390/electronics14112210.

Pilvik, R.; Jairus, T.; Kõrbe Kaare, K.; Sadam, A.; Gentili, A.; Nõmmela, K. (2025). Maritime Fleet-Based 5G Network Extension: A Model for Cross-border Coastal Applications. 2024 IEEE Future Networks World Forum (FNWF): Dubai, UAE, 15–17 October 2024. IEEE, 855–860. DOI: 10.1109/FNWF63303.2024.11028827.

SMART INDUSTRY

Head of the research group: Tenured Full Professor TAUNO OTTO, tauno.otto@taltech.ee

Members: Fjodor Sergejev, Toivo Tähemaa, Jüri Riives, Martinš Sarkans, Lauri Kollo, Meelis Pohlak, Aigar Hermaste, Margus Müür, Tatjana Karaulova

Doctoral students: Kristo Vaher, Simone Lucca Pizzagalli, Yevhen Bondarenko, Madis Moor

TOPICS AND COMPETENCES

KEYWORDS: smart manufacturing, industry 4.0 /5.0, digital twins, digital manufacturing

The competencies of the research group are: production digitalisation, virtualisation, simulation, development of digital twins, reconfiguring manufacturing from conventional machining technologies to 3D related.

The application of Digital Twins, artificial intelligence, robotics and augmented reality (XR) enables companies to plan, optimize and reconfigure production processes more efficiently, while reducing resource consumption and environmental impact. The group's research outcomes address key societal challenges such as labor shortages in the manufacturing sector, occupational safety and the need for a green transition. Flexible and collaborative robot-based production systems and a human-centric approach to production (Industry 5.0) support the transformation of the role of employees from physically demanding work to higher value-added activities, improving working conditions and reducing the risk of occupational accidents.

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29848

IN 2025, the Smart Manufacturing Research Group achieved internationally outstanding research results in the development and application of digitalised manufacturing systems, Digital Twin technologies, Extended Reality (XR), and flexible robotic manufacturing systems. The research and development activities were closely aligned with the Industry 4.0 and Industry 5.0 paradigms, with a strong emphasis on human–robot collaboration, system flexibility, and real-time decision support. A key scientific outcome of the year was the further development of real-time, bidirectionally synchronised Digital Twin methodologies. In contrast to conventional simulation-based approaches, the developed solutions enable Digital Twins to function as active components for the validation, control, and optimisation of manufacturing and robotic systems. The integration of Digital Twins with XR-based user interfaces significantly advanced the planning, simulation, and management of production systems, supporting the design and evaluation of human-centred industrial workflows.

In applied research, the group demonstrated internationally competitive solutions for the design of flexible collaborative robotic systems and autonomously movable robotic manufacturing concepts. The developed frameworks and prototype

implementations confirmed the technical and economic feasibility of rapid reconfiguration of manufacturing systems, addressing critical challenges related to flexibility, resilience, and cost-efficient automation, particularly for small and medium-sized manufacturing enterprises.

SELECTED PROJECTS

- ÕÜF10 "*Development and manufacturing of complex products*" (2023–2029)
- TARISTU24-TK10 "*European Organisation for Nuclear Research*" (2025–2029)
- TT2 "*Smart Industry Centre*" (2021–2024)

SELECTED PUBLICATIONS

Pizzagalli, S. L.; Mahmood, K.; Boychuk, R.; Otto, T.; Kuts, V. (2025). A workflow for extended reality-based learning in engineering education. Proceedings of the Estonian Academy of Sciences, 74, 2, 103–108. DOI: 10.3176/proc.2025.2.03.

Mondellini, M.; Arlati, S.; Urgo, M.; Pizzagalli, S. L.; Kashif, M.; Terkaj, W. (2025). Comparing Traditional and eXtended Reality-based Learning: Effects on Performance, Emotions, and Cogniti-ve Aspects. In: Extended Reality: International Conference, XR Salento 2025, Otranto, Italy, June 17–20, 2025, Proceedings, Part VI. (324–336). Springer. (Lecture Notes in Computer Science; 15742). DOI: 10.1007/978-3-031-97778-7_24.

Remenyi A, L. Kuts V. Tepljakov A. Pizzagalli S, L. (2025). From Virtual to Reality: A Structured Framework to Training Humanoid Robots for Elderly Care Using Learning from Demonstration. In: Lecture Notes in Computer Science. (193–209). Springer. DOI: 10.1007/978-3-031-97772-5_13 [in press].

WEAR RESISTANT COMPOSITES AND COATINGS

Head of the research group: Senior Researcher JAKOB KÜBARSEPP, jakob.kubarsepp@taltech.ee

Members: Fjodor Sergejev, Mart Viljus, Vitali Podgurski, Kristjan Juhani, Maksim Antonov, Mart Viljus, Dmitri Goljandin, Mart Saarna, Märt Kolnes, Marek Tarraste, Andrei Surženkov, Mart Kolnes, Abrar Hussain, Priit Kulu, Andrei Bogatov, Rainer Traksmaa, Hans Vallner, Heinar Vagiström, Artur Klauson, Oleksandr Tarasov, Liudmyla Melakh, Siim Lukas Lokotar

Post-doctoral Researcher: Babak Omranpour Shahreza

Doctoral students: Sibel Yöyler, Tabeen Halawat Pampori, Furqan Anwar

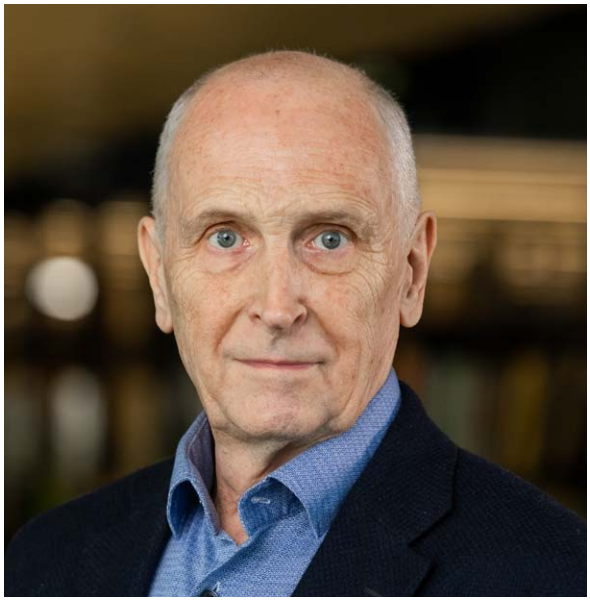
TOPICS AND COMPETENCES

KEYWORDS: ceramic-based composite, hardmetal, cermet, ceramic-matrix composite, coating, composite hardfacing, hydrogen storage material; wear resistance, materials recycling, resource-efficiency; sustainability; durability

The R&D activities of the research group have been focused mainly on the following research topics (a) wear resistant ceramic-metal composites (hardmetals/cemented carbides and cermets) with focus on reduction of critical raw materials (CRM) in composites; (b) ceramic-matrix composites based on refractory compounds; (c) wear resistant composite hardfacings with focus on reduction of CRM in coatings; (d) thin hard and diamond coatings; (e) materials recycling; (f) characterization of materials and products: composition, microstructure, mechanical and tribological (friction and wear) properties.

To find solutions to topical problems in manufacturing, research is focused on resource efficiency and reducing environmental impacts. The main research directions are: (1) materials and manufacturing technologies for enhancement of products (tools, wear resistant structural elements) sustainability, primarily in the industrial environment and (2) technologies of products reuse (giving second life to wear parts) and reprocessing waste materials (recycling).

More information:
https://taltech.ee/en/department-mechanical-and-industrial-engineering/research-groups#p29849



The most important R&D results **IN 2025**:

- Advancement of critical raw materials (primarily Co) free wear resistant composite materials, in particular additive manufacturing technology of such materials;
- Research results in the field of high-entropy carbide ceramics and wear resistant composites on its bases;
- Progress in development of advanced Fe-based composite hardfacings with W-free ceramic reinforcement;
- Advancements in the field of recycling technology of polymeric and textile materials.

SELECTED PROJECTS

- PRG1145 "*Composites "ceramics – Fe alloy" for a wide range of application conditions*" (2021–2025)
- VHE22005 "*RENEW. Re-cycling of Epoxys from Nonferrous E-Waste*" (2022–2024)
- LEMEE20006 "*Car safety component productive fineblanking and functional design*" (2019–2023)

SELECTED PUBLICATIONS

Maurya, H. S.; Marczyk, J.; Juhani, K.; Sergejev, F.; Kumar, R.; Hussain, A.; Akhtar, F.; Hebda, M.; Prashanth, K. G. (2025). Binder jetting 3D printing of green TiC-FeCr based cermets- Effect of sintering temperature and systematic comparison study with Laser powder bed fusion fabricated parts. Materials Today Advances, 25, #100562. DOI: 10.1016/j.mtadv.2025.100562.

Maurya, H.S.; Juhani, K.; Tarraste, M.; Viljus, M.; Sergejev, F.; Pampori, T.H.; Hussain, A.; Kübarsepp, J. (2024). Synergistic effect of Nb and Mo on the microstructural formation of the Ti(C,N)-high chromium ferrous-based cermets. International Journal of Refractory Metals and Hard Mate-rials, 122, #106723. DOI: 10.1016/j.ijrmhm.2024.106723.

Hussain, A.; Goljandin, D.; Podgursky, V.; Rüstü Yörük, C.; Sergejev, F.; Kübarsepp, J.; Maurya, H. S.; Rahmani, R. (2024). Industrial sustainable Fabrication, SEM Characterization, mechanical Testing, ANOVA analysis of PP-PETF recycled Composites: Artificial intelligence and deep learning studies for nuclear shielding applications. European Polymer Journal, 213, #113082. DOI: 10.1016/j.eurpolymj.2024.113082.

KURESSAARE COLLEGE

Director: MERIT KINDSIGO,
merit.kindsigo@taltech.ee

MAIN FIGURES 2025

(as of Dec. 31, 2025)

16 Academic staff — Incl. 1 professor, 9 researchers

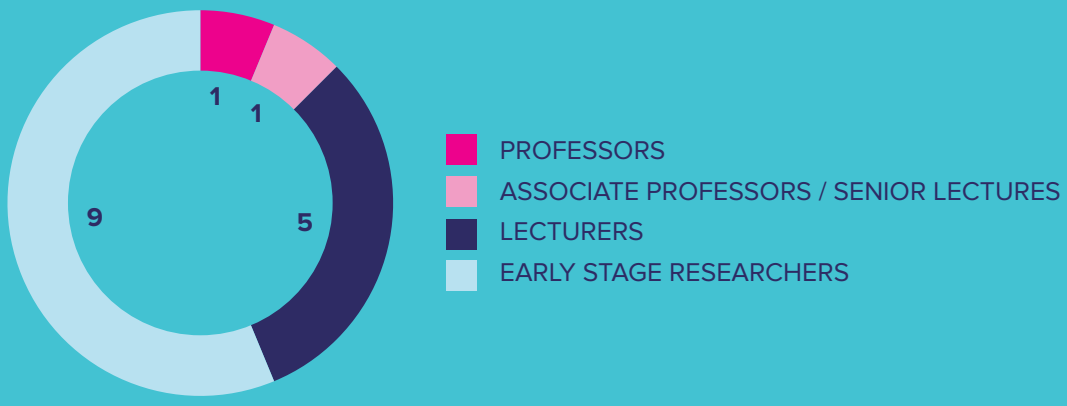
10 Doctoral students

6 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE COLLEGE CONDUCTS RESEARCH WITHIN ONE RESEARCH GROUP:

- **MARINE TECHNOLOGY AND HYDRODYNAMICS.**
  Head: Tenured Associate Professor MIHKEL KÕRGESAAR, mihkel.korgesaar@taltech.ee



MARINE TECHNOLOGY AND HYDRODYNAMICS

Head: Tenured Associate Professor MIHKEL KÕRGESAAR, mihkel.korgesaar@taltech.ee

Members: Kalju Saar, Teär Ruttar, Andrus Šults, Priit Suluste, Hans Korman

Doctoral students: Muhammed Adil Yatkin, Mert Asan, Mikloš Lakatoš, Md Al Amin Khan. Tarmo Sahk

TOPICS AND COMPETENCES

KEYWORDS: advanced ship structures, fluid-structure interaction, ship safety, accidental limit states, material modeling, marine technology, ship digital twin and perception systems

The team's research focuses on innovative solutions for ships, offshore and shore-based structures, and marine infrastructure, developing digital, autonomous, including situational-aware technologies in the marine environment. The conditions arising from the marine environment place high demands on engineering solutions, which require science-based methods to solve the problems. The methods used include numerical simulations as well as experimental testing.

IN 2025:

- PhD student Mert Asan's PhD thesis conducted experiments on the use of machine learning applications and forecasting ship motion for practical applications, such as drone landing.
- PhD student Adil Yatkin's PhD thesis made progress in the development of machine learning applications for structural strength assessment.

- The research group received ASTRA funding to develop machine learning-based strength assessment methods for industry and ARIB funding to develop practical applications for fishermen to check the filling of fishing nets.

SELECTED PROJECTS

- TARISTU24-TK6 "*Marine Technology and Hydrodynamics Research Infrastructure MARTE – Regional Knowledge Transfer Advisory and Technology Center*" (2025–2029)
- PSG754 "*Coupled Simulation Model for Ship Crashworthiness Assessment*" (2022–2025)
- MNKE25052 "*Advanced Marine Environment Monitoring and Rapid Analysis System*" (2025–2028)

SELECTED PUBLICATIONS

Sahk, T.; Kõrgesaar, M.; Yu, Z. (2025). Approach to account for external dynamics in fluid-structure interaction analysis in Abaqus. In: Innovations in the Analysis and Design of Marine Structures. (289–294). CRC Press. DOI: 10.1201/9781003642411-35.

Yatkin, M. A.; Korgesaar, M.; Romanoff, J.; Stuckner, J.; Islak, U.; Kurban, H. (2025). Exploring Various Sequential Learning Methods for Deformation History Modeling. Engineering Applications of Neural Networks : Proceedings, Part I: 26th International Conference, EANN 2025, Limassol, Cyprus, June 26–29, 2025. Ed. Iliadis, L.; Maglogiannis, I.; Kyriacou, E.; Jayne, C. Cham: Springer, 168–180. (Communications in Computer and Information Science (CCIS); 2581). DOI: 10.1007/978-3-031-96196-0_13.

Kõrgesaar, M.; Yatkin, M.A. (2025). Machine Learning Based Computational Models for Increased Accuracy and Enabling Digital Twins. Proceedings of the ASME 2025 ; vol. 7, 7: 44th International Conference on Ocean, Offshore and Arctic Engineering (OMAE2025), Vancouver, Canada, June 22–27, 2025. American Society of Mechanical Engineers (ASME), art. V007T14A014. DOI: 10.1115/OMAE2025-157406.

TARTU COLLEGE

Director: Associate Professor
AIME RUUS,
aime.ruus@taltech.ee,
+372 620 4802

MAIN FIGURES 2025

(as of Dec. 31, 2025)

20 Academic staff — Incl. 2 5 professor researchers

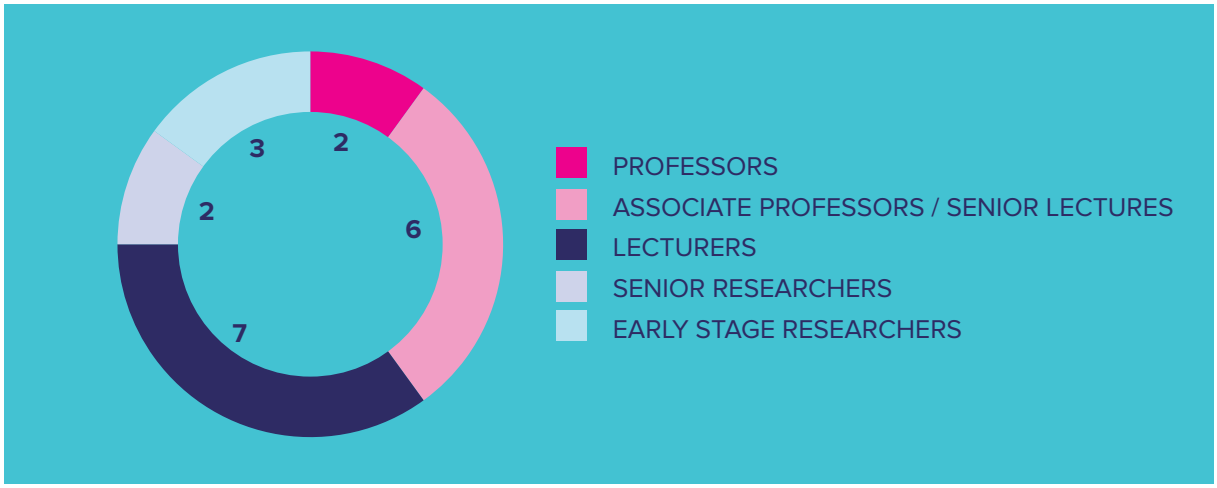
5 Doctoral students

15 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN TWO RESEARCH GROUPS:

- **BUILT ENVIRONMENT RESEARCH GROUP.**
  Head: Associate Professor AIME RUUS, aime.ruus@taltech.ee
- **SUSTAINABLE TECHNOLOGY RESEARCH GROUP.**
  Head: Senior Researcher LEMBIT NEI, lembit.nei@taltech.ee



BUILT ENVIRONMENT RESEARCH GROUP

Head of the research group: Associate Professor AIME RUUS, aime.ruus@taltech.ee

Members: Mihkel Kiviste, Zenia Kotval, Ernst Tungel, Jiri Tintera, Nele Nutt, Jane Raamets, Sirle Salmistu, Karin Muoni, Ago Rootsi, Taisi Kadarik, Kädi Veeroja, Anneliis Muravleva, Kaarel Koppel, Tuuli Muistna

Doctoral students: Minea Kaplinski-Sauk, Ardo Kubjas, Pille-Riin Peet, Kristo Kalbe, Lehar Leetsaar, Rain Martin Torpats

TOPICS AND COMPETENCES

KEYWORDS: brownfields, shrinking and ageing cities, urban planning, recycled aggregate concrete, building materi-als, indoor climate, natural and reusable finishing materials

The research topics of the team are: (1) built environment, urban and regional planning; (2) community development, economic revitalization, reuse and restoration, urban and rural settlement assessment; (3) heritage conservation in urban planning and historical landscapes and parks; (4) revitalization of brownfields; (5) examination of historical buildings; (6) construction materials, indoor climate, aspects of building physics and energy efficiency; (7) possibilities to produce recycled aggregate concrete, (8) cyber-physical systems for buildings and urban and regional planning.

These issues are topical in the field of urban planning and help to solve problems with the implementation of cyber-physics systems in construction, industry and other fields of life.

More information: *https://taltech.ee/en/tartu-college/research#p32467*

IN 2025: Advantages of Using a Seismic Piezocone Penetration Test for Analysis of a Single Screw In Situ Displacement Pile in Silty Soils – the findings of study highlighted the complexity of the correlation between CPTu readings and Vs in silty soils, emphasising the need for further research in this area.

The team completed successfully the tasks related to the European Commission-funded Horizon project eMotional Cities. The process of applying for a building permit is known to be often unpredictable, opaque, and conducted differently in different regions. This creates project delays, increased costs, and generally undermines public trust in government services. Previouss studies have analyzed problems after they arise. This study took a proactive approach by developing a preconsultation tool that addresses issues before applications are submitted. As urbanization and construction demands increase, the need for efficient, transparent permit processes will only grow. The study presents a scalable solution that is adaptable to future regulatory frameworks and application volumes.

SELECTED PROJECTS

- VFP21013 "*eMOTIONAL Cities*" (2021–2025)
- VHE23079 "*A PROactive approach for Communities to enAble Societal Transformation*" (2023–2026)
- PR1144 "*Quality control of knitwear using machine vision*" (2024–2025)

SELECTED PUBLICATIONS

Leetsaar, L.; Korkiala-Tanttu, L. (2024). Advantages of Using a Seismic Piezocone Penetration Test for Analysis of a Single Screw In Situ Displacement Pile in Silty Soils. Indian Geotechnical Journal. DOI: 10.1007/s40098-024-00942-5.

Raamets, J.; Nei, L.; Ruus, A.; Ivask, M.; Muoni, K. (2025). Humidity Impact on Air Quality in Straw- and Reed-Bale Houses. 1–12. DOI: 10.20944/preprints202508.0570.v1.

Kupper, K.; Nutt, N.; Kaplinski-Sauk, M. (2025). Data from urban tree surveys of the 19th–21st centuries as input for planning the maintenance of historical tree stands: A case study of Kaarli boulevard in Tallinn, Estonia. BALTIC FORESTRY, 31 (1), #id793. DOI: 10.46490/BF793.

SUSTAINABLE TECHNOLOGY RESEARCH GROUP

Head of the research group: Senior Researcher LEMBIT NEI, lembit.nei@taltech.ee

Members: Egge Haiba, Nele Nutt, Jane Raamets, Sirle Salmistu, Annika Joy Meitern, Aija Kosk, Tiit Lepasaar, Kärt Kanger, Karin Muoni, Mari Ivask, Kai Kalda-Kiisk, Kaire Luuk, Ellen Hiie

Doctoral student: Ardo Kubjas

TOPICS AND COMPETENCES

KEYWORDS: environmental technology, circular economy, industrial ecology, ecosystem services, environmental microbiology and -chemistry

The main competences of the group are:

- The studies of energy and material flow, LCA, efficiency in using resources.
- Development and implementation of waste recycling technologies (drug residues in sewage sludge and their degradation efficiency).
- Development of methodologies for assessing the status of the environment. In assessing the status of the environment, soil microbiological parameters and the parameters of soil invertebrates are used as bioindicators.
- Use of oil shale ash and crushed oil shale as an anti-mold agent.

More information: https://taltech.ee/en/tartu-college/research#p32468

IN 2025: The research group participated in the successful completion of the Horizon eMotional Cities project funded by the European Commission.

During a research visit to the University of South Florida (USA), a comparative analysis of the previous pollution in Tampa Bay with the potential threats to the Gulf of Finland and Lake Peipsi was conducted (Lembit Nei).

SELECTED PROJECTS

- VFP21013 "*eMOTIONAL Cities*" (2021–2025)
- MNHA23044ET "*The impact of indoor climate on health and the spread of pathogens*" (2023–2024)
- VHE23079 "*A PROactive approach for COmmunities to enAble Societal Transformation*" (2023–2026)

SELECTED PUBLICATIONS

Nei, L.; Haiba, E.; Raamets, J.; Herodes, K. (2024). Degradation of carbamazepine and triclosan in sewage sludge mixtures used for fertilizing agricultural soils. Soil Science Annual, 75 (2), #189545. DOI: 10.37501/soilsa/189545.

Nutt, N.; Nei, L.; Muoni, H.; Kubjas, A.; Raamets, J. (2024). Novel Approach to Making Environmentally-Friendly Plaster – Moisture Buffer Value of Plaster Made of Wastepaper and Different Glues. Latvian Journal of Physics and Technical Sciences, 61 (6), 59–68. DOI: 10.2478/lpts-2024-0043.

Nutt, N.; Salmistu, S.; Kupper, K.; Kotval, Z. (2024). Assessing age-friendliness of contemporary urban outdoor places in Estonia. Quality in Ageing and Older Adults, 25 (3), 204–219. DOI: 10.1108/QAOA-05-2024-0033.

VIRUMAA COLLEGE

Director: MARE ROOSILEHT,
mare.roosleht@taltech.ee,
+372 336 3922

MAIN FIGURES 2025

(as of Dec. 31, 2025)

43 Academic staff — Incl. 2 professor, 17 researchers

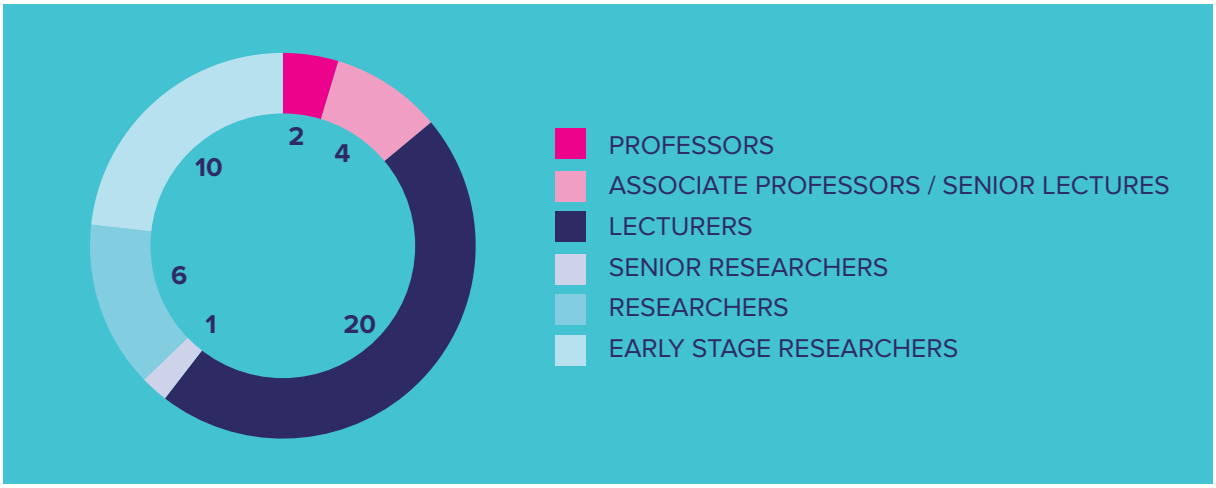
9 Doctoral students

19 Scientific publications*

** Data from the Scopus (as of February 25, 2026)*

THE DEPARTMENT CONDUCTS RESEARCH WITHIN FOUR RESEARCH GROUP:

- **APPLIED CHEMISTRY RESEARCH GROUP.**
  Head: Tenured Associate Professor ALLAN NIIDU, allan.niidu@taltech.ee
- **DEVELOPMENT OF ROBOT-HUMAN CO-CREATION WORKING GROUP.**
  Head: Senior Lecturer OLGA DUNAJEVA, olga.dunajeva@taltech.ee
- **LABORATORY OF FUELS TECHNOLOGY AT OIL SHALE COMPETENCE CENTER.**
  Head: Researcher, Laboratory Manager OLGA PIHL, olga.pihl@taltech.ee
- **MECHANICAL ENGINEERING AND ENERGY TECHNOLOGY PROCESSES CONTROL WORK GROUP.**
  Head: Senior Lecturer VEROONIKA SHIROKOVA, veroonika.shirokova@taltech.ee



APPLIED CHEMISTRY RESEARCH GROUP

Head of the research group: Tenured Associate Professor ALLAN NIIDU, allan.niidu@taltech.ee

Members: Moonika Ferschel, Martin Jürisoo, Tanel Mõistlik

Doctoral students: Bijan Barghi, Diana Berseneva, Dmitri Tsõvarev, Viktorija Mironova, Anastassia Raag

TOPICS AND COMPETENCES

KEYWORDS: metal-organic framework, CO_2 adsorption and utilization (CCSU), heterogeneous and photocatalysis, adsorption, nanomaterials, liquid separation, oil shale as raw material for chemical industry, mechanochemistry

The research group's competencies include:

- Co-valorization of CO_2 and oil shale into catalysts and adsorbents for chemical industry.
- Application of said catalysts to oxidation of organic sulfur and relevant adsorbents to adsorb sulfurous compounds form liquid hydrocarbon streams.
- Extracting added value from mining waste and process waters via selective removal of required metals.

In cooperation with University Montpellier, mechanochemical formation of API-s and metal salts are studied.

More information: *https://taltech.ee/en/virumaa-college/development*

IN 2025, two roadmaps commissioned by the Ministry of Climate were prepared with the participation of the Applied Chemistry Group. Firstly, the roadmap for CO_2 and low emission fuels and secondly, the roadmap for the wood valorisation.

SELECTED PROJECTS

- ÕÜF16 "*Circular valorization of non-fossile CO2*" (2023–2029)
- TEM-TA138 "*Sustainable Artificial Internet of Things (SAIoT)*" (2024–2028)
- TEM-TA96 "*CO2-derived carbon materials for energy storage and production*" (2025–2028)

SELECTED PUBLICATIONS

Barghi, B.; Mõistlik, T.; Panov, D.; Raag, A.; Järvik, O.; Niidu, A. (2025). Kinetic Modeling of Deep Oxidative Desulfurization over Functionalized UiO-66 from a Model Fuel Using Complex Reaction Theory. ACS Omega, 10 (16), 15947−15958. DOI: 10.1021/acsomega.4c06722.

Barghi, B.; Mõistlik, T.; Raag, A.; Volokhova, M.; Reile, I.; Seinberg, L.; Mikli, V.; Niidu, A. (2024). Deep Oxidative Desulfurization of Planar Compounds Over Functionalized Metal-Organic Framework UiO-66(Zr): An Optimization Study. ACS Omega, 9 (22), 23329−23338. DOI: 10.1021/acsomega.3c09971.

Barghi, Bijan; Jürisoo, Martin ; Volokhova, Maria; Seinberg, Liis; Reile, Indrek; Mikli, Valdek; Niidu, Allan (2022). Process Optimization for Catalytic Oxidation of Dibenzothiophene over UiO-66-NH2 by Using Response Surface Methodology. ACS Omega, 7 (19), 16288−16297. DOI: 10.1021/acsomega.1c05965.

DEVELOPMENT OF ROBOT-HUMAN CO-CREATION WORKING GROUP

Head of the working group: Senior Lecturer OLGA DUNAJEVA, olga.dunajeva@taltech.ee

Members: Jüri Majak, Žanna Gratšjova, Rivo Lemmik, Sergei Pavlov, Sónia Cláudia Da Costa Sousa, Mati Mõttus, Mare Roosileht, Siarhei Autsou, Žanna Gratšjova, Viktor Rjabtšikov, Monika Kiik

Doctoral students: Avar Pentel, Kadri Kristjuhan-Ling, Mustafa Can Özdemir, Oleg Shvets

TOPICS AND COMPETENCES

KEYWORDS: human-robot interaction; modelling; testing; artificial intelligence; robotisation of production processes; robotic workplace design; risk assessment and analysis; user trust

The working group focuses on the topic of collaborative robotics. Research areas include the study of social and psychological aspects of human-robot interaction (HRI), HRI modeling, assessment and analysis of impact factors and risks, user trust in robotic systems, robotic workplace design. The goal is to develop a methodologies and validated human-robot interaction models, impact and risk assessments. The provision of user-centered design services is also considered important.

The main activities **IN 2025**, the main outcome of the research group is the establishment of a Human–Robot Interaction (HRI) laboratory in Ida Virumaa. The focus of the laboratory is research in the field of human–robot interaction, with emphasis on the specific needs and challenges of industry in Ida-Virumaa. The laboratory enables the investigation and modelling of the psychological aspects of human-machine collaboration, human-centred workplace design, trust-related constructs, and the adaptability of devices and systems within production processes. The research group has developed an initial service package to offer companies opportunities for education, innovation, and collaboration in human–robot interaction in the Ida-Virumaa region, supporting and promoting local industrial sectors.

SELECTED PROJECTS

- ÕÜF9 RIKT "*Development of robot-human co-creation in Industry*" (2023–2029)
- TF23059 "*Increasing the volume of continuing education in Ida-Viru and developing and launching new level education curricula in vocational and higher education*" (2023–2029)

SELECTED ARTICLES:

Autsou, S.; Dunajeva, O.; Pentel, A.; Shvets, O.; Roosileht, M. (2025). Application of Fuzzy Logic for Collaborative Robot Control. Electronics, 14 (20, 4029), 1–27. DOI: 10.3390/electronics14204029.

Matsulevitš, J.; Majak, J.; Eerme, M.; Sarkans, M.; Dunajeva, O.; Kristjuhan-Ling, K.; Raamets, T.; Kekšin, V. (2025). Human-robot interaction: a conceptual framework for safety/risk analysis. Proceedings of the Estonian Academy of Sciences, 74 (2), 137–142. DOI: 10.3176/proc.2025.2.09.

Raamets, T.; Karjust, K.; Majak, J.; Hermaste, A. (2025). Implementing an AI-Based Digital Twin Analysis System for Real-Time Decision Support in a Custom-Made Sportswear SME. Applied Sciences, 15, 14, #7952. DOI: 10.3390/app15147952.

LABORATORY OF FUELS TECHNOLOGY

Head of the laboratory: Researcher OLGA PIHL, olga.pihl@taltech.ee

Members: Hella Riisalu, Larisa Grigorieva, Aleksei Penežko, Viktoria Petrova, Maria Tšepelevitš, Larissa Kruglenkova, Dmitri Suštšik, Jelena Upan, Olga Suštšik, Nadežda Merkulova, Julia Kravetskaja, Aleksandr Nossov, Eduard Pihl, Olga Kornõljeva

TOPICS AND COMPETENCES

KEYWORDS: waste fuels, waste, pyrolysis, co-pyrolysis, two-stage pyrolysis, hydrogenation, semi-coking, distillation, solid and liquid fuels, water and gas analysis, phenols, standardization

The Laboratory of Fuels Technology at Oil Shale Competence Center (OSCC) offers both direct research and analysis services in accredited areas.

THE LABORATORY'S RESEARCH MAIN DIRECTIONS ARE:

- Organic substances (including waste, plastics, tyres, RDF, SRF) pyrolysis (pyrolysis, two-stage pyrolysis, hydrogenation) at various temperatures and conditions.
- The analysis of technological properties and composition of the obtained products.

Particular attention is paid to the co-processing/processing of different materials to produce the desired chemicals. Co-processing of waste with stored oil-shale ash provides good prerequisites to be the basis for the development of industrial technology for the recycling of non-recyclable waste.

The laboratory's competencies include determining the quality of solid and liquid fuels in accordance with standards and determining the component composition of samples of gases and liquids using chromatography and mass-spectrometry methods.

The Laboratory is accredited in accordance with the requirements of the standard EVS-EN ISO / IEC 17025: 2017. The laboratory is in the working group of the Estonian Centre for Standardisation and Accreditation EVS / TK 57 "Processing of oil shale and oil shale products".

More information: *https://taltech.ee/en/oil-shale-competence-center/services*

SELECTED PROJECTS

- ÕÜF18 "*Development of a process for chemical recycling of waste non-suitable for mechanical recycling*" (2023–2029)
- TK228 "*Centre of Excellence in Circular Economy for Strategic Mineral and Carbon Resources*" (2024–2030)
- LEVEE25007 "*Catalyst production*" (2025–2025)

SELECTED PUBLICATION

Penezko, A.; Pihl, O.; Sustsik, D.; Nossov, A.; Khaskhachikh, V. (2025). Production of hydrogen from packaging wastes by two-stage pyrolysis. Waste Management, 206, #115068. DOI: 10.1016/j.wasman.2025.115068.

MECHANICAL ENGINEERING AND ENERGY TECHNOLOGY PROCESSES CONTROL WORK GROUP

Head of the working group: Senior Lecturer VEROONIKA SHIROKOVA, veroonika.shirokova@taltech.ee

Members: Tatjana Baraškova, Sergei Bereznev, Karolina Kudelina, Elizaveta Shmagina

TOPICS AND COMPETENCES

KEYWORDS: nanocomposite materials; anti-corrosion coatings; renewable energy; solar panels; sustainability measurements; equipment diagnostics, , physical and mechanical properties of materials

The work group's scientific activities are focused on the following areas:

- Implementation of innovative renewable energy technologies (e.g. solar panels, wind power plants, micro-cogeneration, etc.) in the electricity system;
- Integration of novel storage technologies (e.g. hydrogen technologies, including the production and storage of ammonia and synthesis gas, Li-Ion batteries, etc.) into the electricity system;
- Adoption of advanced flexibility technologies (e.g. examining storage options in industrial processes, including heat and air storage, for offering flexibility services);
- Application of digital and AI-based solutions (e.g., analysis, forecasting, management, protection, security solutions, and monitoring systems for energy production, storage, and consumption) in energy systems;
- Solutions and implementation of small-scale and community-based energy;

- Advanced materials to ensure energy efficiency, specifically researching polymer nanocomposite protective and thermoemission films for solar and hydrogen energy;
- Universal anti-corrosion coatings based on polymer nanocomposites for broad industrial applications;
- Sustainable measurement technologies (LIDAR technologies, object measurement for material consumption and quality assessment, vibration measurements, and analysis);
- Equipment/drivers diagnostics (early fault detection, including in shafts, bearings, belts). Real-time monitoring of technological processes. Vibration measurements.
- Experimental investigation of the physical and mechanical properties of materials with different origins and compositions, including the analysis of micro- and nanohardness, microstructure, surface roughness, and wear resistance. The research also involves tensile, compression, and other mechanical tests to assess the durability and suitability of materials for various engineering applications.

IN 2025, the research group systematically developed and implemented new research and development capabilities in nanocomposite materials for renewable energy and energy storage technologies. During this period, a full set of planned scientific equipment was acquired and put into operation, enabling the establishment of the Sustainable Energy Materials Technology Laboratory. The new infrastructure is actively used in research, education, and industrial collaboration, supporting master's theses and providing analytical and technical services to regional companies.

SELECTED ARTICLES

Baraškova, T.; Kudelina, K.; Shirokova, V. (2024). New Opportunities in Real-Time Diagnostics of Induction Machines. Energies, 17 (13), #3265. DOI: 10.3390/en17133265.

Shmagina, E.; Antonov, M.; Kasikov, A.; Volobujeva, O.; Khabushev, E. M.; Kallio, T.; Bereznev, S. (2024). Structural, Mechanical, and Optical Properties of Laminate-Type Thin Film SWCNT/SiOxNy Composites. Nanomaterials, 14, 22, #1806. DOI: 10.3390/nano14221806.

Barashkova,T.; Shirokova, V. (2023). Efficiency of diagnosing the condition of rolling bearings in real time. Ukrainian Metrological Journal, 4, 34–38. DOI: 10.24027/2306-7039.4.2022.276322.

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