VIRUMAA COLLEGE

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MAIN FIGURES 2025

(as of Dec. 31, 2025)

43 Academic staff — Incl. 2 professor, 17 researchers

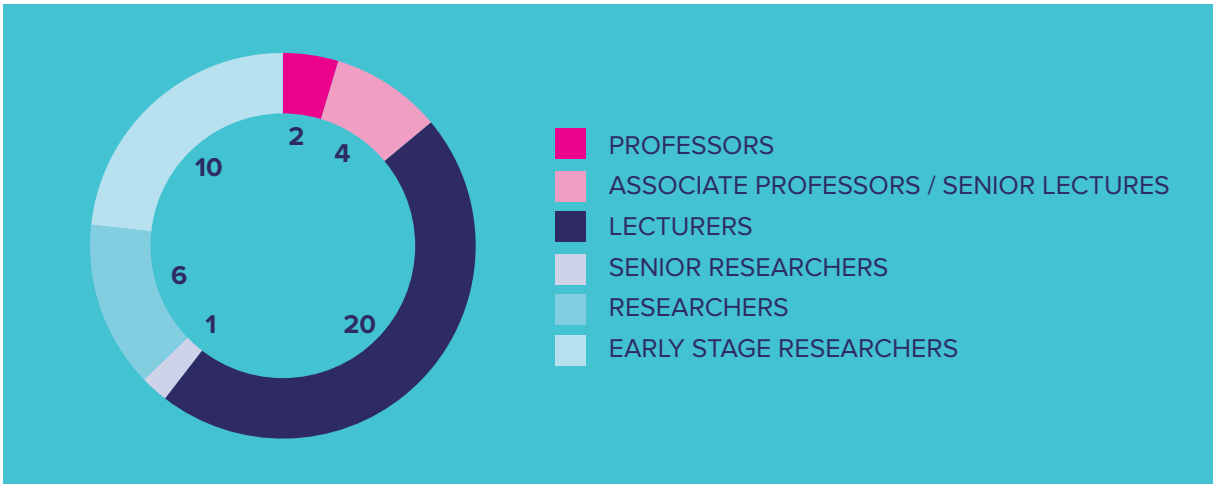
9 Doctoral students

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.