AARHUS
UNIVERSITY
DEPARTMENT OF BIOLOGICAL AND CHEMICAL ENGINEERING

Project Catalogue

Department of Biological and Chemical Engineering

September 2024

Preface

This booklet contains a brief introduction to the different research groups at Biological and Chemical Engineering (BCE) together with proposed projects. Additional information about the research groups can be found here: https://bce.au.dk/en/research/key-areas-in-research-and-development

Furthermore, this booklet contains information and guidance about project work including bachelor projects, master thesis and R&D-projects.

Bachelor projects, Master Thesis and R&D-projects:
The project is your independent research work to develop entirely new knowledge. All projects can be performed in a research group at the university, or they can be performed in a company supported by a university supervisor with scientific insights. If you wish to perform your project in a company, you must first make an agreement with a relevant university supervisor. Together with the supervisor you can identify relevant companies.

As inspiration for your projects, you can have a look in our booklet about projects at BCE or you can talk with the research groups at the biannual project days. When you find a relevant supervisor, just send the researcher an email or go visit them in their offices and laboratories to have an informal talk on ideas and expectations.

A project work can be completed in many ways; here is just one example of how this can be done in practice:

A purely experimental project in which the student, on the basis of a prior literature study, elucidates a problem with experimental work. "Experimental work" must be understood in a broad sense, i.e. both as wet-biological/chemical work (in the laboratory) and dry-work (experiments solved by the use of a computer, e.g. by simulation, modeling etc.).

Regarding the format and size of the report, you decide this together with your supervisor. The final report should be less than 40 pages

- **Bachelor (BSc) projects** at Biotechnology (Bioteknologi) and Chemical Engineering (Kemiteknologi) are 15 ECTS. The project has a scope equivalent to 450 working hours.
- **Research and Development Projects** of 5, 10 or 15 ECTS only have a final report to deliver, while the 20 ECTS R&D both have a report and an oral exam. For 5 ECTS projects, evaluation is only passed/non-passed by your supervisor, while remaining types are graded on 7-scale by your supervisor and an internal censor. For further details, please look at the course catalogue. The project could (but is not required to) be closely related to your master project, however, it cannot overlap with it (including copied text; plagiarism regulations, etc.).
- **A Master (MSc) thesis** at the Biological and Chemical Engineering can be 30 or 45 ECTS. A 45 ECTS MSc thesis requires higher workload and, typically, a larger project report compared to a 30 ECTS MSc thesis. In total, Master thesis plus R&D project cannot exceed 60 ECTS in your MSc program.

Enrollment:
You can register for BSc projects and R&D projects through Student-Self-Service (STADS) based on your approved projects contracts with the Head of Degree Program. Registration for the projects in the Spring semester is November 1-5, and registration for R&D projects in the Autumn semester is May 1-5.

However, you are automatically registered for your MSc thesis after approval of your MSc Contract (see below with link) on the contract generator. Once registered for your thesis, there is no option of withdrawal. Deadlines for submission of the MSc Thesis Contract, MSc thesis etc. appears on the study portal, which is regularly updated (see below with link).

BSc projects, R&D projects and MSc Thesis Contracts

Before starting a project a contract is required, which is made by using the contract generator. For Bsc and R&D projects, please use the project generator and for MSc Thesis the MSc Thesis generator. The contract generator contains instructions on how to fill in the contracts.

Deadlines for submission of the contracts appear on the study portal. After contract submission, your internal supervisor and your UA will receive your contract for approval; if it is rejected due to some details, you shall just change according to the comment made by one of us and re-submit it.

Contents of BSc projects, R&D projects and MSc Thesis Contracts must contain:

- Project title;
- A project plan: a project plan of 1/4 to 3/4 page including background on the problem that must be solved; the potential solution; and details on how you will investigate the potential solution;
- A supervision meeting plan: 2 to 4 sentences on who, where, when and topics for supervisor meetings and feedback;
- Deadlines: date for start-up (=semester start) and report deadline (count 1.5 week per ECTS if at full-time; if followed by the MSc thesis in the same semester you must submit project after 7-8 weeks, and you should not initiate the MSc work before the submission);
- **Non-Disclosure-Agreement (NDA):** if it is required by the company or as a part of a research project that you work under an NDA, see further here: https://studerende.au.dk/en/studies/subject-portals/bce/bachelors-project-masters-thesis-and-rd-projects/non-disclosure-agreements
    - Remember to note the NDA in the contract, which will ensure the necessary confidentiality. Further, note that typically a NDA is not there to protect you, thus there is no reason for you to encourage it, but not discourage it either.

Useful websites:

- **Course Registration**: http://studerende.au.dk/en/studies/subject-portals/biotechnology-and-chemical- engineering/teaching/course-registration/
- **Course Catalogue** https://kursuskatalog.au.dk
- **Study Portal:** Information and guidance about your thesis writing process including deadlines for submission of MSc Thesis Contracts, beginning of the thesis, submission of the thesis, and last examination date. https://studerende.au.dk/en/studies/subject-portals/bce/bachelors-project-masters-thesis-and-rd-projects
- **Contract Generator:** Study contracts, project contracts and master thesis contracts: https://kontrakt.nattech.au.dk/

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Environmental Engineering

The aim of the section of Environmental Engineering is to provide solutions to environmental challenges and hazards caused by modern society. We are primarily targeting water and air pollution as well as GHG emissions and we use a combination of advanced analytical characterization methods, process engineering and modelling tools to analyze environmental challenges and develop solutions for implementation in industrial and public facilities.

Our focus areas include persistent pollutants in natural and engineered water systems, recovery of valuable products from waste streams, measurement methods and technologies for controlling gaseous emissions from agricultural activities (GHG, VOC, Sulfur and Ammonia), anaerobic digestion of waste for energy recovery, and indoor air technologies. In environmental engineering, we are dealing with complex systems and challenges that often involve both biological and chemical processes. Many of our activities are therefore taking place in the cross-section between chemical engineering and biotechnology.

Microbial Technologies for Clean Water

Leendert Vergeynst

Assistant Professor

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At the group for Microbial Technologies for Clean Water, we are working on the transformation of wastewater treatment plants into resource recovery facilities. We exploit the variety of bio- chemical processes that are catalyzed by micro- organisms and investigate how microbes can be optimally managed in biotechnologies to pro- duce clean water and recover valuable products from wastewater. We work with innovative lab- scale bioreactors such as biofilm reactors for removal of micropollutants (pharmaceuticals, biocides, hormones), high-rate activated sludge for energy recov- ery and biofilm reactors for biological phosphorus recovery. We conduct also several projects that are in close collaboration with in- dustrial partners such as Krüger, Danish Technological Institute and several wastewater treatment plants. Currently, we are involved in a unique project that will accomplish the first full- scale integration of hydrothermal liquefaction in wastewater treatment to produce biofuel from sewage sludge.

We use advanced equipment and methods such as liquid chro- matography coupled to mass spectrometry for chemometric analy- sis of micropollutants in water and DNA sequencing combined with bioinformatics to characterize the microbial communities in biore- actors.

List of project topics

- The first full-scale integration of hydrothermal liquefaction in wastewater treatment to produce biofuel from sewage sludge
- High-rate activated sludge to recover energy from wastewater
- Biofilm-based enhance phosphorus recovery from wastewater
- Biofilm reactors of removal of micropollutants from wastewater
- In vitro bioassays for measuring (eco)toxicity cause by mi- cropollutants
- Hydrothermal liquefaction for the degradation of PFAS in sewage sludge

Air Quality Engineering

Anders Feilberg

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The research at 'Air Quality Engineering' within the area of Chemical and Biological Air Cleaning focuses on the development and characterization of advanced technologies for protection of environment and human health. The activities include development of new highly reactive chemical processes for air scrubbers, application of advanced oxidation processes and optimization of biological air filtration. Mass transfer is often a key parameter to be optimized. Our research group offers challenging and novel projects for students aiming for a career in Environmental Engineering, exploring the increasing demand for cost-effective technologies in many areas.

List of project topics:

- Kinetics of metal-ion-catalyzed degradation of volatile sulfur compounds (P. Kasper)
- Mass transfer optimization in air scrubbers for removal of poorly soluble contaminants (P. Kasper)
- Minimization of formation of adverse byproducts from photocatalytic air cleaning for indoor air quality (A. Feil- berg)
- Optimizing removal of volatile sulfur compounds in biological filters for mitigation of biogas emissions (M. Kofoed)

The research at 'Air Quality Engineering' within the area of Process Analytical Chemistry focuses on the development and characterization of online technologies for monitoring chemical processes in real time. The methods include new applications of online mass spectrometry for measuring volatile organic com- pounds, cavity-ringdown spectroscopy for iso- tope ratio measurements and development of low-cost micro- scrubbers. The methods can be used for optimization of e.g., environmental technologies, emission processes and for indoor air quality research. Our research group offers challenging and novel projects for M.Sc. students aiming for a career in Chemical and Environmental Engineering, exploring the increasing demand for time-resolved data in many areas.

List of project topics:

- Optimization of a microscrubber-fluorescence method for measuring ammonia (J. Kamp)

	• Application of PTR-TOF-MS for eddy-co- varianceflux measurements (J. Kamp, A. Feilberg) • Characterization of indoor air pollution and source contributions (K. Kristensen) • Combining PTR-MS and cavity ring- down spectroscopy for characterizing methane formation and mitigation (A. Fuchs, F. Dalby)

Air Quality Engineering

Michael Jørgen Hansen

Senior Researcher

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The research at 'Environmental Engineering' within the area of Low-Emission Livestock Facilities focuses on mechanical and chemical technologies that can preventthe emission of greenhouse gases, ammonia, hydrogen sulfide and volatile organic compounds from animal houses and storage facilities for manure. The activities include development of mechanical liquid manure systems with low- emission footprint and chemical additives for inhibition of emission driving microbial processes in liquid manure. Projects within this area are for students aiming for a career in Environmental Engineering, working with some of the most important environmental challenges in our society. List of project topics (MSc, BSc, R&D)

List of project topics

- Development and design of mechanical liquid manure systems with small surface area and residence time for emission reduction
- Chemical additives for inhibition of methane producing bacteria in liquid manure
- Biogas methane potential of manure from different types of manure systems and manure treated with additives
- Feed enzyme for reduction of methane emission from manure systems
- Modelling of greenhouse gas emissions from production systems based on chemical and biological parameters

Air Quality Engineering

Kasper Vita Kristensen

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The research at 'Air Quality Engineering' within the area of Indoor Air Quality focuses on development and implementation of technologies for monitoring and improving air quality. The activities include fundamental research on the sources, fate, and impact of air pollution, development of analytical methods and sensors, material selection and ventilation/air purification strategies. The research is highly interdisciplinary including atmospheric, analytical and environmental chemistry, public health, civil, architectural, electrical, and chemical engineering.

Projects within this area are for students aiming for a career in Environmental Engineering striving to ensure clean and healthy air for all.

List of project topics

- Development of Do-It-Yourself Air cleaners for mitigation of classroom air pollution
- Development of sensor nodes for indoor air quality assessments (CO2, Particles, VOCs, temperature, RH etc)
- Electrochemical sensors for speciated detection of airborne chemicals
- Mapping and reducing chemical off-gassing related to microbial activity in biobased building materials
- New analytical methods for the detection and quantification of PFAS in air

Microbial Biointerfaces in Water Engineering

Thomas William Seviour

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In the Microbial Biointerfaces group, we aim to develop innovative solutions to environmental challenges throughan understanding of biofilmcomposition and formation. We are particularly interested in the extracellular polymeric substances (EPS) that bind the biofilms. One major focus area is developing technologies that enable the recovery and valorization of EPS from microbial biomasses derived from waste treatments, which are one of society's largest biosolid waste streams. We thus hope to help build a new circular economy in water management. We also aim to elucidate new strategies to control biofilm growth, specifically those targeting EPS production, composition and structure. Both focus areas require innovative approaches for downstream processing, and chemical and biophysical analyses. We are always looking for motivated students at both Bachelor and Master level. Please contact us if your interest and/or expertise aligns with the activities of the group.

List of project topics

- Producing Bioplastics from EPS hydrogels isolated from activated sludge
- EPS hydrogels for removingpersistent chemicals by sorption
- Optimization of EPS hydrogelrecovery from activated sludges
- Comparison of aerobic granularsludge EPS from continuous and sequencing batch re- actors
- Method development for partial hydrolysis of activated sludge exopolysaccharides to oligosaccharides for structural elucidation by NMR EPS recoveryand analysis from activated sludge microbial isolates

Water Engineering Innovation Lab

Zongsu Wei

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The Water Engineering Innovation (WEI) Lab, led by Dr. Zongsu Wei, has focused on developing advanced treatment processes to purify water and promote water safety. The ubiquitous presence of emerging contaminants (ECs) such as micropollutants and pathogens in water sources (e.g., subsurface water and groundwater) poses serious health threats to both humans and the environment. Yet, conventional treatment technologies have failed to remove those ECs in wastewater treatment plants, necessitating innovation and upgrade in current technologies. Our research interests are motivated by the need to address these problems and are focused on a fundamental understanding of the nexus of contaminant- water- environment.

List of project topics

- Radical-based advancedoxidation processes
- Photocatalytic defluorination of PFAS
- Advanced reduction of PFAS
- Sonochemical degradation of PFAS
- Engineering carbonbased photoregenerable composite materials for efficient removal of emerging micropollutants
- Power-to-X, e.g., electrodialysis-based acid/base production for CO2 capture

Anaerobic Digestion Technologies

Henrik B. Møller

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The research within the Anaerobic digestion (AD) group is focused on improving biogas production and covers technologies that can increase gas pro- duction, improve impact on greenhousegas emissions, optimal use of digestate and biogas. The research covers pre-treatment, new innovative digester design, improved process understanding, up-stream and down-stream processes as well as process kinetics, greenhouse gases, value of the digestate as fertilizer by separation. Furthermore, the integration of the AD technology in organic farming has increasing interest. The research co-vers both basic research and final application with a strong collabo- ration with industry.Radical-based advancedoxidation processes.

List of project topics

- Chemical pre-treatment of biomass with (ammonia, KOH, acids etc.)
- Improved biogas from manureby up- stream reduction of losses
- New improvedreactor designs like re-di- gestionof fibers, UASB, fil-ter reactors etc.
- Biological and physical pre-treatment of bio- mass
- Improving the value of nutrients by digestate processing.
- Additives for improved biogas
- Integration of biological gascleaning and fertilizer production
- Micro-aeration of the biological process

EMMA: Emission measurements and mitigation in agriculture

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Johanna Pedersen
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The research in 'EMMA' is focused on developing and testing mitigation strategies for agricultural emissions (greenhouse gases, ammonia, VOCs, and sulfur compounds) from application of organic fertilizers, housing and storage of animal manure.

List of project topics

- Comparing and optimizing N2O measurements in the field after organic fertilizer application. Specifically, looking into online and spot (GC) sampling of N2O.
- Testing different biogas digestate and the effect of various properties on NH3 emission.
- Optimizing dynamic flux chambers for measurements of NH3 and VOC after field application of fertilizer.
- Measurements of CO2:CH4 ratio just above the slurry surface in storage tanks to estimate surface respiration.
- Including chamber data in ALFAM2 model for relative effects of mitigation technologies.
- Method development to measure enteric CH4 production from grazing cattle.
- Quantification of NH3 and N2O from urine patches and cattle dung in the field.
- Method development for NMR analyzer for digestate slurry.
- Method development for estimating NH3 emissions from synthetic fertilizers.
- Investigating buffer capacity of slurry and slurry digestate and how which predictor parameters are most important.

Industrial Biotech

The aim of the Industrial Biotechnology section is to provide biobased and sustainable solutions for industrial, environmental, food and health related applications. Our research contributes to solving some of the challenges - environmental and technical - that our society has to deal with.

We study the fundamental basics of enzymes and microbes, and translate our knowledge to optimize bioprocesses, to produce chemicals and to modify micro- and macromolecules in artificial and natural ecosystems. Our research profiles combine expertise in enzyme engineering, biocatalysis, microbial engineering and synthesis, microbiome research and food (bio-)technology. The section has state of the art-facilities for molecular cloning, protein expression and engineering, microbial cultivation at aerobic and anaerobic conditions, an analytical platform and a food processing pilot plant.

The section contributes to the Bachelor and Master programs in Biotechnology at Aarhus University.

Agro-Biotechnology Science Group

Zheng Guo

Associate Professor

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The research interest at the Agro-Biotechnology Science Group is to seek for innovative methods, new chemistry and greener solutions for effective and efficient utilization and valorization of natural and agricultural resources. Green chemistry and enzyme catalysis are the cores of biotechnological science to be advanced and developed. In our laboratory we develop green technology and enzyme catalysis to transform lipids, biomass and industrial crops into new value-added products. These products include food ingredients, agro-chemicals, biofuels, biomaterials and cosmetic/pharmaceutical excipients for oriented applications.

List of BSc/Msc project topics

- Programmable Synthesis of Designer Lipidsfor Continuous Liquid Interface (3D) Printing;
- Engineering of extra dioxygenase for enzymatic production of lignin-based biochemicals;
- Enzyme Engineering of P450 for New-to-Nature chemistry;
- Facile synthesis of hierarchical-structured layereddouble hydroxides as catalysts for oxidation of alcohols
- Synthesis and characterization of solvent- free liquid cellulases

Biocatalysis and Bioprocessing

Selin Kara

Full Professor

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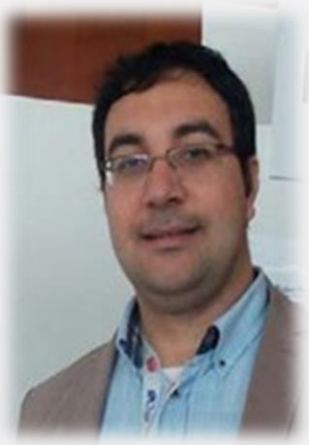
The research at 'Biocatalysis and Bioprocessing' focuses on the development of environmentally benign and highly productive biotransformations by combining (i) biotechnology, (ii) chemistry and (iii) re- action engineering in a multi-disciplinary platform. Our research group offers challenging and novel pro- jects for B.Sc. and M.Sc. students aiming for a career in Industrial Biotechnology, exploring the great potential of enzymes for the synthesis of chemicals e.g. fine-, speciality- or bulk chemicals.

List of BSc/Msc project topics

- Light-driven hydroxylations in non-conventional media
- Reaction engineering of light-driven decarboxylations
- Design and development of artificial (redox-neutral) enzymatic reaction cascades
- Evaluation of the effectof organic solventson redox enzymes
- Immobilization of (redox) enzymesfor their use in non- conventional media and in continuous processes
- Kinetics modelling of multi-enzymatic re- action cascades

Enzyme Engineering



Bekir Engin Eser

Assistant Professor

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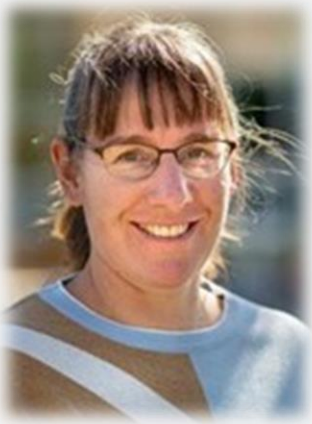
The research in our group focuses on improvement of biocatalytic capacity of enzymes through biocatalyst engineering. We aim to explore natural and non-natural enzymatic reactions for the synthesis of industrially and medically useful compounds. Our research also includes discovery of novel enzymes as well as mechanistic and kinetic studies of enzymatic reactions. Through our projects, students can develop skills in molecular biology, protein expression & purification, enzyme kinetics and enzyme assay design.

List of BSc/Msc project topics

- Exploring Polymethoxyflavone O-demethylases for their capacity in lignin valorization and in organic synthesis
- Biocatalytic production of short-medium chain terminal alkane diols and diacids for plastic upgrading

Functional Microbe Technology



Clarissa Schwab

Associate Professor

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The Functional Microbe Technology Group investigates activities of food and gut microbes which might have beneficial or adverse impact. We want to manipulate these activities and are interested in the role these functions play in their ecosystem. Our research program employs a combination of advanced molecular tools, enzymatic assays, aerobic and anaerobic cultivation, biotechnological processes such as food, batch and continuous fermentation systems and downstream processing, and various analytical chromatography techniques.

List of BSc/Msc project topics

- More than slick seaweed (FERMOSE). Identify the potential of seaweedpolysaccharides to act as next- generation prebiotics.
- Develop novel bioprotective consortia (BIOFUNC). Predict strains that form interactive networks to produce propionate based on genome data. Combine and test candidate strains in co-culture studies with different substrates. Optimize production to employ consortia as bioprotectants in food fermentations.
- Make them glow! Develop a biosensor hosting the redox sensitive expression system roGFP that can be used in model systems in vitro and in vivo.
- How do gut microbes and diet components interact? (LacFerm and InfantAD) Combine *in vitro* models with nutrient/microbial modulations to determine the causal effects of food-gut microbiome interactions.

Microbial Biosynthesis

Thomas Tørring

Associate Professor

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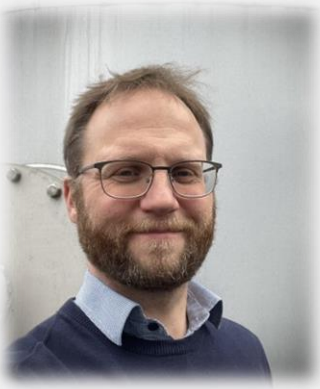
The research at 'Microbial Biosynthesis' focuses bacteria producing complex natural products. We aim to isolate new microorganisms and identify natural products with antibiotic or anticancer activity. We work on understanding how enzymes construct complex natural products and exploitthese enzymes for new purposes and we work on optimizing the production in bothshaker flasks and bioreactors. We are a dynamic research group and have several projects for creative students within Industrial Biotechnology.

List of BSc/Msc project topics

- Using CRISPR-Cas9 genome editingtools to investigate the enzymes involved in natural product biosynthesis
- Expression and characterizing enzymes involved in RiPP (RIbosomally synthesized and Post-translationally modified Peptides) biosynthesis
- Isolating and characterizing antibiotic-producing microorganisms
- Optimizing production and isolation of complex natural products from microorganisms
- Screening novel antibiotics againsthuman pathogens
- Using bioinformatics to identify new natural products for heterologous expression

Microbial Conversion Technologies



Michael Vedel Wegener Kofoed

Project Director & Associate Professor

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The research at the research group of 'Microbial Conversion Technologies' focus on the use of microorganisms for solving some of the great societal, environmental and technical challenges. Our main focus is the capture and conversion of CO2 from industrial sources using microorganisms and bio-reactors.

We work with microorganisms and bioreactors at both lab- and pilot-scale, using expertise within microbiology and engineering to develop new solutions that can reduce the anthropogenic impact on climate and environment.

List of project topics

- Use of bioreactors for capture and conversion of flue gas CO2 at our new flue gas test facility.
- Operation of pilot-scale CSTR bioreactor for biogas upgrading using new injector technology
- Biological conversion of biogas CO2 using gas-phase bioreactors
- Desulfurization of industrial CO2 sources using biological and chemical methods.
- Coupling green protein production and biomethanation for production of sustainable green fuels.

Microbial Electrosynthesis

Jo Philips

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Our group studies microorganisms with the intriguing capacity to upgrade CO2 with H2 into more valuable products, including acetate and methane. These acetogenic and methanogenic microbes are of high interest to develop biological CO2 utilization technologies. The required H2 can be added by an electrode placed in the bioreactor, in this case the process is called Microbial Electrosynthesis, which is also the name of our research group. Microbial electrosynthesis also offers opportunities to store excess renewable electricity and is thus a biological Power-to-X technology.

Our research mainly focusses on understanding these acetogenic and methanogenic microbes better, by studying their H2 consumption characteristics and various other properties. Our research aims to deliver new insights that contribute to the optimization of microbial electrosynthesis applications.

We offer BSc/MSc thesis topics for students eager to learn how to work with anaerobic microbes and interested in microbial biotechnologies for CO2 utilization.

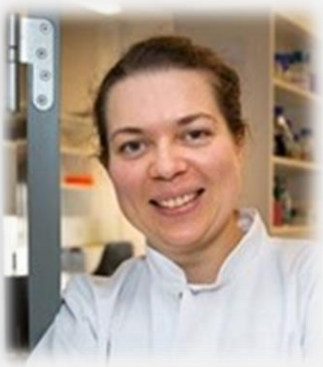
Possible bachelor projects:

- Evaluation of the role of GalU in biofilm formation by Sporomusa ovata (co-supervised by Marta Irla)
- Exploration of the diversity in growth yields among acetogenic bacteria
- Quantification of cell decay of acetogenic bacteria in different biotechnological setups
- Measurement and modelling of H2 and pH gradients in artificial biofilms

Possible master projects:

- Competition experiments to investigate which strains are best for microbial electrosynthesis
- Operation of microbial electrosynthesis reactors under different applied currents
- Come and talk to us for more information!

Microbial synthetic biology



Marta Katarzyna Irla

Assistant Professor

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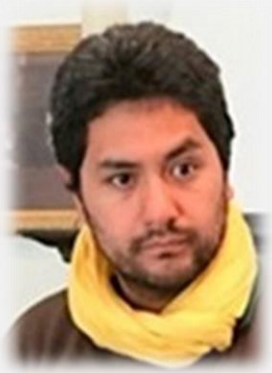
In the group of Microbial Synthetic Biology we harness microbial C1 metabolism to establish methanol-based bioprocesses for production of industrially relevant value-added compounds. Our research is centered around thermophilic Bacillus methanolicus which has potential to become an industrial workhorse for biotechnological production. We aim at development of a technology where C1 compounds are converted into higher carbon molecules using native and synthetic metabolic pathways in methylotrophic microorganisms. Such approach has twofold impact on current challenges of (bio)chemical industry (i) introduction of sustainable feedstock for biotechnology which we do not compete with food and feed industries for resources, (ii) establishment of biocatalysts for activation of stable C1 molecules and their selective transformations, particularly formation of C-C bonds.

List of project topics

- Establishment of production of sugars from methanol in *Bacillus methanolicus*
- Deletion of cell lysis pathway in *Bacillus methanolicus*
- Deletion of flagella in *Bacillus methanolicus*
- Characterization of sporulation deficient *Bacillus methanolicus* strains
- Use of the T7 RNAP-based expression system for cadaverine production in *B. methanolicus*
- Effect of EfgA on formaldehyde toxicity in *B. methanolicus*

Multiscale Microbial Engineering



Alvaro R. Lara

Associate Professor

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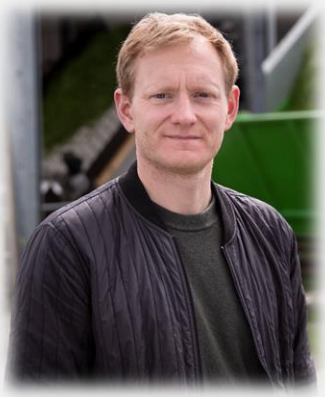
In our research group we aim at reprogramming microbial cells to improve their robustness for biomanufacturing. We combine genome edition, metabolic engineering, and synthetic biology strategies to developed streamlined and smart cells with superior performance to produce recombinant proteins and DNA vaccines. The engineered microbial factories display advantages for small scale cultures and potentially for industrial bioprocesses.

List of project topics

- Dynamic control of the metabolic fluxesto improve biomass formation under oxygen limitation.
- Streamlined Escherichia coli: Less is more?
- Production of a novel DNA vaccinevector in proteome- reduced E. coli
- Production of an auto inducible DNA vaccine vector
- Microaerobic production of the Clostridium difficile
- toxin A subunit in proteome reducedE. coli

Multiscale Microbial Engineering



Morten Ambye-Jensen

Associate Professor

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The Green Biorefining Technologies Group (GBT) work with separating fresh green biomass into a fibre pulp, protein products and a residual liquid known as brown juice on a demonstration platform located in AU Viborg, Foulum.

Here, different plants like grass, clover, lucerne, after crops, seaweed, and more exotic bio resources like cassava leaves are processed and tested in the demonstration platform in three levels: the biorefinery, the process hall and the laboratory.

The demonstration platform is unique of its kind. Since it was inagurated in 2019, it has delivered solid data and state-of-the art-results in the technology of green biorefinery with focus on technologies which can be used commercially. The demonstration platform is flexible, and is continuously optimized and innovated - depending on the research- and develop projects it is used for. The machines are made for industrial use and can be scaled and used by stakeholders who wants to work with green biorefinery and produce high value products like feed, food, biomaterials, bio energy and fertilizer.

There is a huge potential for growing more perennial green crops with significant environmental advantages in Denmark. By increasing our domestic agricultural biomass production and green biorefining capacity, we can begin to rely less heavily on imports like soya.

List of project topics

- Protein extraction from green leafy plants, quality and yields
- Using residual liquid (brown juice) from green biorefining as a substrate for microbial production.
- Using the press cake fiber from green biorefineries for biomaterials (cellulose-materials or full lignocellulosic fibre utilisation)
- Process modelling og integrated biorefineries comparing different technology scenarios

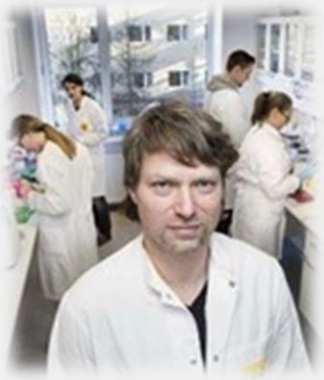
Medical Biotechnology

The Medical Biotechnology section thrives for designing, engineering and applying macromolecules, cells and tissues for application in a health and patient benefit related context. The research spans from fundamental insights into physiological processes and their function to engineering of biological and chemical molecules and their interaction with targets, tissues and biomaterials for precision medical applications. Biochemical systems for production and application in health technologies are studied and designed using experimental and computational methods. The section research also includes and applies protein design, cell engineering, sensors and diagnostics, and precision medicine for solving urgent clinical needs.

The section has available state of the art platforms and instrumentation for protein engineering and production and in basic and advanced host systems, electrospinning of biomaterials, biomechanics, advanced tissue culture, flow cytometry and biomolecular interaction analysis.

The section is strongly engaged in the Bachelor and Master programs in Biotechnology and Chemical Engineering at Aarhus University.

Immunological Biotechnology



Edzard Spillner

Associate Professor

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The research of the 'Immunological Biotechnology' group focuses on the development of diagnostic and therapeutic concepts within biomedical applications.

We apply a broad spectrum of protein technologies, e.g. production in higher expression hosts, combinatorial approaches, in vitro and cellular assay systems, functional and structural characterization, etc.

List of project topics

Our research group offers challenging and interdisciplinary projects for B.Sc and M.Sc. students within the research of Medical Biotechnology, designing and exploring the potential of highly evolved proteins and other biomolecules for a future patient- tailored precision medical treatment

- Identification, characterisation, production and application of proteins such as biomarkers and antigens involved in disease
- Establishment of novel binding molecules against clinically important molecular and cellular structures
- Functional and structural analyses of antibodies
- Therapeutic targeting of immunologically important key molecules and biomarkers of disease

Infections, carcinogenesis and regeneration

Cindrilla Chumduri

Associate Professor

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The Infections, Carcinogenesis, and Regeneration (ICR) research group focuses on uncovering cellular and molecular factors critical for antimicrobial and early cancer intervention strategies. We investigate the dynamics of tissue regeneration, particularly how infections, inflammation, and dietary factors disrupt tissue balance and exploit conditions like metaplasia contributing to cancers.

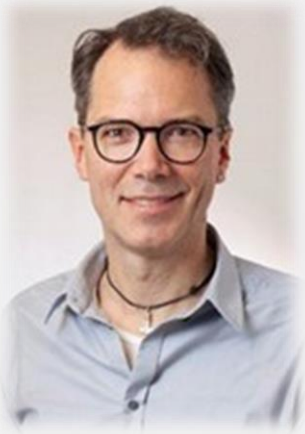
Our approach centers on advanced techniques, including 3D- organoids, co-culture systems, in vivo models, CRISPR/Cas9 genome editing, high-resolution microscopy, and single-cell and spatial omics analysis.

List of project topics

We offer wet lab and bioinformatics research opportunities. Choose your focus, and let's advance our understanding of these critical areas together.

- Developing novel complex preclinical patient-derived organoid systems
    - Establishing Epithelial-stromal-immune co- cultures.
    - Analyzing organoidsfrom healthy, infection, and pathological states.
    - Generation of mutant organoidlines applying e.g. CRISPR/cas9.
    - Biomarkers screeningand validations
- Modeling infections and carcinogenesis in vivo
    - Establishing and optimizing infectionand precancer mouse models
    - Characterizing tissue alterations in mouse models
- Integrated bioinformatics
    - Single-cell sequencing and spatial- transcriptomics and mutational analysis
    - Data mining and integration with public datasets

Organoid and imaging biotechnology



Thomas Lykke-Møller Sørensen

Associate Professor

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The research in the OIB group focuses on developing organoid and imaging technologies to improve dis- ease modelling and drug testing.

Organoids are mini-organs – tiny, self-organised three- dimensional tissue cultures derived from stem cells or tumours. Their size, advanced differentiation, and potential human origin provide a convincing alternative to "classic" cell culture and animal models for preclinical drug testing and disease modelling. We primarily use imaging and biochemical analysis to compare development and responses of healthy and disease organoids.

List of project topics

- Development and functional characterization of epithelial and endothelial model systems.
- Automation of organoid screening technology – how to streamline the process for drug screening
- Assay development for intestinal or- ganoids – how to monitor uptake of food and drugs
- Cerebral organoid imaging – what can we learn about neurodegenerative diseases
- Imagining technology and processing - development of analysisand segmentation tools
- Microscopy and labelling development – identifying cell types and morphologies
- Electron- and X-ray tomographic imaging of organoids

Nanofiber Technology and Cellular Engineering

Menglin Chen

Associate Professor

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The research in the OIB group focuses on developing organoid and imaging technologies to improve dis- ease modelling and drug testing.

Organoids are mini-organs – tiny, self-organised three- dimensional tissue cultures derived from stem cells or tumours. Their size, advanced differentiation, and potential human origin provide a convincing alternative to "classic" cell culture and animal models for preclinical drug testing and disease modelling. We primarily use imaging and biochemical analysis to compare development and responses of healthy and disease organoids.

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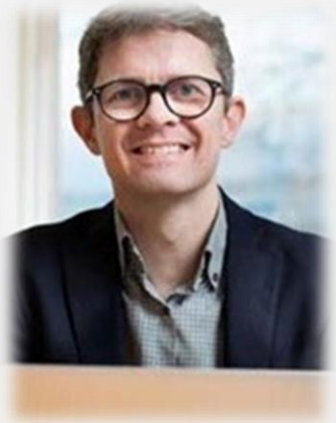
Biomechanics and Mechanobiology



Jens Vinge Nygaard

Associate Professor

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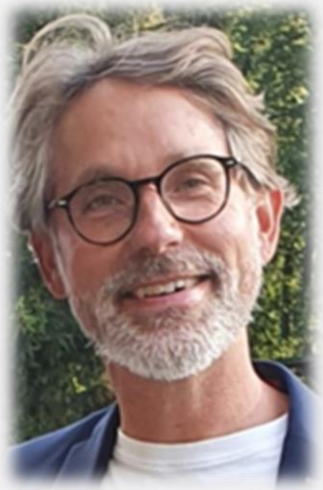
The research at 'Biomechanics and Mechanobiology' is closely linked to Medical Biotechnology. We focus on understanding and using molecular mechanisms related to how mechanical forces alter biological and chemical functions. The aim is to develop new bio- technologies that quantify mechanobiological mechanisms or take advantage of them in new ways to de- liver drugs or to understand diseases initiation and progression. You can join the group by focusing on an experimental or computational topic selected from be- low. Most projects are in collaboration with scientific or industrial partners.

List of project topics

- Theoretical Bioinformatics and Systems Bio- chemistry:
    - Mechanobiology of gastrointestinal in- flammation and regeneration.
    - Mechanobiology of structural guidedor- ganoidal self-assembly.
    - Blood Brain Barrier mechanobiology.
    - Mitral Heart Valve mechanobiology.
- Experimental MedicalDevice Development:
    - Microfluidic devicefor Blood Brain Barrier replication – mechanosensitive drug screening.
    - Mechano activated mitral valvedevel- opment.
    - Nanostructured SiN membranes and foams for screening of mechano sensitivity.
- Nanostructured foams for gastrointestinal organogenesis.

Function and modulation of the human skin microbiome
(Department of Biomedicine, Faculty of Health, AU)



Holger Brüggemann

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The skin microbiome research group investigates the role of the human skin microbiome in health and diseases such as skin disorders, implant-associated infections and immunological pathologies. Complementary areas of research include (counteracting) antimicrobial resistance, molecular epidemiology, host-pathogen interaction, microbiome editing, and the development of sequence-based tools for microbiome interrogation. We offer wet lab and bioinformatics research opportunities.

List of project topics

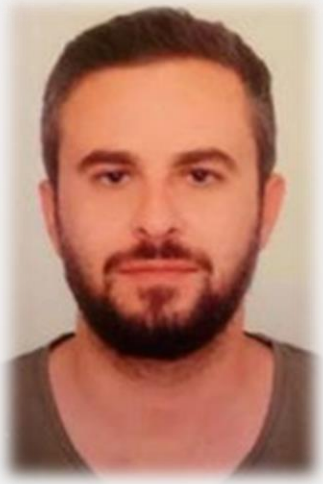
- Skin microbiome mining: Identification of host beneficial traits of skin bacteria
- Skin microbiome modulation: application of a common skin bacterium to treat acne vulgaris
- Skin microbiome engineering: Reprogramming a common skin bacterium to counteract skin ageing
- The lung-skin microbiome axis and its role in sarcoidosis
- Prevalence and role of mysterious corynebacteria in implant-associated infections
- The landscape of antimicrobial resistance in E. coli and K. pneumoniae in Denmark and India/Nepal

Process & Materials Engineering

The section for Process & Materials Engineering has a tot has a total staff of about 60 employees. Research focus of the section is almost entirely on development of new sustainable solutions, materials and processes for the green transition. This includes research, development and demonstration of a range of technologies within like green bio-refining, hydrothermal liquefaction (HTL), catalysis, polymers and plastic engineering, recycling and electrochemical energy conversion technologies like batteries, electrolysis, and Power-to-X technologies. AU-BCE has strong competencies within all these technologies, associated process engineering and covers a large part of the TRL ladder. This includes basic research as well as activities within demonstration and pilot-scale testing of renewable energy technologies, in particular at the section's sites in Foulum.

Co-operation with other institutes, companies and universities both in Denmark and internationally is an integrated part of our culture.

Sustainable Process Systems Engineering (SuPSE)



Konstantinos Anastasakis

Associate Professor

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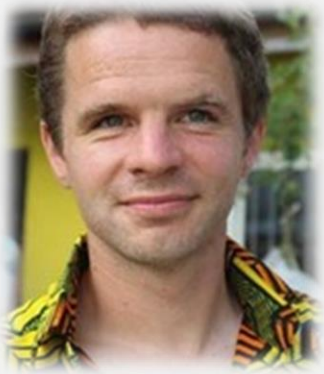
Research in the Sustainable Process Systems Engineering (SuPSE) group focuses on the development of highly efficient processes for the successful transition into a sustainable future. The group uses a combination of computational and experimental methods to advance the development of emerging sustainable technologies. Computational methods include the use of Process Systems Engineering (PSE) tools to synthesize, integrate and analyze processes by taking into account the needs of people (social), planet (environment) and profits (economy), the tri-fold metrics of sustainability. These tools include process synthesis/modeling and integration, techno-economic (TEA) and Life Cycle Assessments (LCA). Particular interest is given in integration of chemical and renewable energy tech-nologies for exploiting synergies leading to optimization of processes in a circular economy concept. Of particular interest are renewable fuels and chemicals based on biomass & waste (with special focus on hydrothermal liquefaction-HTL), chemical energy storage (Power-to-X), circular economy and waste (water) treatment.

List of project topics

- Modeling of sustainable aviation fuel (SAF) production from CO2 and H2 via reversewater gash shift and fischer-tropsch.
- Modeling hydrotreatment of bio-crude oils.
- Modeling and Techno-economic analysis (TEA) of the integration of hydrothermal liquefaction (HTL) in wastewater treatment plants.
- General projects on modeling, Technoeconomic evaluation and Life Cycle Assessment (LCA) of advanced biofuels, synthetic fuels and sustainable bio-refineries.

Hydrothermal Processing



Patrick Biller

Associate Professor (Paternity Leave, back in January 2025)

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The Hydrothermal Processing group (HTP-Group) focuses on the development of sustainable chemicals, fuels and nutrients made from biomass and wastes. We apply process and chemical engineering concepts to optimise lab and pilot scale production technologies at Hangøvej and in Foulum. The main technologies we work with employ high temperature and pressure, termed hydrothermal liquefaction and carbonization which can replace petroleum based fuels and chemicals. This is primarily applied to produce sustainable aviation fuels from waste such as manure and sewage sludge but also for the chemical recycling of plastic waste to monomers.

List of project topics

- Integration of HTL at wastewater treatment plants
- Chemical recycling of plastic waste to produce monomers
- Upgrading of HTL oil to jet fuel via catalytic hydrotreatment
- Cleaning high strength wastewaters via wet air oxidation
- Pyrolysis of biogas to produce hydrogen and solid carbon

Nanomaterials engineering for sustainable technologies – NEST

Jonathan Quinson

Tenure Track Assistant Professor

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At NEST we focus on developing new approaches to design and prepare outperforming nanomaterials and in particular nanocatalysts. We (i) develop new synthetic approaches. We (ii) understand the strong relationships between synthesis-structure-properties at the nanoscale (i.e. how nanomaterials form and how does that influence the resulting properties, e.g. collaboration with iNano). We (iii) investigate their applications in energy conversion (e.g. a range of small molecules electro-oxidation for fuel cells or electrolyzers, possibly CO2 electro-reduction). To date we focus on precious metals such as gold, silver, platinum, iridium, ruthenium, but we are open to new opportunities and horizons. To date we focus on electrocatalytic applications but we are also open to new horizons and collaborations since the nanomaterials are relevant for energy conversion, catalysis, medicine, water/air treatment, sensing, imaging and many more.

List of project topics

- Development of green scalable surfactant- free colloidal syntheses of nanomaterials at low (room) temperature – towards high throughput and/or automation for machine learning
- Development towardsbi/multi metallic nano- particles (e.g. high entropy alloys)
- Electrocatalysis (e.g. alcohols oxidation – possibly CO2 reduction)
- Water Treatment

See also: http://nestresearchlab.com/

Carbon Engineering

Aidan Mark Smith

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The carbon engineering group predominantly investigates the production of engineered carbons from bio- mass. The group used hydrothermal carbonisation (HTC), a process which uses hot compressed water to simulate a natural coal forming process to produce a biocoal and pyrolysis which uses heat to thermo- chemically reform a carbon-based feedstock to a charcoal. The group works at a range of scale from small lab scale for fundamental research to larger scale pilot reactors at Foulum. Applications of the carbon materials include fuels for combustion and metal making, biochar for carbon sequestration, growth substrates, pretreated carbon for liquid fuel and chemical production, carbons for water treatment and carbon electrodes.

List of project topics

- Effect of surface coating on carbon deposition/ fouling in hydrothermal reactors (can be tailored to BSc or MSc students).
- High temperature settlement behaviour of solid carbon in subcritical water conditions and the influence high temperature char extraction will have on char carbon structures, yield and toxicity (can be tailored to BSc or MSc students).
- Influence of metals and heteroatoms on hydrothermal carbon polymerisation chemistry (can be tailored to BSc or MSc students).
- Synthesis of metals and heteroatoms on hydrothermal carbon polymerisation chemistry (can be tailored to BSc or MSc students).
- Influence of pyrolysis processing conditions on biochar pH, structural integrity and energy yield, with the intention to use the resultingchar as growth media in commercial green- houses (MSc).
- Carbon recalcitrance of anaerobicdigestates and the influence of recalcitrance following hydrothermal and/ or thermal treatment (MSc
- students).
- The use of biochar augmented sand filters in cleaning water for drinking and groundwater recharge (can be tailored to BSc or MSc studentsor R&D project).
- Review of standards in the production of com- posted material for the use in commercial greenhouses (R&D project).

Power-to-X research group for technology development

Behzad Partoon

Assistant Professor

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The PtX research group is working on the development of novel technologies at a high Technology Readiness Level, known as TRL. The test facility is located at the PtX process hall in the biogas plant at the AU Viborg campus, and the core of the research is converting electrical energy to chemical energy with different PtX technologies. As part of technology development, a new product or process should be tested on a pilot scale at an industrially relevant environment (TRL 5-6) and operational environment (TRL- 7) for a sufficient time (typically 1000 to 4000 hours). The PtX process hall is a unique environment where academia meets the industry and works closely to demonstrate and test new technologies. You will experience research projects that target real industrial problems and investigate the feasibility of novel solutions. We offer a wide range of projects, including both experimental and simulation works. Currently, we are testing two technologies, namely Solid Oxide Electrolyser cells (SOEC) for hydrogen production and Electrified Steam Methane Reforming (eSMR) for syngas production, using renewable feeds and (renewable) electricity. At the same time, we are developing two new pilot plants, one for methanol and one for the Jet Fuel production from CO2-rich mixtures.

Currently, we have 6 master projects in line with the mentioned projects. You can write to me or come and visit us at Foulum to discuss a master project.

Note: Due to the confidentiality agreement of projects, all projects need to be approved by our industrial partners, and your thesis will be confidential.

Carbon dioxide capture research

Behzad Partoon

Assistant Professor

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While different technologies exist for carbon capture as the first link in CCS, to achieve the ambitious path for decarbonization, novel, less energy-demand technologies must be developed, especially when small to medium size emission sources are taken into account. Based on energy statistics reported by the Danish Energy Agency, in 2020, approximately 14.8% of heat and power (40% of heat), equivalent to 15.3 TJ, was produced from smaller-scale plants. To produce such energy, 0.66 MT of CO2 were emitted in 2020 by smaller-scale plants in Denmark. Approximately 900 small and medium-sized local heat plants exist in Denmark, in which both CAPEX and OPEX of capturing CO2 are too high for a broad implementation to be feasible. Developing cheaper and more efficient CO2 capture technologies targeting these smaller-scale industries could be key to achieving the 2030 goal. A novel technology aims to explore the potential of gas hydrate- based carbon capture (GHBCC) as one of the most promising low-energy demand CO2 capture alternatives and clarify the potential bottlenecks in further technology development. A GHBCC technology could be used for all scales of CCS; however, it will open up an opportunity for smaller emitters to engage in the global efforts of reducing GHG emissions.

At the first step, I have a project to investigate promoters to change the thermodynamic equilibrium of flue gas mixture (experimental work) and perform a techno-economic assessment of a GHBCC process (theoretical). I can offer two MSc projects for Spring 2024 in line with these topics. You can write to me or come and have a cup of coffee to discuss a master project.

Electrochemical Energy Conversion and Batteries

Emil Drazevic

Associate Professor

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Power to Chemicals group researches in electro- chemical conversion technologies for producing value-added chemicals in situ e.g. ammonia. We also focus on water for electrolysis, and how organic molecules might degrade during electrolysis of water.

List of project topics

- NOx reduction to ammonia under H2, examination of Ru, Cu, and other catalysts as well as operating in between the regime catalysis/electrocatalysis
- N2 reduction to ammonia- in non-aqueous solvent, lithium mediated
- N2 reduction to ammonia- anhydrous, on metal catalyst and separation of liquid ammonia
- Fate of organic molecules during electrolysis - involves analytical chemistry as well

Membrane Engineering

Jacopo Catalano

Associate Professor

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The research group "Membrane Engineering" focuses on the synthesis of materials for membrane- based (electrochemical) processes, and on under- standing the theory of transport phenomena of ions in charged thin film and nanopores.

Membranes allow us to selectively separate the component(s) of interest from a mixture, based on molecular sieving and/or chemical and electrochemical affinity. The research group offers projects in very different fields, such liquid separation and purification, CO2 sequestration and electro-reduction, and membrane reactors.

List of project topics

- Synthesis of novel catalyst-impregnated membranes and electrodes for CO2 reduction (collaboration with iNano)
- Development of gas flow reactor for electro- chemical CO2 conversion and on-line monitoring (hardware/software).
- Characterization of membranes for water alkiline electrolysis (in collaboration with ASP/HydrogenPro)
- Preparation and characterization of electrodes for water alkiline electrolysis (in collaboration with ASP/HydrogenPro)
- Light gases, vapour, and ammonia permeation in thin films
- Novel processes for food industry (in collaboration with the Department of Food)

Electrochemical Energy Conversion and Batteries

Anders Bentien

Professor

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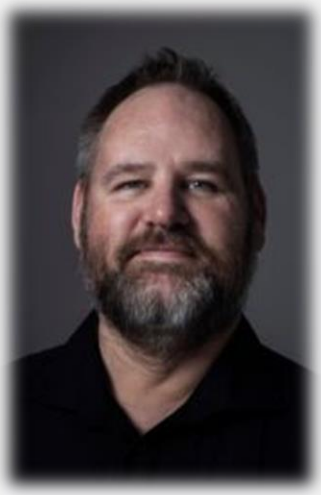
Research and projects focus on electrochemical conversion technologies and in particular batteries and alkaline electrolysers. The aim of the research is to develop and up- scale new low-cost battery technologies for storage of renewable electricity from solar cells and wind turbines. Current scope in this area is (i) Flow batteries (vanadium and Zinc/air) (ii) Optimisation of components for alkaline electrolysers (electrodes, membranes, geometry). In general, we focus on known battery chemistries and try to solve challenges related to upscaling with respect to battery design and life-time. Besides battery tests all projects will typically also involve use of more general techniques like cyclic voltammetry, imped- ance spectroscopy and half-cell battery tests.

List of project topics

- Optimisation and test (new) of flow battery chemistries.
- Optimisation of components for alkaline electrolysers (electrodes, catalysts, membrane seperators)

Plastics and Polymer Engineering



Mogens Hinge

Associate Professor

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The research at Plastic and polymer engineering (PPE) focuses on polymerization, formulation and testing for polymeric and plastic systems. This includes e.g. Adhesion of rubbers, Medicinal Gels, 3D printing of food, and novel polymer degradation.

Further PPE is active within open science at AU and developing and making advance glass flow reactors, controllers, etc. Please note: None of the pro- jects below is "ready-made" all projects in the PPE group are made in collaboration between the industrial partner(s), the Student and PPE

List of project topics

- Synthesis of medicinal gels for prediction of premature birth.
- Inline plastic analysis and sorting of household waste plastic.
- Plastic degradation during recycling
- Development of fire-retardant coating for construction paints

Hybrid Materials Lab (iNANO)

Nina Lock

Associate Professor

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The research in 'Hybrid materials lab' focuses on i) engineering of advanced materials with tailored properties. We use such compounds in ii) heterogeneous photocatalysis i.e. solar-light driven chemical reactions, and iii) electrocatalysis using electricity for chemical conversions. For example, we focus on the reduction of CO2 and on hydrogen production from water splitting. This is achieved through iv) modification of the catalyst light adsorption/conductive properties and v) modifying the materials surface area and gas adsorption (e.g. CO2) capacity. Scaling-up of these processes is envisioned.

List of project topics

• Synthesis of novel porous materials for gas ad- sorption (e.g. CO2)

• Modifying light absorption properties of solids

• Screening of novel materials for heterogeneous photo- and electrocatalysis, e.g. CO2 reduction and hydrogen production

• Investigation of catalytic mechanisms to rationally engineer improved catalysts or processes

Intelligent Advanced Materials

Anja Verena Mudring

Professor & Villum Investigator, Director of the SMARTER Center

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Research in the Mudring group is driven by understanding structure-property relationships with the aim to design new materials for energy related applications for a sustainable society.

In this effort, on the one hand, ionic liquids and molten salts are investigated as a transformative tool in the synthesis and development of improved materials for energy related applications.

On the other hand, complex alloys intermetallics are studied, specifically how the relativistic effect present in heavier metals can be used to uncover new compounds with unusual properties.

Both classes of materials, ionic liquids and complex intermetallics, have in common that they are highly modular which offers a unique opportunity to discover the unimagined and can unlock new technologies for a sustainable society. Translation of research outcomes from the lab workbench to real application is considered an important aspect.

Applications that are in mind are energy efficient lighting, (photo-)catalysis, magnetic refrigeration and thermoelectric energy conversion. All of which help, in a direct or indirect way, to meet the Sustainable Development Goals as being put forward in the United Nations Development Programme.

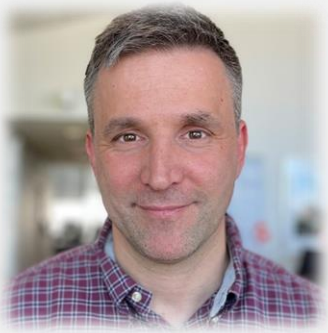
The research group is mainly supported by large research grants from the Carlsberg Foundation, the Villum Foundation and the NovoNordisk Foundation.

List of project topics

- Development of ionic liquids and molten salts as thermal fluids for heat transfer and storage (NovoNordisk Foundation, SMARTER Center)
- Development of ionic liquids as lubricants to reduce mechanical wear (NovoNordisk Foundation, SMARTER Center)
- Development of ionic liquids for the synthesis of nanomaterials (Villum Foundation)
- Development of nano-catalysts for hydrogen production (Villum Foundation)
- Development of photocatalysts for waste treatment (Villum Foundation)
- Development of luminescent nanoparticles for application in lighting and biomedicine (Villum Foundation)
- Development emitter materials for the next generation of light sources, light-emitting electrochemical cells (Vetenskabsrådet, Sweden)
- Development of new intermetallic materials for magnetic refrigeration (DFF)
- Development of new intermetallic phases for thermoelectric power generation (AUFF)

	• Development of new intermetallic phases as corrosion resistant construction materials (NovoNordisk Foundation, SMARTER Center) • Development of ionic liquids as crystallization media for pharmaceutical drugs (NovoNordisk Foundation) • Development of new hybrid material framework materials (NovoNordisk Foundation) • Development of new intermetallic phases with complex physical properties (NovoNordisk Foundation, SMARTER Center) Prospective BSc/MSc students will become part of the intelligent Advanced Materials Group and participate in research network activities. The new members will be teamed-up with a senior group member for introduction to the projects and practical help with the project on a daily basis. visit also http://www.intelligent-advanced-materials.org/ or http://materials-engineering.org/

Carbon Capture



John William Phair

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Post combustion capture technology, Direct air capture technology, mineralization technology, BECCS

List of project topics

- Design and simulation of membrane/separation processes for direct mineralization of CO2 using reverse osmosis brine.
- BECCS design, simulation and analysis for a novel biogas plant