InStreams Hub
Research community for inorganic circular economy at the University of Oulu
InStreams Hub –
Inorganic circular economy research community

InStreams Hub is a cross-disciplinary hub at the University of Oulu for solving sustainability challenges related to inorganic industrial side streams.

InStreams Hub focuses on cross-disciplinary inorganic materials research and engineering and the management and utilization of inorganic side streams. It develops sustainable value chains and has high interest to put scientific research into practice. The Hub also provides research-based information to support decision-making and participates in public debate. The activities create conditions and models for a continuous cross-border and inter-sectoral cooperation, between companies and research institutes.

InStreams Hub consists of following research areas:
• Sustainable materials processing
• Inorganic energy materials
• CO₂-concious materials for construction
• Advanced material characterization
• Preventing environmental contamination
• Value streams and productization

The InStreams Hub is committed to focus on sustainable materials and systems and has a wide academic base for cross-disciplinary inorganic materials research and engineering, readily combined with sustainable value streams and business.

Find out more from: www.oulu.fi/instreams/

UNIVERSITY OF OULU
Pushing the boundaries of the known for a more sustainable, healthy and intelligent world.
Sustainable materials processing

Achieving sustainability in inorganic materials production requires recycling or re-use of all output streams as well as carbon-free production routes.

In order to achieve a waste-free production in industrial processes, we need to find environmentally and economically sustainable ways to deploy unutilized waste and to find high-value utilization targets for all side streams.

Another key issue for achieving sustainability is the production of metals without fossil-based carbon. Firstly, fossil carbon is partially replaced by biocarbon from renewable sources, and secondly, carbon-based reduction processes are replaced by hydrogen reduction.

To obtain these goals, it is necessary to develop new treatment and production processes and also to understand the impact of changes in the downstream processes.

Primary contact:
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Focus areas:

- Pyro- and hydrometallurgical treatments
- Mechanical processing
- Recycling and re-use
- Sustainability assessment
Inorganic energy materials

Enhanced energy storage and production methods play a key role in sustainable development towards low-carbon society.

Batteries and capacitors as energy storage devices are crucial for a wide range of applications, such as consumer electronics, electric vehicles, and stationary applications for wind and solar energy storage. The development of batteries and capacitors with higher energy densities, longer cycle lifetimes, and acceptable levels of safety at an affordable cost are critically needed.

The transition from carbon towards hydrogen-based technologies in fuels and industrial processes sets new challenges for advanced active materials. Production of hydrogen is a pre-requisite towards sustainable energy production. Inorganic side streams are a source for the development of environmentally friendly materials with low cost, and they offer a way to improve sustainability throughout the value chain in energy production and storage.

Primary contact:
Professor Ulla Lassi, Sustainable Chemistry

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Focus areas:

- Energy storage
- Batteries and capacitors
- Battery chemicals
- Materials for hydrogen production
Various inorganic side streams can be used as cementitious binders to build more sustainable society.

Circular economy research focuses also on CO$_2$-conscious concrete-like materials, such as geopolymers. Our goal is to find out new applications for inorganic side streams from the process, energy and construction industries, as well as to develop materials that could replace traditional CO$_2$-intensive cement-based materials.

Understanding the reactivity of materials is equally important as the research on the properties of the end-product. Safety of the materials both from the environmental and end-user viewpoints is fundamental.

Primary contact:
Professor Mirja Illikainen, Fibre and Particle Engineering

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Focus areas:

- Geopolymers
- Alternative cementitious binders
- Foams and composites
- CO₂ utilization
Advanced material characterization

Novel imaging and characterization are enabling multidisciplinary research of inorganic materials.

Our goal is to benefit local and international state of the art methodologies on characterization of physical and chemical properties of inorganic materials and processes aiming at efficient use of resources and minimization of waste. The exact in-situ characterization of raw materials and end products, as well as profound fundamental understanding of the behavior of materials in operating conditions, is at the core of research.

The unique role in synchrotron radiation-based research, local facilities as well as AI methods and inverse problem understanding benefit from advanced imaging and characterization of inorganic materials and are developed for the purpose.

Primary contact:
Professor Marko Huttula, Nano and Molecular Systems

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Focus areas:

- In-situ and operando characterization
- Novel imaging techniques
- Spectroscopy in process control and material research
- Synchrotron-based methods
Preventing environmental contamination

Transforming useless side streams into sustainable functional materials is essential for the future of circular economy.

Environmental contamination is a major concern of today. Emissions to air, water and soil are changing our way of living. Utilization of inorganic side streams in cleantech applications helps us to reduce the amount of waste and the contamination of our environment.

Our research focuses on the development of novel materials for wastewater treatment and for emission control. Ensuring high quality, safety and good performance of these materials is very important. Based on the scientific information from both the raw materials and the products developed, the materials are tailor-made for specific applications. Our multidisciplinary collaboration is an excellent forum for this.

Primary contact:
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Environmental and Chemical Engineering

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Focus areas:

- Materials for wastewater and emissions treatment
  - Catalytic materials and adsorbents
  - Waste stabilization
- Utilization of pollutants, e.g. VOC, CO₂ and other small molecules
Wasteful economy is transferring towards circular economy and sustainable value chains.

To decrease the amount of inorganic waste, or to transform waste into value-added products, we need new technologies, processes and value chains, which profoundly shape the future of our economy and society. We focus on developing operative supply chains, new strategic value chains and business ecosystems as well as productization and commercialization of novel technological solutions.

Our research integrates knowledge to anticipate challenges in sustainable value chains, linking value chain analysis to engineering and feeding information to policymakers and actors in the public and private sectors. Employing the understanding of the business behavior provides a strong basis for examining sustainable business model development towards circular economy for inorganic side streams.

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Focus areas:
- Business ecosystems
- Sustainable business models
- Product life cycle management
- Operative supply chain and value stream renewal
- Productization and commercialization