

RESEARCH ON

MATERIALS

**AND NANOTECHNOLOGY
IN TURKU, FINLAND**

OVER 20
RESEARCH INSTITUTIONS
WORKING ON
FUTURE MATERIALS.



RESEARCH ON MATERIALS AND NANOTECHNOLOGY IN TURKU, FINLAND

This booklet presents research activities within the fields of materials science at the two local universities in Turku, University of Turku and Åbo Akademi University. Materials science in Turku has strong traditions in the research of polymeric, metallic, and ceramic materials. While technological development has enabled research at the nanometer scale as well as the engineering of matter on the atomic and molecular level, nanotechnology has further merged the scientific disciplines of chemistry, physics, biology and electronics. These developments have opened new possibilities and applications for research on so-called traditional materials.

Turku Science Park Ltd. has assembled this collection of brief profiles of academic research groups dealing with materials science in Turku, Finland. Each research group's profile presents their expertise and highlights their most relevant research topics at present. This booklet aims to draw attention to knowledge on new materials and recent technology expertise that could serve as key offerings for potential industry stakeholders. It also serves as a way to readily share the contact information of material science research groups in Turku. With this publication, scientists and technology company representatives are encouraged to further enrich the fruitful collaboration between the universities, private companies and public institutions in Turku.

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Åbo Akademi University

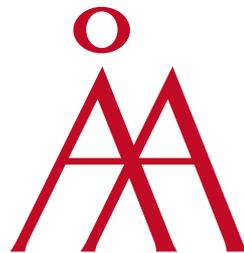
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Turun yliopisto University of Turku

University of Turku has seven faculties and internationally acknowledged expertise from humanities to medicine and natural sciences. University of Turku is one of the leading universities in Finland and is recognized for the quality of teaching, research and excellent student support services.



Åbo Akademi

Åbo Akademi University is a Swedish-language university in Turku. It offers both undergraduate and graduate studies and extensive research opportunities to some 7000 students. Åbo Akademi University has an acknowledged position at the forefront of research in such areas as biosciences, computer science, democracy, human rights, materials sciences, process chemistry and psychology.

FUNMAT

Center for Functional Materials

Center for Functional Materials (FUNMAT) is a national center of excellence in printed intelligence based at Åbo Akademi University and University of Helsinki. FUNMAT combines the expertise in chemistry, physics, polymer technology, paper coating and printing to develop functional materials and devices for printed intelligence. The multidisciplinary research is done in close collaboration with industry and our extensive collaboration network throughout the world.



MatSurf

Turku University Centre for Materials and Surface

Turku University Centre for Materials and Surfaces is a joint endeavour of the materials scientists in the University of Turku from different disciplines representing physics, chemistry and biomaterials. The Centre promotes co-operation and dialogue across disciplinary and institutional boundaries within the field of materials research and sciences.



PCC

Process Chemistry Centre

The Åbo Akademi Process Chemistry Centre (ÅA-PCC) is a research group studying detailed physico-chemical processes in complex environments of industrial interest, this way aiming at finding novel solutions to industrial processes and products. This approach with the focus on the detailed understanding of the process chemistry we have called Molecular Process Technology. The research work is done in close collaboration with industrial companies, and the Centre also has an extensive international collaboration network with partners in Europe, the United States, Canada and Japan.



TCBC

Turku Clinical Biomaterials Centre

Turku Clinical Biomaterials Centre is a core-facility laboratory for biomaterial research in Turku. Research is done both on material development as well as on applied biomaterial research with medical doctors and bio-companies. Different types of biomaterial devices for medical and dental applications are developed and investigated utilising mainly non-metallic and composite biomaterials.



Turku Clinical Biomaterials Centre

EPNOE

European Polysaccharide Network of Excellence

EPNOE is a research and education network connecting 16 European research institutions from 9 countries and 22 companies from 4 continents focusing on polysaccharide science and technology. EPNOE's main missions, in the fields of materials, food and pharmacy/medicine, is to organize education in polysaccharide science and to perform basic and applied research for the development of new products based on or containing polysaccharides.





Turun yliopisto
University of Turku



Wihuri Physical Laboratory; Nanophysics

Professor Kurt Gloos, personnel 3

Main research topics

- Point contact spectroscopy mainly on superconductors and magnetic metals.
- Josephson effect.
- Andreev-reflection spectroscopy and its applications, for example spintronics.

General introduction and special knowhow

We specialize in the properties of point-contact interfaces between metals. Instead of the conventional nano-lithography we use bulk metals (like wires or foils) as electrodes to fabricate mechanically-controllable break junctions, spear-anvil or shear type contacts. The experiments are carried out at low temperatures from about 10 K and down to less than 0.1 K. The contacts can be changed at such low temperatures, allowing us to measure their properties as function of interface area.

Core competence

Point-contact spectroscopy of small interfaces between two metals at low temperatures (0.1 – 10 K) and in magnetic fields up to 8 Tesla.

Possible utilization of the results

- | | | | |
|---------------------|---|-------------------------|-----------------------------------|
| · Chemical industry | · Forest industry | · Biomaterial companies | · Plastics and polymers |
| · Food industry | · Pharma / Medical | · Ceramic industry | √ Sensors |
| · Metal industry | · Building industry | · Diagnostics | √ Research & Metrology |
| · Energy | √ ICT & Electronics & Semiconductors | · Characterization | · Safety |

Applications areas

- The properties of superconductor-ferromagnet interfaces could, in the widest sense, benefit everyone who is working in field of spintronics.

Fundamental research

- We investigate the properties of small “devices” with sizes in the nanometer range. Those devices can be quite complex, but most simple ones are point contacts between two pieces of metal. Such a contact represents a constriction across which electrons can be accelerated, and their scattering processes observed. Spectacular results can be achieved when at least one of the electrodes is either superconducting or magnetic.

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Laboratory of Materials Chemistry and Chemical Analysis; Inorganic Materials

Professor Jorma Hölsä, personnel 5

Main research topics

- Energy storage luminescence and its materials.
- Up-conversion luminescence and its materials.
- Materials for harvesting Solar energy.
- Materials for medical diagnostics and imaging.

General introduction and special knowhow

Synthesis, characterization, development of solid state inorganic materials. The focus is on, but not limited to, luminescent materials. Syntheses both in the nano and micro scales with solid state, combustion or wet routes. Characterization by various laboratory methods concerning structure and purity (XRD, FT-IR, FT-Raman), thermal stability (TG-DTA-DSC) as well as optical (absorption and luminescence spectroscopy), energy storage (thermoluminescence) and magnetic properties. Synchrotron facilities employed for analysis of optical properties in the VUV range as well as for dopant valences (XANES) and local structure (EXAFS). Theoretical calculations are used for complementary information.

Core competence

Combination of a wide range of experimental and theoretical methods for material development.

Possible utilization of the results

✓ Chemical industry	· Forest industry	✓ Biomaterial companies	✓ Plastics and polymers
✓ Food industry	✓ Pharma / Medical	✓ Ceramic industry	✓ Sensors
· Metal industry	✓ Building industry	✓ Diagnostics	· Research & Metrology
✓ Energy	✓ ICT & Electronics & Semiconductors	· Characterization	✓ Safety

Applications areas

- Human safety.
- Medical diagnostics, sensing and imaging.
- Energy storage and conversion, sustainable energy production.

Fundamental research

- Optical, structural and magnetic properties of synthetic inorganic materials and minerals.

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Materials Research Laboratory; Material Physics; Computational Sciences

Professor Kalevi Kokko, personnel 10

Main research topics

- Surfaces of metallic alloys and compound semiconductors.
- Mechanical and electromagnetic properties of alloys and compounds.
- Thermodynamic properties of alloys and compounds.
- Quantum mechanical simulations of alloys and compounds.

General introduction and special knowhow

First-principles computational research on metallic and semiconducting alloys and compounds, emphasizing on different atomic-scale processes and their implications on the macroscopic properties of materials. The main research interest include: surface concentration profiles, surface segregation, surface energy and stress, atomic-scale energetics, mechanical properties, chemical reactivity, resistance to oxidation, thin oxide films, surface reconstructions on compound semiconductor surfaces, nano-structures on surfaces and analysis of experimental data obtained by spectroscopic and microscopic methods.

Core competence

Computational simulation of the properties of alloys and compound semiconductors using first-principles methods.

Possible utilization of the results

- | | | | |
|----------------------------|--------------------------------------|-------------------------|-----------------------------------|
| √ Chemical industry | · Forest industry | · Biomaterial companies | · Plastics and polymers |
| · Food industry | √ Pharma / Medical | · Ceramic industry | √ Sensors |
| √ Metal industry | · Building industry | · Diagnostics | √ Research & Metrology |
| · Energy | · ICT & Electronics & Semiconductors | · Characterization | √ Safety |

Applications areas

- Surface finishing and corrosion protection of alloy surfaces.
- Compound semiconductor materials design.
- Alloy design.

Fundamental research

- Effect of atomic-scale phenomena on materials properties.

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Materials Research Laboratory; Materials Physics; Experimental section

Professor Kalevi Kokko, personnel 10

Main research topics

- Research and development of crystalline insulators (e.g. oxides) films on semiconductor substrates.
- Research and development of GaInAsN materials for efficient solar cells.
- Growth of InN semiconductor layer on silicon substrates.
- Oxidation and metal adsorption on semiconductor on substrates.

General introduction and special knowhow

The growth (manufacturing) and characterization of novel thin films which are potential materials of improved devices based on established semiconductor substrates. The novelty of these thin films prepared arises from the crystalline form of the film and /or its new chemical composition. The preparation methods of the materials are based on the vacuum technology, and the characterization expertise includes photoelectron spectroscopy (also synchrotron-radiation based one), scanning tunneling microscopy, and diffraction probes.

Core competence

The growth and characterization of novel well-defined thin films on various semiconductor substrates.

Possible utilization of the results

- | | | | |
|---------------------|---|-------------------------|-------------------------|
| - Chemical industry | - Forest industry | - Biomaterial companies | - Plastics and polymers |
| - Food industry | - Pharma / Medical | - Ceramic industry | ✓ Sensors |
| - Metal industry | - Building industry | - Diagnostics | - Research & Metrology |
| ✓ Energy | ✓ ICT & Electronics & Semiconductors | - Characterization | - Safety |

Applications areas

- Electronics: new materials and properties can be united with the established semiconductor-based technology, e.g., improved transistor.
- Optoelectronics: development of efficient multijunction solar cells.
- Sensor technology based on changes in surface properties.

Fundamental research

- Preparation of new well-defined materials and discovering their properties.

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Materials Research Laboratory; Materials Research

Professor Edwin Kukk, personnel 10

Main research topics

- Electronic structure and nuclear dynamics of clusters and molecules.
- Layered systems and atomic diffusion by High Kinetic Energy Systems.
- Nanoscale structures of minerals.
- Applied surface science for dental materials etc.

General introduction and special knowhow

Synchrotron radiation instrumentation; Surface composition and structure investigations; Advanced spectroscopic techniques; Spectral analysis tools.

Core competence

Electron, ion and coincidence spectroscopies using synchrotron radiation; Electronic structure of materials; Molecular modelling; Surface analysis.

Possible utilization of the results

- | | | | |
|---------------------|--------------------------------------|-------------------------|-----------------------------------|
| · Chemical industry | · Forest industry | · Biomaterial companies | · Plastics and polymers |
| · Food industry | √ Pharma / Medical | · Ceramic industry | √ Sensors |
| · Metal industry | · Building industry | · Diagnostics | √ Research & Metrology |
| · Energy | · ICT & Electronics & Semiconductors | · Characterization | · Safety |

Applications areas

- Development of analysis instrumentation.
- Improvement of surface or interface properties of paints, welds, composites, dental filling.
- Problem-solving for industrial production- faulty components and coating.

Fundamental research

- Understanding the process due to the absorption of light in molecules, nanoparticles and surfaces.

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Laboratory of Materials Chemistry and Chemical Analysis; Materials Chemistry

Professor Carita Kvarnström, personnel 7

Main research topics

- Organic materials (i. e. conducting polymers, fullerenes) for several applications.
- Reduced graphene oxide characterization and application.
- Chiral conducting polymers, donor-acceptor polymers and redox active conducting polymers.
- Ionic liquids and their application in carbon materials.

General introduction and special knowhow

Synthesis (mostly electrosynthesis) and characterization of organic electroactive materials like functionalized conducting polymers (redox active, chiral or low band gap n- and p-type polymers), derivarized fullerenes with self-ordering properties or complexing properties, graphene oxide and reduced graphene oxide films. Characterization of the opto-electronic properties of the organic materials. Simultaneous recording of electrochemical and spectroscopical parameters so called in situ spectro-electrochemical measurements in the Uv-vis, FTIR and Raman spectral region.

Core competence

Synthesis and characterization of organic electroactive materials, spectroelectrochemistry (i.e. in situ FTIR, UV-vis and Raman (NMR) spectroscopy), thin film production and characterization.

Possible utilization of the results

- | | | | |
|----------------------------|---|--------------------------------|--------------------------------|
| ✓ Chemical industry | · Forest industry | ✓ Biomaterial companies | ✓ Plastics and polymers |
| · Food industry | · Pharma / Medical | · Ceramic industry | ✓ Sensors |
| · Metal industry | · Building industry | · Diagnostics | · Research & Metrology |
| ✓ Energy | ✓ ICT & Electronics & Semiconductors | · Characterization | · Safety |

Applications areas

- Organic electroactive materials can be applied as active layers in organic solar cells as parts in sensors, transistors, LED:s or in memory devices.
- Reduced graphene oxide thin films can be applied in optoelectronic devices or as tools in bioimaging.
- Organic acceptor-donor material can be applied in ambipolar transistors.

Fundamental research

- Application of fullerenes and organic electroactive polymers as materials for the construction of new electronic devices depend on a thorough understanding of their electrochemistry, molecular structure and charge transfer mechanism. In our research group the focus lies on such a thorough materials characterization by combination of electrochemical and spectroscopic techniques.

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Laboratory of Materials Research and Chemical Analysis; Functional Materials and Thin Films

Professor Jukka Lukkari, personnel 5

Main research topics

- Structure and properties of polyelectrolyte multilayers and mechanisms of their build-up.
- Functional ultrathin films.
- Nanomaterials (nanotubes, nanoparticles, graphene) and their incorporation into ultrathin films.
- Conducting polymers.

General introduction and special knowhow

Preparation and characterisation of functional (esp. electroactive and conducting) materials, especially nanomaterials, and their ultra thin films. Electrical, spectroscopic and mechanical properties of the films, especially in situ (under liquid). Film preparation by successive layer-by-layer self-assembly or spraying. Polyelectrolyte multilayers in general.

Core competence

Electrochemical, spectral and mechanical characterisation in situ, preparation of ultrathin layer-by-layer films.

Possible utilization of the results

- | | | | |
|------------------------|--------------------------------------|--------------------------------|--------------------------------|
| · Chemical industry | · Forest industry | √ Biomaterial companies | √ Plastics and polymers |
| √ Food industry | √ Pharma / Medical | · Ceramic industry | · Sensors |
| · Metal industry | · Building industry | · Diagnostics | · Research & Metrology |
| √ Energy | · ICT & Electronics & Semiconductors | · Characterization | · Safety |

Applications areas

- Sensors.
- Solar cells.
- Biocompatibility.

Fundamental research

- Film build-up mechanisms, structure-property relations.

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Laboratory of Industrial Physics; Electrostatics

Adjunct Professor Matti Murtomaa, personnel 3

Main research topics

- Tailored instrument design and manufacture.
- Aerosol electrostatics.
- Static electricity in process industry, especially powders and solids.
- Production of novel drug particles using electrostatic atomization.

General introduction and special knowhow

Electrostatics research has been carried out in the Department of Physics and Astronomy since 1996. Research topics cover a wide range of different disciplines. The topics vary from pharmaceutical aerosols to paper and printing industry. Common denominator in these studies has traditionally been problem solving and instrumentation. Static electricity can cause different problems such as electrical malfunctions, processing difficulties, adhesion and sticking, dusting, etc. In the group, the problems are assessed using wide array of electrostatic instruments, both commercial and self-made. Long history in the area and good international contacts provide a background for successful research.

Core competence

We have a deep understanding of electrostatic phenomena. This can be used when problems caused by charging need to be tackled. Also, electric fields and forces can be exploited in many applications.

Possible utilization of the results

- | | | | |
|----------------------------|---|---------------------------|-----------------------------------|
| √ Chemical industry | √ Forest industry | · Biomaterial companies | √ Plastics and polymers |
| √ Food industry | √ Pharma / Medical | √ Ceramic industry | √ Sensors |
| · Metal industry | · Building industry | · Diagnostics | √ Research & Metrology |
| · Energy | √ ICT & Electronics & Semiconductors | √ Characterization | √ Safety |

Applications areas

- Problem solving. Determination of the origin of static charge and application of counter measures.
- Instrumentation. On-line instrumentation for process control and monitoring process industry.
- Electro spraying. Controlled generation of uniform droplets for liquid dispensing and particle production.

Fundamental research

- Fundamental physical explanation for charge transfer between insulators.

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Wihuri Physical Laboratory; Magnetism and Superconductivity

Professor Petriina Paturi, personnel 6

Main research topics

- Measurements of magnetic properties.
- Modelling flux pinning in superconductors.
- Process of magnetoresistance in complex oxide films.
- Spintronic devices with complex oxide thin films.

General introduction and special knowhow

The magnetism and superconductivity group in the Wihuri Physical Laboratory has excellent facilities on determining magnetic properties of materials at a wide temperature and magnetic field range. Our own research concentrates on complex oxide magnetism and high temperature superconductivity. We prepare thin oxide films with nanoscale structural manipulation and analyze structural, electrical and magnetic analysis of the samples. Also we model the flux pinning in superconductors and prepare spintronic devices with complex oxide thin films.

Core competence

Measurements and analysis of magnetic properties of materials.

Possible utilization of the results

- | | | | |
|---------------------|--------------------------------------|-------------------------|-------------------------|
| · Chemical industry | · Forest industry | √ Biomaterial companies | · Plastics and polymers |
| · Food industry | · Pharma / Medical | · Ceramic industry | √ Sensors |
| √ Metal industry | · Building industry | · Diagnostics | √ Research & Metrology |
| √ Energy | √ ICT & Electronics & Semiconductors | · Characterization | · Safety |

Applications areas

- Energy applications of superconductivity.
- Spintronic devices.
- Permanent magnets.

Fundamental research

- Complex oxide magnetism and high temperature superconductivity. Preparation of thin films and structural, electrical and magnetic analysis of samples. Nanoscale manipulation of film structure to enhance magnetic flux pinning. Modelling flux pinning in superconductors.

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Laboratory of Electron Microscopy

Laboratory Manager Markus Peurla, personnel 4

Main research topics

- Organic and inorganic materials: structural characterization of nanoparticles, polymers, etc.
- Biomedical specimens: tissue pieces, cells, bacteria, viruses, macromolecules, etc.

General introduction and special knowhow

Laboratory of Electron Microscopy in University of Turku offers full service including consultation in the planning of experiments, specimen preparation, microscopic examination, and image interpretation for anybody, who needs these facilities in their research. If detailed structural characterization at nanometer resolution are required, micro- and nanostructural imaging combined with molecular analysis is the method of choice, applicable to samples of nanoparticles, polymers, tissues, cells, bacteria, viruses, macromolecules and other related materials.

Core competence

Research planning, specimen preparation, microscopy, and image interpretation in the field of light and electron microscopy.

Possible utilization of the results

- | | | | |
|---------------------|--------------------------------------|-------------------------|-------------------------|
| √ Chemical industry | √ Forest industry | √ Biomaterial companies | √ Plastics and polymers |
| √ Food industry | √ Pharma / Medical | √ Ceramic industry | √ Sensors |
| √ Metal industry | √ Building industry | √ Diagnostics | √ Research & Metrology |
| · Energy | √ ICT & Electronics & Semiconductors | √ Characterization | √ Safety |

Applications areas

- Structural characterization and imaging of organic and inorganic materials at nanometer resolution.
- Applications fields are fundamental research, product development, and monitoring of environmental and productions processes.
- Characterization of the ultrastructure of biological and medical specimens.

Fundamental research

- Characterization of nanoparticles, organic and inorganic matrices, polymers and related materials.

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University of Turku

Faculty of Mathematics and Natural Sciences
Department of Information Technology

Microelectronics Laboratory

Professor Risto Punkkinen, personnel 3

Main research topics

- Fabrication of particle detectors used for space and earth applications.
- Micro and nanotechnology: Production of superlattices of Si/SiO₂, where faint light from silicon have been detected. Origin: Si/SiO₂ structures (size some nm). Manufacture of light emitting diodes. Is silicon laser possible?
- Measuring technology: characterization of InAs structures and hydrogen sensitive TiO₂.

General introduction and special knowhow

Manufacturing and processing of silicon: Multichamber semiconductor processing facility (Basic processes: CVD, etching, sputtering), thermal oxidation, lithography, wet chemistry. All in clean room area about 95 m².

- Fabrication of radiation detectors (large area Si-based diodes)
- Special measuring technology

Core competence

Designing and Production of special Si devices, measuring technology.

Possible utilization of the results

- | | | | |
|---------------------|---|---------------------------|-----------------------------------|
| · Chemical industry | · Forest industry | · Biomaterial companies | · Plastics and polymers |
| · Food industry | · Pharma / Medical | · Ceramic industry | √ Sensors |
| · Metal industry | · Building industry | · Diagnostics | √ Research & Metrology |
| · Energy | √ ICT & Electronics & Semiconductors | √ Characterization | · Safety |

Applications areas

- Radiation detection on earth and in space (e.g. EPT Energetic particle telescope/ESA and RADMON for the first Finnish nanosatellite Aalto-1B).

Fundamental research

- Construction of special silicon diodes (final goal Si laser).

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Laboratory of Industrial Physics; Porous Silicon Research Group

Adjunct professor Jarno Salonen, personnel 7

Main research topics

- Drug delivery applications of nanoporous materials.
- Gas sensor application of nanoporous materials.
- Drug stability, compatibility and polymorphism.
- Novel calorimetry methods.

General introduction and special knowhow

Industrial physics has been focused on the use of thermoanalytical and x-ray diffraction methods in material research. It has collaborated with national and international pharmaceutical industry for decades already. Laboratory has also expertise research of nanoporous materials in drug delivery and gas sensing applications.

Core competence

Nanoporous drug carriers.

Possible utilization of the results

- | | | | |
|----------------------------|--------------------------------------|--------------------------------|-------------------------|
| √ Chemical industry | √ Forest industry | √ Biomaterial companies | · Plastics and polymers |
| · Food industry | √ Pharma / Medical | · Ceramic industry | √ Sensors |
| · Metal industry | · Building industry | √ Diagnostics | · Research & Metrology |
| · Energy | · ICT & Electronics & Semiconductors | √ Characterization | · Safety |

Applications areas

- Pharmaceuticals.
- Diagnostics and chemical sensing.
- Gas sensors.

Fundamental research

- Development of novel XRD and thermoanalytical methods.

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Fibre-Reinforced Composites Research Group

Professor Pekka Vallittu, personnel 31

Main research topics

- Non-metallic medical and dental devices.
- Composites made of fibers / particulate fillers and polymer systems.
- Zirconia.
- Biomimetics of bone.

General introduction and special knowhow

Research group has special knowhow in designing and characterizing of new types of composites with special emphasis of fiber-reinforced materials. There is knowhow of reinforcing fibers of various types, their sizing and incorporation to the resin matrix systems of various kinds. Knowhow relates to the increasing use of non-metallic medical and dental devices.

Core competence

Core competence of the research group is in basic research of monomer systems and polymerization of thermoset resins which could be utilized as medical and dental biomaterials.

Possible utilization of the results

- Chemical industry	- Forest industry	√ Biomaterial companies	√ Plastics and polymers
- Food industry	√ Pharma / Medical	√ Ceramic industry	- Sensors
- Metal industry	- Building industry	- Diagnostics	- Research & Metrology
- Energy	- ICT & Electronics & Semiconductors	√ Characterization	- Safety

Applications areas

- Dental restorations (fillings, fixed prostheses, anchoring devices).
- Implants (head- and neck region, orthopaedics).
- Bone filling cements and tissue engineering scaffolds.

Fundamental research

- Biomimetics of natural composite structures of bone and tooth structures by synthetic materials.

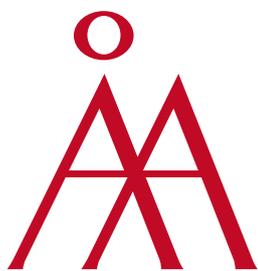
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Åbo Akademi

Laboratory of Fibre and Cellulose Technology (FCT)

Professor Pedro Fardim, personnel 18

Main research topics

- Biomass Engineering to materials, chemicals and fuels.
- Sustainable processes, clean energy and environment.
- Natural fibres, bioparticles, bioplastics, and biocomposites.
- Nanotechnology in biomass engineering: molecular and supramolecular functionalisation.

General introduction and special knowhow

Biomass Engineering is our common theme at FCT. We investigate biomass (hardwoods, softwoods, and annual plants) for fibre and biopolymer-based materials, specialty chemicals and clean energy. Engineering include processing of biomass, i.e. chemical and mechanical pre-treatments, fractionation, functionalisation, bleaching, regeneration, low-consistency refining and preparation of biocomposites and bioparticles. Our research set-up makes it possible to investigate the whole value chain from raw material through processing until post-treatment and performance of the final product. Our special know-how is to combine topochemistry and biomass engineering, i.e. the understanding and control of functional properties in a 3D perspective for disassembly and reassembly of bio-based materials. We use natural fibres and biopolymers as material on which we perform physical and chemical modification, shaping and advanced characterization.

Core competence

Fibres from biomass, biopolymer dissolution and regeneration, chemical and mechanical functionalisation of biomass, biocomposites, chemistry and engineering in pulping and bleaching technology.

Possible utilization of the results

✓ Chemical industry	✓ Forest industry	✓ Biomaterial companies	✓ Plastics and polymers
✓ Food industry	✓ Pharma / Medical	· Ceramic industry	✓ Sensors
· Metal industry	✓ Building industry	✓ Diagnostics	· Research & Metrology
✓ Energy	· ICT & Electronics & Semiconductors	· Characterization	· Safety

Applications areas

- Pulp and paper industries: biorefinery, pulping and bleaching, tissue and packaging.
- Cellulose based industries: fibres, films, casings, particles and derivatives.
- Bioplastic industries and biocomposite industries: bionanocomposites of high performance.
- Pharmaceutical industry: controlled release and tissue healing.
- Chemical and food industry: bio-based chemicals and polymers.

Fundamental research

- Topochemistry of biomass, surface chemistry, nano-analysis and spectrometry.
- Supramolecular chemistry and interactions at nanoscale.
- Modelling and multivariate data analysis.

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Laboratory of Inorganic Chemistry

Professor Mikko Hupa, personnel 40

Main research topics

- Future fuels for sustainable energy conversion (biofuels).
- Corrosion of metals and ceramics at high temperatures.
- Bioactive glasses with controlled reaction kinetics.
- Fuel cell electrode materials.

General introduction and special knowhow

Combustion chemistry, CFD modeling, chemical thermodynamics, biofuels, inorganic high temperature materials, glasses and ceramics, bioactive glasses, fuel cell electrode materials.

Core competence

Inorganic high temperature processes and materials.

Possible utilization of the results

- | | | | |
|----------------------------|---|--------------------------------|-----------------------------------|
| √ Chemical industry | √ Forest industry | √ Biomaterial companies | · Plastics and polymers |
| · Food industry | √ Pharma / Medical | √ Ceramic industry | √ Sensors |
| √ Metal industry | · Building industry | · Diagnostics | √ Research & Metrology |
| √ Energy | √ ICT & Electronics & Semiconductors | √ Characterization | · Safety |

Applications areas

- Boiler manufacturers.
- Ceramic and glass industry.
- Companies manufacturing implant materials for medicine.

Fundamental research

- High temperature reaction thermodynamics and kinetics, dissolution rate of materials.

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Laboratory of Analytical Chemistry

Professor Ari Ivaska, personnel 24

Main research topics

- Electroactive materials.
- Chemical sensors.
- Environmental and industrial analysis.
- Modelling of the responses of chemical sensors.

General introduction and special knowhow

Electroanalytical chemistry. Chemical analysis of industrial, environmental and clinical samples. Development of chemical sensors and their application in assay work. Combination of spectroscopic and electrochemical techniques.

Core competence

Chemical sensors and spectroelectrochemical methods.

Possible utilization of the results

- | | | | |
|----------------------------|---|--------------------------------|--------------------------------|
| √ Chemical industry | √ Forest industry | √ Biomaterial companies | √ Plastics and polymers |
| √ Food industry | √ Pharma / Medical | - Ceramic industry | √ Sensors |
| √ Metal industry | - Building industry | √ Diagnostics | - Research & Metrology |
| √ Energy | √ ICT & Electronics & Semiconductors | √ Characterization | √ Safety |

Applications areas

- Clinical analysis.
- Environmental analysis.
- Industrial analysis.

Fundamental research

- Characterization of electroactive materials for chemical sensors.

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Mössbauer Spectroscopy

Professor Johan Lindén, personnel 2

Main research topics

- Fe-pnictide superconductivity.
- Charge-ordered and valence-mixed perovskites.
- Magnetically ordered solids.

General introduction and special knowhow

Mössbauer spectroscopy, solid state physics, magnetism, superconductivity, perovskite phases, magnetoresistivity.

Core competence

Mössbauer spectroscopy, magnetic measurements.

Possible utilization of the results

- | | | | |
|----------------------------|--------------------------------------|---------------------------|-------------------------|
| √ Chemical industry | · Forest industry | · Biomaterial companies | · Plastics and polymers |
| √ Food industry | √ Pharma / Medical | √ Ceramic industry | · Sensors |
| √ Metal industry | √ Building industry | · Diagnostics | · Research & Metrology |
| √ Energy | · ICT & Electronics & Semiconductors | · Characterization | · Safety |

Applications areas

- Useful for analysis of iron impurity phases and valence states of Fe.
- For analysis of magnetism in various solid state material.
- For identification of lattice sites occupied by Fe.

Fundamental research

- Solid state physics: characterization of new materials.

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Laboratory of Industrial Chemistry and Reaction Engineering

Professor Dmitry Murzin and Academy Professor Tapio Salmi, personnel 45

Main research topics

- Heterogeneous catalysis.
- Process technology.
- Reaction engineering.
- Biomass transformations.

General introduction and special knowhow

Chemical technology. Chemical reaction engineering, catalytic materials.

Core competence

Catalyst preparation, catalyst characterization, kinetic modelling, reaction modelling.

Possible utilization of the results

- | | | | |
|----------------------------|--------------------------------------|---------------------------|-------------------------|
| √ Chemical industry | √ Forest industry | - Biomaterial companies | - Plastics and polymers |
| √ Food industry | - Pharma / Medical | - Ceramic industry | - Sensors |
| √ Metal industry | - Building industry | - Diagnostics | - Research & Metrology |
| - Energy | - ICT & Electronics & Semiconductors | √ Characterization | - Safety |

Applications areas

- Heterogeneous catalysis.
- Biomass valorization.

Fundamental research

- Understanding influence of catalyst properties on the nanometer level on performance.

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Laboratory of Physical Chemistry

Professor Jouko Peltonen, personnel 26

Main research topics

- Materials for printed functionality including ink formulations, processing and characterization.
- Nanostructured metal oxide materials as biomolecular separation media and sensors.
- Nanomaterial synthesis and functionalization for drug delivery and bioimaging.
- Inorganic polymer coatings and sol-gel technology.

General introduction and special knowhow

Laboratory of Physical Chemistry at Åbo Akademi University has long traditions in surface and colloid chemistry starting from 1930's. Recently, the laboratory has specialized in materials research with several focus areas: self-assembled systems and organized monomolecular films, hierarchical structures, functional porous nano-materials, functional surfaces and interfaces, thermodynamic modeling of materials, sol-gel processing, biomaterials, drug development and diagnostics. The laboratory is equipped with a versatile instrument park enabling characterization of the crystallographic, topographic, spectroscopic, solution chemical and thermodynamic properties of materials.

Core competence

Synthesis of colloidal and nanoparticles, versatile characterization of materials (rheology, crystallography, microscopy, sorption, wetting), surface science, sol-gel science.

Possible utilization of the results

✓ Chemical industry	✓ Forest industry	✓ Biomaterial companies	✓ Plastics and polymers
✓ Food industry	✓ Pharma / Medical	✓ Ceramic industry	✓ Sensors
✓ Metal industry	✓ Building industry	✓ Diagnostics	✓ Research & Metrology
✓ Energy	✓ ICT & Electronics & Semiconductors	✓ Characterization	- Safety

Applications areas

- New functional materials can be applied in printed electronics, medical and environmental diagnostics and energy industry (e.g. solar cells).
- Targeting cancer cells by design of mesoporous metal oxides, and printable array platforms for cell studies, aim for therapeutic applications.
- Development of printable pharmaceutical oral dosage forms, i.e. medicines, has numerous potential applications in pharmaceutical industry.

Fundamental research

- Synthesis, chemical composition, topography and functional properties of colloidal and nanomaterials.

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Drug-Delivery and Pharmaceutical Technology and Research Group

Professor Niklas Sandler, personnel 4

Main research topics

- Printing technology in drug manufacturing.
- Process behaviour of pharmaceutical powders.
- Novel nanoscale drug delivery concepts using new host materials.
- Process analytical technologies in powder handling processes.

General introduction and special knowhow

The goal of the DDPT research group is to study and develop novel drug delivery systems for small and large bioactive molecules. The aim is to explore new technologies in drug manufacturing. In this context, the group is investigating the use of printing technologies in fabrication of drug delivery systems and their possibilities in personalised dosing of medicines. An important aspect is the development and research of new carrier materials for printed substances and drug formulations. An essential part of all activities is the physicochemical characterisation of raw materials, intermediates and the final dosage forms including their surface, solid-state and drug release properties.

Core competence

Physical characterisation of pharmaceutical systems (active substances, excipients and final products). Drug formulation and process research. Experimental design and multivariate modelling.

Possible utilization of the results

√ Chemical industry	√ Forest industry	√ Biomaterial companies	√ Plastics and polymers
√ Food industry	√ Pharma / Medical	- Ceramic industry	- Sensors
- Metal industry	- Building industry	√ Diagnostics	- Research & Metrology
- Energy	- ICT & Electronics & Semiconductors	√ Characterization	- Safety

Applications areas

- Novel drug delivery concepts.
- Increased understanding material characteristics and behavior during processing.
- Functionality and behaviour of drug delivery systems.

Fundamental research

- Physical characterisation of materials and on different levels (molecular, particle, bulk) systems.

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Laboratory of Paper Coating and Converting

Professor Martti Toivakka, personnel 20

Main research topics

- Large area nanoparticle coatings.
- Paper electronics (printed electronics on paper).
- Complex and porous composites.
- Printing as a fabrication method for functional materials.

General introduction and special knowhow

Surface engineering and coating of natural fiber-based products and composites for various end-uses. Ultra thin coatings, printing technologies and roll-to-roll processing. Porous material characterization and simulation. Composite materials from natural resources. Rheology and processability of complex materials.

Core competence

Pigment coating and surface sizing, novel surface treatment and printing processes, composite and porous material characterization, optics of complex materials, modeling and numerical simulation.

Possible utilization of the results

√ Chemical industry	√ Forest industry	√ Biomaterial companies	√ Plastics and polymers
√ Food industry	√ Pharma / Medical	√ Ceramic industry	- Sensors
- Metal industry	√ Building industry	- Diagnostics	- Research & Metrology
- Energy	- ICT & Electronics & Semiconductors	√ Characterization	- Safety

Applications areas

- Smart packaging and sensors.
- Paper and board for graphic communication and packaging.
- Environmentally friendly composites.

Fundamental research

- Porous structures, composite materials, nano optics, microfluidics.

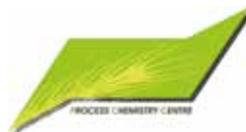
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Laboratory of Wood and Paper Chemistry

Professor Stefan Willför, personnel 22-30

Main research topics

- Wood and Fibre Chemistry.
- Papermaking and Chemistry.
- Biorefinery.
- Tools and Techniques.

General introduction and special knowhow

We are working towards molecular-level understanding of biorefinery processes and products there of creating the base for renewal of the forest and biorefinery industries. Our laboratory's technology expertise can also be formulated as: molecular process technology for the forest and biorefinery industry cluster. To achieve our goals we develop and apply state-of-art analytical methodology and work in close contact with the industry. We also have a wide spread contact network with research centres, universities, SHOKs and industrial laboratories.

Core competence

Recovery, characterization, modification and utilization of wood and plant compounds. Papermaking chemistry and wet-end interactions. Development of novel analytical techniques, e.g. flow cytometry.

Possible utilization of the results

√ Chemical industry	√ Forest industry	√ Biomaterial companies	√ Plastics and polymers
√ Food industry	√ Pharma / Medical	- Ceramic industry	- Sensors
- Metal industry	√ Building industry	- Diagnostics	√ Research & Metrology
√ Energy	- ICT & Electronics & Semiconductors	- Characterization	- Safety

Applications areas

- Novel product development for the industry.

Fundamental research

- Fundamental research at academy and industry.

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Laboratory of Physics; Organic Electronics

Professor Ronald Österbacka, personnel 12

Main research topics

- Large area organic electronics.
- Electro-optical properties in disordered organic materials.
- Charge transport and recombination in organic solar cells.
- Electro-optical properties of new materials.

General introduction and special knowhow

Solution processed electronics, electronic properties of new materials, printed functionality, printed electronics, sensors and devices.

Core competence

Electro-optical properties of disordered organic materials, novel measurement techniques, photomodulation spectroscopies, extraction current transients, modelling, novel organic electronic components.

Possible utilization of the results

- | | | | |
|----------------------------|---|--------------------------------|--------------------------------|
| √ Chemical industry | √ Forest industry | √ Biomaterial companies | √ Plastics and polymers |
| √ Food industry | √ Pharma / Medical | - Ceramic industry | √ Sensors |
| - Metal industry | - Building industry | √ Diagnostics | - Research & Metrology |
| √ Energy | √ ICT & Electronics & Semiconductors | √ Characterization | - Safety |

Applications areas

- Printed and large area electronics and functionality.
- Materials characterization.
- Solar cells.

Fundamental research

- Charge transport and recombination, electronic properties of new materials

Contact information

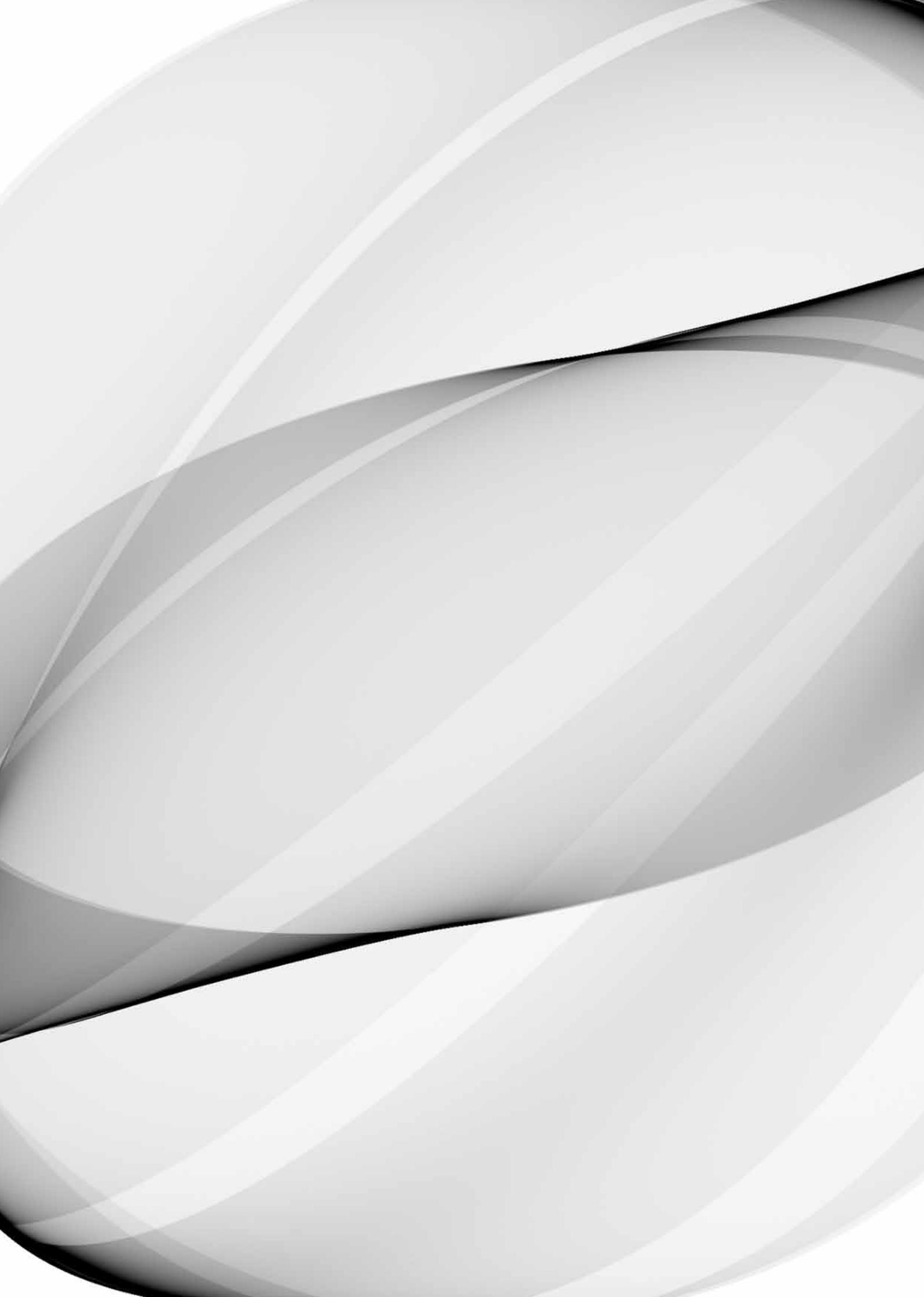
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Group leader	Chemical Industry	Forrest Industry	Food Industry	Metal Industry	Energy	Pharma / Medical	Building Industry	ICT & Electronics & Semiconductors	Biomaterial Companies	Ceramic Industry	Diagnostics	Characterization	Plastics and Polymers	Sensors	Research and Metrology	Safety
Kurt Gloos								•						•	•	
Jorma Hölsä	•		•		•	•	•	•	•	•	•		•	•		•
Kalevi Kokko 1	•			•		•								•	•	•
Kalevi Kokko 2					•			•						•		
Edwin Kukk						•								•	•	
Carita Kvarnström	•				•			•	•				•	•		
Jukka Lukkari			•		•	•			•				•			
Matti Murtomaa	•	•	•			•		•		•		•	•	•	•	•
Petriina Paturi				•	•			•	•					•	•	
Markus Peurla	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•
Risto Punkkinen								•				•		•	•	
Jarno Salonen	•	•				•			•		•	•		•		
Pekka Vallittu						•			•	•		•	•			
Pedro Fardim	•	•	•		•	•	•		•		•		•	•		
Mikko Hupa	•	•		•	•	•		•	•	•		•		•	•	
Ari Ivaska	•	•	•	•	•	•		•	•		•	•	•	•		•
Johan Lindén	•		•	•	•	•	•			•						
Dmitry Murzin	•	•	•	•								•				
Jouko Peltonen	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
Niklas Sandler	•	•	•			•			•		•	•	•			
Martti Toivakka	•	•	•			•	•		•	•		•	•			
Stefan Willför	•	•	•		•	•	•		•				•		•	
Ronald Österbacka	•	•	•		•	•		•	•		•	•	•	•		



Materials science is an interdisciplinary field that combines chemistry and physics for innovative material development. Materials science researchers investigate the relationship between the structure of materials on atomic and molecular levels and their properties on a macroscopic level. Nanotechnology has brought yet another dimension to the research and development work of materials. With this new dimension, the applications for so-called traditional materials have further increased.

Materials research in Turku has long traditions. Today, the primary results are in advanced technologies and the development of highly intelligent materials with specific functionalities for applications in a wide range of industries. In Turku, both the University of Turku and Åbo Akademi University provide a broad platform for forefront research within the fields of materials science and nanotechnology. Research groups at the two universities are presented in this booklet.

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