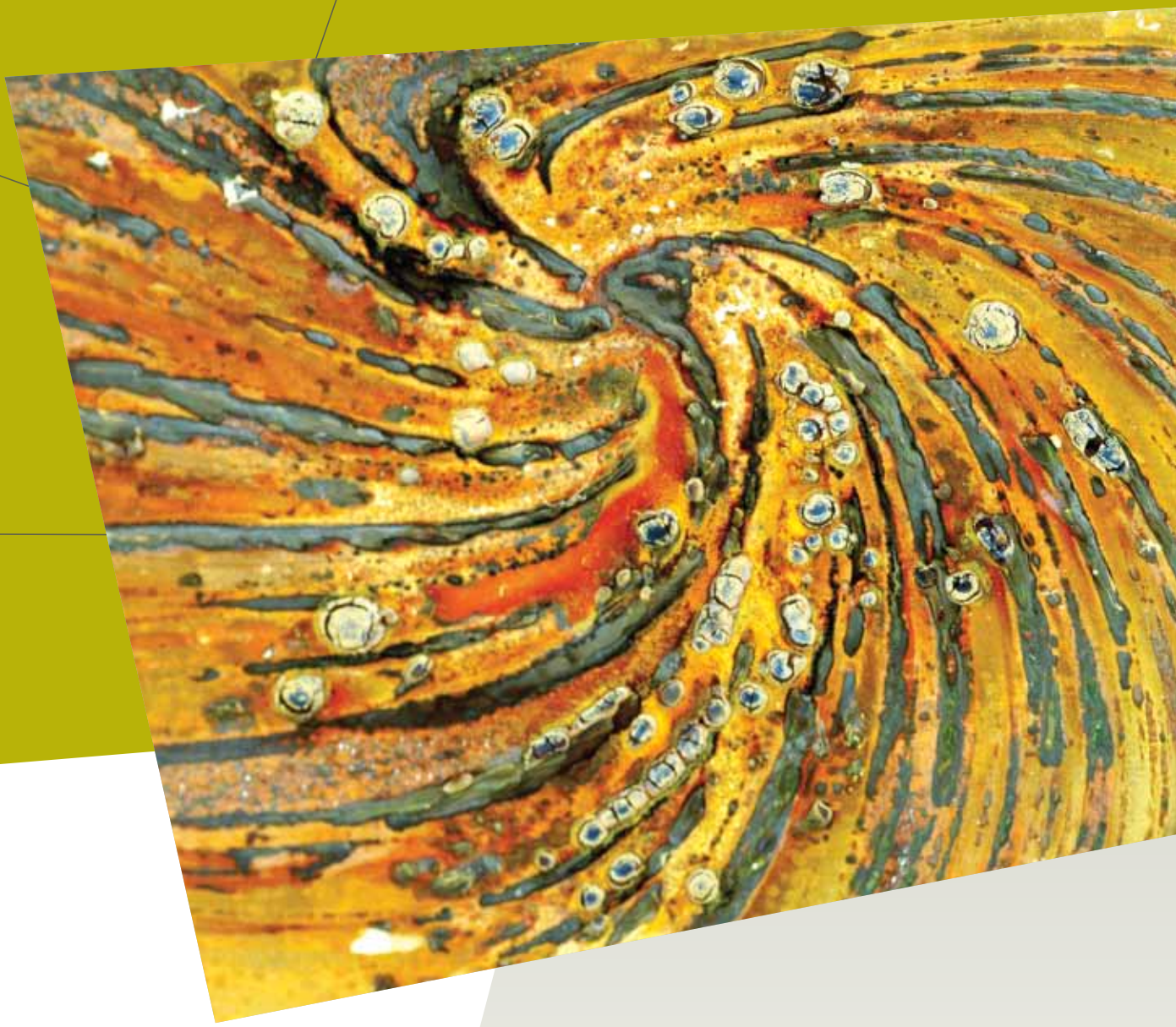

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Brussel

Materials Research
2010

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Materials Research at the Vrije Universiteit Brussel

The availability of suitable materials is fundamental to the development of successful technological innovations. During recent years, there has been an explosion in the development of new materials. Nanotechnology is taking materials science into a new dimension, leading to properties and performance never before imagined. Control over the nanostructure of materials allows the creation of a generation of products that best fulfill the extreme properties required by different technological innovations. Materials Research programs are driven by important economic sectors, such as materials production, transportation, civil engineering, the chemical industry, the energy and power industries, medical devices, microelectronics and the sport and leisure industry. Creating new materials requires several research domains, and these innovations occur at the boundary between these disciplines. Therefore, various groups at the Vrije Universiteit Brussel are active in Materials Research, each of them having contacts with a wide spectrum of different industries and with many research institutes all over the world.

From this point of view, Materials Research at the Vrije Universiteit Brussel can be split up into various themes:

Understanding of the properties of materials

Fundamental understanding of the mechanics and physics of structural and functional materials at different length scales is being researched with a view to the accurate prediction of properties in relation to the underlying multi-material microstructure. Structure, processing and property relationships are characterized for polymers, inorganic materials and composites. Key trends are the increasing importance of miniaturization, better control of mechanical and functional properties, functional integration, predictability of failure, and reliability.

Processing technologies of functional materials

Research is performed to gain fundamental insight and understanding into the processing and assembling of functional materials at micro, meso and nano length scales. This leads to and guarantees a required level of performance reliability in the resulting products. Two types of applications are considered: microelectronics and photonics. One of the key factors of our success is having access to an entire technology chain comprising modelling, measurement, and rapid-prototyping of different types of 3-D micro-optical components in a variety of materials. And this even before considering assembling the specialty components into practical proof-of-concept demonstrators.

Surface engineering—durability and prediction

More and more materials are regarded as hybrid systems with specific design targeting bulk properties and advanced surface properties. Research focuses on the modification and quantitative characterization of materials' surfaces. Durability is the keyword here. Energy and materials' conservation during all stages of the lifetime of constructions and devices is being aimed at. Therefore the relationship between microstructure and surface properties to optimize the corrosion performance, the development of new and improved protective coatings, and the behavior of the interface between the substrate and the often multiple coating-layers is being studied.

Characterization of materials

The Vrije Universiteit Brussel has a unique infrastructure for the characterization of materials. This infrastructure allows characterization of structure and composition at the nano-level. Various important properties can be monitored.

Materials Research at the Vrije Universiteit Brussel is future-oriented and always on the cutting edge of new developments. The infrastructure and equipment of the university laboratories are continuously updated according to the newest technological evolutions.

Together with 10 major materials producing and materials processing companies (including AGC Flat Glass, Agfa Gevaert, Arcelor-Mittal, Bekaert, Recticel, Solvay, Umicore) and with the support of the Flemish Government, Agoria Vlaanderen and Sirris, the 5 Flemish universities founded the Strategic Initiative Materials 'SIM' in June 2009. VUB materials groups actively participate in this Strategic Research Centre.

In this overview, we invite you to discover the research groups that are involved in Materials Research at the Vrije Universiteit Brussel. For questions concerning their research or collaboration opportunities, you can directly contact the teams concerned. For more information on research valorisation, do not hesitate to contact the Technology Transfer Interface, our vital link between university and industry.

Herman Terryn
Research Group Electrochemical and Surface Engineering

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Acoustics and Vibration Research Group – AVRG

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Group AVRG:	17 people

Keywords

acoustics, vibration, fatigue testing, non-destructive inspection.

Objectives

Central goal is to conduct fundamental and applied research in the broad field of acoustics and vibration, with special emphasis on vibration and fatigue testing, non-destructive inspection, modal analysis, vibration-based structural health monitoring, and optical measurement techniques.

Research orientations

Area 1: Fatigue testing

The Vrije Universiteit Brussel is participating in several international research projects related to the fatigue testing, material testing and design optimisation of airplane components. This research is conducted in close collaboration with ASCO Industries and LMS International.

An aeroplane is a complex system composed of a great number of safety critical components such as slat tracks. Along with safety, weight is another important issue in aircraft design. Our goal is to design and make lighter slat tracks in the future. Therefore, we optimise the design of an existing track of an Airbus A320 based on crack initiation and propagation simulation software. Slat tracks following the new design are tested on our advanced fatigue test rigs. Different materials including stainless steels have been considered.

Area 2: Non-destructive inspection

The use of innovative materials such as composites (Glare, CFRP, GFRP ...) demands new testing and inspection techniques. The field of Nondestructive Testing (NDT) is a very broad, interdisciplinary field that plays a critical role in assuring that structural components and systems perform their function in a reliable and cost effective fashion. NDT technicians and engineers define and implement tests that locate and characterize material conditions and flaws that might otherwise cause planes to crash, reactors to fail, trains

to derail, pipelines to burst, and a variety of less visible, but equally troubling events. These tests are performed in a manner that does not affect the future usefulness of the object or material. In other words, NDT allows parts and materials to be inspected and measured without damaging them. Attention is being paid to in situ Structural Health Monitoring (SHM), which is a new key development, a cost-effective maintenance of high-value assets such as aircraft. SHM technology will be an integral component of an increasing number of future engineering structures.

Equipment & Infrastructure

Fatigue test rig, NDT equipment (ultrasound probes, infrared thermography, scanning laser Doppler vibrometer, digital image correlation ...)

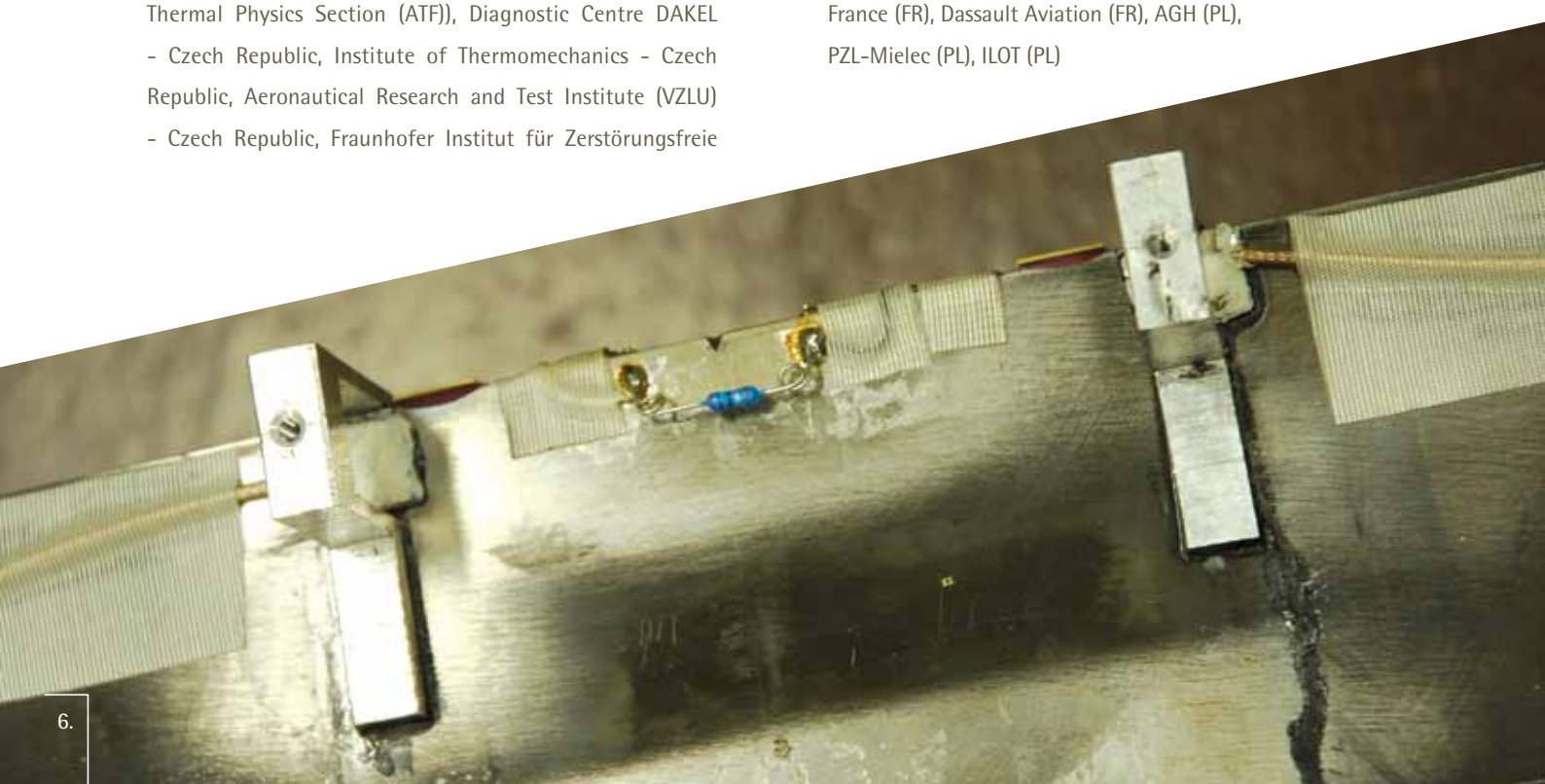
Collaboration

Inter-university & research centres

KULeuven - Belgium (Group of Materials Performance and Nondestructive Evaluation (MTM) / Acoustics and Thermal Physics Section (ATF)), Diagnostic Centre DAKEL - Czech Republic, Institute of Thermomechanics - Czech Republic, Aeronautical Research and Test Institute (VZLU) - Czech Republic, Fraunhofer Institut für Zerstörungsfreie Prüfverfahren (IZFP) - Germany, Politecnico di Torino - Italy, Università di Napoli - Italy, Consejo Superior De Investigaciones Científicas - Spain, The University of Exeter - UK, The University of Bristol - UK, The University of Nottingham - UK, Cranfield University - UK, Riga Technical University (RTU) – Aviation Institute - Latvia, Centro de Tecnologías Aeronáuticas (CTA) - Spain, Universität Leipzig – Department of Solid State Optics and Acoustics (UNL) - Germany

Industrial partners

ASCO Industries (Belgium), LMS International (Belgium), GIP Ultrasons (France), NDT Expert (France), Boeing Research & Technology Europe (Spain), CSM Materialteknik (Sweden), Aisha Partners, Metalogic nv (Belgium), Deutsches Zentrum für Luft- und Raumfahrt (DLR, German Aerospace Center) - Institute of Composite Structures and Adaptive Systems, CEDRAT TECHNOLOGIES SA CED (France), EUROCOPTER - Marseille EUR (France), InSensor A/S (Denmark), Fraunhofer Institute for Manufacturing Technology and Applied Materials Research in Bremen (IFAM – Germany), Brussels Airlines nv (Belgium), Lufthansa Technik (Germany), SOPEMEA (FR), INRIA (Rennes: Sigma2 and Rocquencourt: Metalau) (FR), AIRBUS France (FR), Dassault Aviation (FR), AGH (PL), PZL-Mielec (PL), ILOT (PL)



Applied Physics and Photonics – TONA

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Group TONA: 48 people

Keywords

photons, photonics engineering, micro-optics, data-communication, biophotonics, Bragg-Grating-enhanced Photonic Crystal Fibres (BG-PCFs), nonlinear optics, radiation, microlasers

Objectives

Photonics, **the 'Science-and-Technology-to-Harness-Light'**, is a discipline that involves fundamental research on photons, on light-matter interactions, and on the development of novel technologies and applications based on the unique properties of light. Photonics takes advantage of these unique properties to probe, sense, transmit, process, display and store information, and to accomplish a multitude of original functionalities, which cannot be achieved otherwise. Today it is indispensable to have access to an entire technology chain comprising modelling, measurement, and rapid-prototyping of different types of 3D micro-optical components in a variety of materials, before one can even consider assembling the specialty components into practical proof-of-concept demonstrators. Over the years TONA has successfully set up an in-house micro-optics chain which enabled the research group to stay at the international top in this research domain.

Research orientations

The main research field of TONA is **PHOTONICS ENGINEERING**. Research focuses on the following topics:

The **optical interconnect and datacom team** investigates the opportunities for introducing high-speed optical data communication in information processing systems. Confident with its successes in optical system demonstrators and encouraged by industry-driven research projects, this research team is currently extending its work area to low-cost mass-producible components for fibre-to-the home networks (FTTH) and to optical interconnects at the Printed Circuit Board level (PCB).

The **biophotonics team** is a young TONA team that was recently created. One part of the team aims at designing, modelling, prototyping and demonstrating low-cost manufacturable photonics-based systems for biochemical microanalysis. In most cases these optical-lab-on-a-chip microsystems aim at measuring the absorption spectrum and detecting the weak signal emission of fluorescence-marked molecules that flow in microcapillary systems or in microfluidic channels. The other part of the group focuses on the modelling, prototyping, and characterization of bio-inspired micro-optical components. The future goal here is to analyze the operation of compound insect eyes, to mimic their functionality with in-house micro-fabrication technologies, or to synthesize micro-optical systems with novel functionalities inspired by nature's evolutionary design.

The **micro-optical fibre sensor team** pursues the development of all-fibre solutions for optical sensing applications, based on Bragg-Grating-enhanced Photonic Crystal Fibres (BG-PCFs). The team masters the numerical simulation and design of these novel microphotonic structures, has unique strategic partnership with the Marie Curie University in Lublin (Poland) for PCF manufacturing, and is fully equipped to measure the sensitivities of the developed microsensors to external perturbations such as pressure, strain, temperature, transverse force and bending.

The **nonlinear optics team** is a young and emerging team at TONA. It studies fundamental nonlinear light-matter interactions and it models effects such as the generation of mid-infrared coherent light in optically pumped silicon-based Raman lasers and of super continuum generation in silica and chalcogenide PCFs. On the basis of these models it develops and patents revolutionary concepts such as laser cooling based on Coherent Anti-Stokes Raman Scattering. The team relies heavily on the computer cluster of TONA's modelling and design platform.

The **photonics for radiation and space environments team** has a long standing research experience in studying highly-energetic radiation on a variety of optical, optoelectronic and photonic materials, components and systems. This experience was built in very close collaboration with the Belgian Nuclear Research Centre SCK.CEN and exploits both the cyclotron facility of the Vrije Universiteit Brussel and the irradiation facilities at SCK.CEN. The team's topical field is becoming increasingly important with the growing impact of photonics in space applications (ESA), of high energy physics experiments (CERN), and of future thermonuclear fusion reactors (ITER). At present the team investigates radiation effects on specialty glasses for space-borne lasers and optical instruments, radiation effects on semiconductor materials for photonic devices, and radiation effects on a variety of passive and active microphotonic components.

The **microlaser team** is specialized in theoretical and numerical modelling, and in experimental characterisation of semiconductor lasers. The team focuses on edge emitting lasers and Vertical Cavity Surface Emitting Lasers (VCSELs), the two most widely used types of microlasers in the Information and Communication Technologies (ICT) industry. More in particular it investigates noise in such lasers, as well as the dynamic behaviour of their intensity and polarisation properties for feedback and injection.

The **dynamics in photonics team** studies the physics of photonic metamaterials, new microresonator configurations, and the complexity of the collective dynamic behaviour of coupled microcavities. It also experimentally characterizes the real-life performance of such devices.

Equipment & Infrastructure

The research teams within TONA have access to **5 distinct photonic research and technology platforms:**

- the general photonics laboratories platform, which consists of photonics research labs which feature state-of-the-art high-precision optical and opto-mechanical components, opto-electronic and photonic measurement equipment, lasers, and a variety of high-end optical sources
- a broad spectral laser system, which consists of a combination of high-end scientific-grade laser sources
- a powerful computer cluster equipped with a variety of professional modelling software to support optical modelling and photonic design efforts
- a unique rapid prototyping technology for the fabrication of high aspect ratio plastic micro-optical components, based on Deep Proton Writing: it is set up around TONA's large-scale ion accelerator facility, the same facility is used to investigate the behaviour of optical materials and micro-photonic components in radiation environments
- the micro-optical measurement and nanoinstrumentation facility, which hosts a unique collection of high-end instrumentation for the quantitative characterization of

photonic micro- and nanocomponents and structures, under clean room conditions

Today TONA can make use of the following **unique measurement instruments all accomodated in a class 100 cleanroom to characterize optical materials and photonic demonstrators:**

- Wyko non-contact optical profilometer for measuring the geometrical characteristics and surface roughnesses of micro-optical and micromechanical components
- Atomic force microscope for measuring surface roughnesses and geometrical dimensions of nano- and microstructures
- Dektak stylus profilometer for determining geometrical characteristics and surface roughnesses of micro-optical and micromechanical components
- Twyman-Green interferometer for measuring the sphericity and the radius of curvature of microlenses
- Mach-Zehnder interferometer for the optical characterization of microlenses
- Carl Zeiss microscopes for visual inspection of micro-optical components
- Scatterometer for measuring the light scattering profile in reflection and transmission
- Instrumentation for optical fiber characterization (optical spectrumanalyzer, polarisation analyzer, tunable lasers ...)
- Integrating sphere and optical spectrum analyzer for characterizing optical sources

Collaboration

Intra-university

Chemical Engineering Techniques, Applied Mechanics, Metallurgy, Stomatology, Art Science and Archeology, Immunology and Microbiology, Physical Chemistry and Polymer Science, Chemistry Department

Inter-university & research centres

Photonics Integration and Packaging Group of the UGent, Interuniversity Attraction Pole 'Photonics@be' (UGent - Université Libre de Bruxelles - Faculté Polytechnique de Mons).

At the international level TONA has privileged collaborations with Stanford University and with the Sandia National Laboratories. Currently TONA is expanding its network of strategic partners by exploring collaborative research opportunities with photonic research institutes or networks in South Korea, Australia, Canada, Japan and the US.

Industrial partners

Fujitsu, Polish Telecom, NIPPON Telegraph & Telephone Corp. (NTT), Punch Graphix International, Umicore, Anteryon, Tyco Int., Barco, Melexis, Agfa, Intel, Philips, ICOS, FOS&S

Networks

At the European level TONA is coordinating a Network of Excellence in Micro-Optics and is as such structuring and integrating the fragmented landscape of micro-optics in intensive collaboration with 30 European laboratories (www.micro-optics.org/). It also is a vice-coordinator of the Network of Excellence on Biophotonics 'Photonics for Life' (www.photonics4life.eu/).

Chemical Engineering and Industrial Chemistry – CHIS

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Group CHIS:	28 people

Keywords

nanomaterials, microstructured materials, mesoporous materials, catalysis, adsorption, analytical seperations

Objectives

One of the main research themes of the department of Chemical Engineering and Industrial Chemistry is the **characterization and production of materials** that are either ordered on the **Angstrom scale, the nanoscale or the microscale and their use in the chemical process industry and chemical analysis.**

As future building blocks for microscopically ordered analytical separation devices, the department also **produces inorganic (mainly silica-based) non-ordered mesoporous materials.**

Research orientations

Area 1: Nanomaterials for catalysis and adsorption

Nanoporous solids such as zeolites, metal-organic frameworks and mesoporous solids are studied for bulk scale separation of base chemicals, CO_2 capture and separation and catalytic applications. Techniques are developed to characterize such materials and to test their performance in separation and catalysis.

Area 2: Nano- and microstructured materials for analytical separations

In this area, we target the fabrication of the next generation of chromatographic columns by producing monolithic structures with a mesoporous skeleton with one to two micrometer-size branch thickness and using hydrolytically initiated polycondensation reactions of tetraalkoxysilane in the presence of poly-ethylene glycol as the porogenic solvent. Another example is the use of free-radical initiated co-polymerization reactions involving methacrylate esters in combination with a porogenic solvent yielding polymeric monoliths. The group also works on the production of aerogel and xerogels. The final aim of the project is to use these materials as separation and catalytic reaction supports.

Equipment & Infrastructure

High-throughput techniques are developed to characterize and test materials in automated and parallel manner. Both gas and liquid phase adsorptive and catalytic applications are studied. CHIS has developed and installed several high-throughput devices to study adsorption and diffusion phenomena (8 channel liquid chromatography setup, automated robotic techniques for static adsorption measurements, 16 channel fully automated frontal analysis setup for the simultaneous study of adsorption, diffusion and deactivation effects on porous solids, Zero Length Column Technique for ultra-rapid determination of multicomponent adsorption/diffusion by on-line Time of Flight Mass Spectrometry). This equipment allows screening a large number of materials, components and operational conditions. This equipment is unique, worldwide. Nitrogen porosimetry, Hg intrusion porosimetry, pycnometry, gravimetric and volumetric determination of gas and vapor phase isotherms, GC, GC-MS, HPLC are available.

Collaboration

Inter-university & research centres

Area 1

Cooperation with COK (KULeuven), VITO, LCT (UGent), CMM (UGent), EMAT (Universiteit Antwerpen), Laboratory of Adsorption and Catalysis (Universiteit Antwerpen).

Exchange of data with University Pablo de Olavide (SP), Northwestern University (USA), Beijing University of Chemical Technology (China) in the field of Monte-Carlo Molecular Modelling of Adsorption.

Collaboration with the Department of Chemical Engineering, Monash University (Australia) in the field of CO2-separation (materials delivery).

Area 2

Cooperation with IMEC (Integrated Systems Department) and VITO (Expertise Center Environment & Process Technology).

Mesa+ Institute for Nanotechnology - Universiteit Twente (The Netherlands) and Department of Chemistry - Kyoto University (Japan)

Industrial partners

Institut Français du Pétrole, ENI, DOW, Proviron, UCB, Solvay, BASF, Ineos, TotalFinaElf, Taminco, ExxonMobil, Janssen Pharmaceuticals, Pall-Schumacher, international chromatography companies

Networks

IAP-VI, SBO Nextchrom, FWO scientific community: 'The active site: from catalyst to reactor'.

Electrochemical and Surface Engineering – SURF

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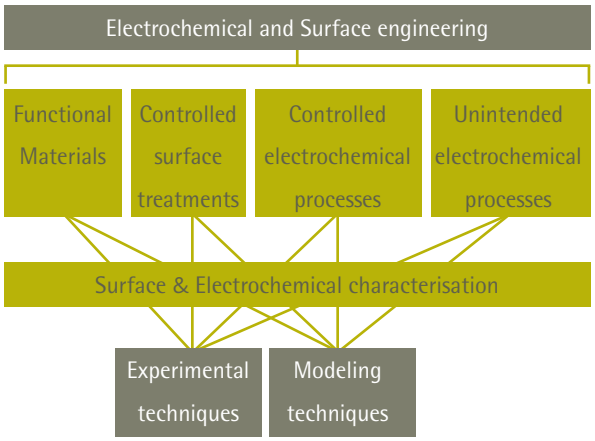
Group SURF: 35 researchers + 9 administrative & technical staff

Keywords

surface engineering, electrochemical processing, surface characterization, functional surface properties, corrosion, electrochemical process modeling, functional modelling

Objectives



Electrochemical engineering covers the area of the study of controlled electrochemical processes (such as electrolysis) as well as the study of unintended electrochemical processes, with corrosion as a typical example.

The connection to the domain of surface engineering is through the development and optimization of processes to perform dedicated surface treatments, such as the anodisation of aluminium. Another important link is the ability to make functional materials, for example self-healing materials.

The aim is twofold: (i) gaining fundamental insight in the mechanisms governing the processes and (ii) using this knowledge to design and optimize these processes.

SURF's approach to deal with both fundamental and application driven aspects is one of combining experimental and modeling techniques. Experimental techniques are oriented towards surface and electrochemical characterisation. We combine expertise in both electrochemical methods and in-situ and ex-situ surface analytical techniques. Modeling in SURF's context means (i) construction of models and (ii) developing numerical tools to handle the mathematics behind the models. Modeling techniques are implemented at different levels: (i) to model controlled or unintended electrochemical processes, (ii) to model physical properties of materials (such as charge transport through oxide layers) and (iii) to support the interpretation of experimental data (e.g. in fitting tools). The continuous interaction between data obtained from measurements and data calculated by models allows to acquire fundamental knowledge and to predict real life behaviour.

Research Orientations

The unique combination of expertise in experimental and modeling techniques in the area of electrochemical and surface engineering promotes a multidisciplinary research focus in the domains listed below.

Dimension 'downscaling' to nanometer resolution

Our state of the art lab infrastructure puts us in the position of analyzing and manipulating the material surface on the very localized, submicron and nanotechnological scale.

Multifunctional metals

Controlled surface modifications that can create a unique combination of functional properties are the next generation

of processes for metals. Our metal surface research is not only directed towards mechanical properties, corrosion and coating adhesion, also additional properties such as optical properties (colour, gloss and reflection), biocompatibility, electrical conductivity, anti-fouling are studied. Also the so-called 'smart coatings' are more and more being explored for future applications.

Process and technique modeling

Process modeling consists of quantitative modeling of processes and electrochemical reactors to optimize production techniques, to predict durability of materials (corrosion), and to save energy. Emerging topics are e.g. fuel cell design and electrochemistry in microfluidic applications.

Technique modeling is developed to maximize the interpretation of experimental data and to extract reliable parameters as input for process and functional modeling. An example is the technique of electrochemical impedance spectroscopy (EIS) where we implemented a new data collection technique to optimize the reliability of the parameter extraction.

Functional modeling

Functional means modeling of the physical properties of the materials. The ultimate goal is to be able to modify on demand different material's properties. An active area of research in that perspective is corrosion modeling. SURF also has strong expertise in optical modeling. We can e.g. predict the appearance (colour, reflectivity etc.) of modified surfaces.

Equipment & Infrastructure

SURF is in the unique position of having an advanced technological infrastructure and electrochemical software/ modeling tools.

- Complementary electrochemical methods
  - Electrochemical Impedance Spectroscopy Methods
  - Electrochemical Stationary and Non Stationary Methods
  - Electrochemical reactors operating under different flow regimes (e.g. rotating disc reactor, wall jet reactor, parallel flow reactor)
- In-situ & ex-situ surface analytical techniques
  - Scanning electron microscopy (FE-SEM)
  - Auger electron spectroscopy (FE-AES)
  - X-ray photoelectron spectroscopy (XPS)
  - In situ Spectroscopic ellipsometry (visual and infrared)
  - Confocal Raman spectroscopy
  - In situ AFM-STM
- Electrochemical modeling tools
  - Numerical software for macro, meso & micro scale systems
  - Dedicated fitting tools based on maximum likelihood estimator

Collaboration

The spectrum of our projects goes from fundamental research (FWO) through basic research (IWT, SBO, IWOIB, European Programmes) to applied research (IWT, bilateral with industry).

Intra-university

SURF has close collaboration with research groups of the faculty of Engineering, the faculty of Sciences and others:
Applied Physics and Photonics (TONA), Physical Chemistry & Polymer Science (FYSC), High Resolution NMR Centre, Fundamental Electricity and Instrumentation (ELEC), Architectural Engineering (ARCH), General Chemistry (ALGC), Mechanical Engineering (MECH), Chemical Engineering (CHIS), Art Sciences and Archaeology (SKAR).
The group also decided strategically to partner with the team Technological Entrepreneurship, bringing in some economic & business DNA into the research group.

VUB Spin-off

Elsyca NV (1997)

Inter-university & research centres

Through a vast portfolio of interdisciplinary research projects, SURF has built up a broad network of academic contacts and research groups, both nationally and internationally.
Recently, SURF has set up a strategic alliance with the Metals Science and Technology (MST) research group of University of Ghent. The entire chain of metallurgical research from manufacturing till observation and testing can be done there in-house, which offers a truly unique environment for an academic research facility. The interuniversity research group 'Materials and Surface Science & Engineering' (MASS) is combining the competences of the two individual groups: MST being a very strong group in Physical Metallurgy of Metals and SURF being a very strong group in Surface Technology.
SURF has important collaborations (non exhaustive) with:
Center of Excellence in Surface Technology and Materials (CEST) – Austria; Chalmers University – Sweden; Institute of Physical Chemistry – Bulgarian Academy of Sciences (IPCBAS); Instituto Superior Tecnico – Technical University of Lisbon (ICEMS); Interuniversitair Micro-Elektronica Centrum (IMEC); Katholieke Universiteit Leuven; Universiteit Antwerpen; University of Birmingham – UK; University of Bourgogne – France; Universitatea Tehnica Cluj-Napoca – Romania; Universiteit Gent; Université Libre de Bruxelles; University of Paderborn – Germany; Materials Innovations Institute (M2i) at TU Delft; Max Planck Institute –MPEI Düsseldorf; Swiss Federal Laboratories for Materials Testing and Research (EMPA); VITO; von Karman Institute; Warsaw University of Technology (WUT) – Poland.

Industrial partners

Afga Gevaert, Aleris, ArcelorMittal/OCAS, Asco, BASF, Bekaert, Bodycote, Chemetall, Coil, Cormet Testing Systems, Corus, EADS/Airbus, Elsyca, FLAMAC, Henkel, Hydro, Infineon Technologies, SEZ AG (division of Lam Research Corporation), Technikon, Umicore.

Networks

SURF participates in various networks:

- EAA European Aluminium Association with EATP European Aluminium Technology Platform
- HERCULES project network: 'Hoog technologisch multidisciplinair meetcentrum van de Universitaire Associatie Brussel'
- IWT: virtual helpdesk for surface analysis
- Scientific Research Community of FWO Flanders – on Structural and chemical characterisation of Materials at the Micro- and Nanometre scale
- Scientific Research Community of FWO Flanders – on Surface modification
- Scientific Research Community of FWO Flanders – on Tuning the functional properties of nanoparticles and nanowires
- SIM: Strategic Initiative Materials; steering committee member for surface technology
- International Society of Electrochemistry (ISE)
- SIRRIS, the collective centre of the Belgian technological industry

General Chemistry – ALGC

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Group ALGC: 17 people

Keywords

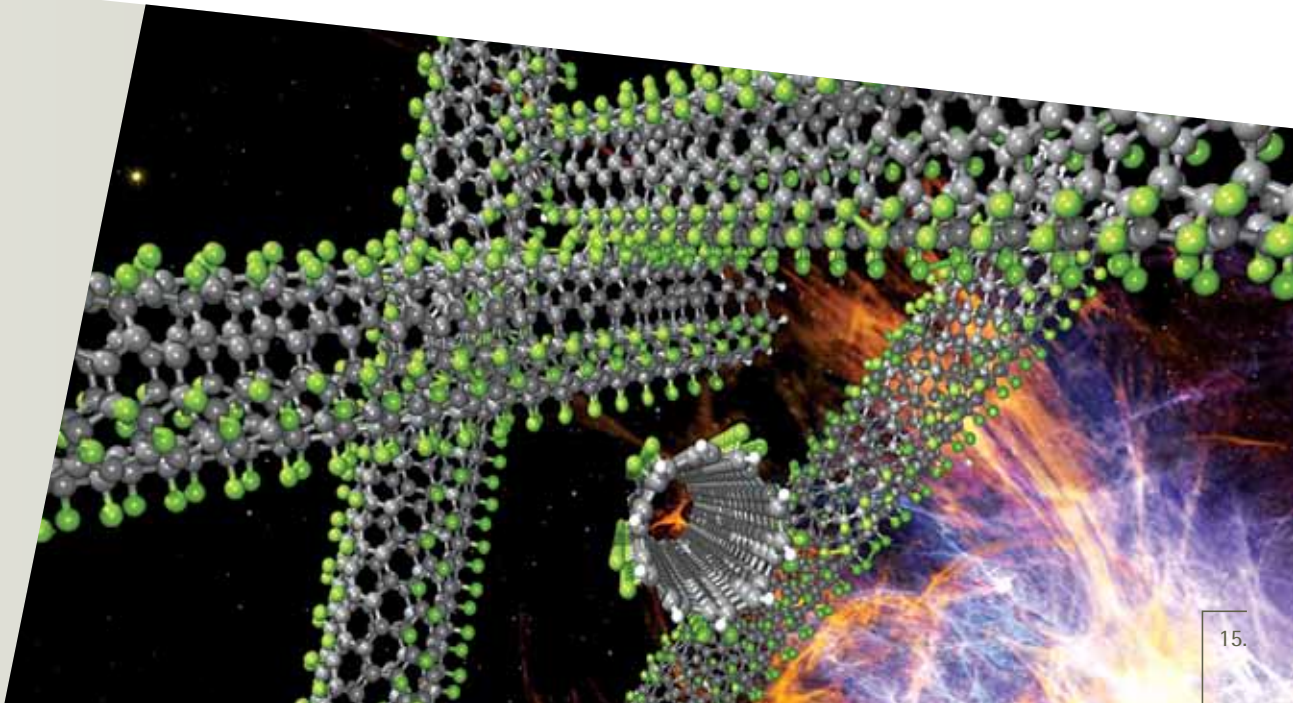
quantum chemistry, computational chemistry, density functional theory

Objectives

In recent years **Quantum Chemistry** (i.e. the application of quantum mechaniscs to chemical problems such as structure, stability and properties of molecules and their behaviour during reactions) has made enormous progress via the so called **Density Functional Theory (DFT).** In this approach the electron density in each point is considered as the basic property of an atomic or molecular system from which all properties are derived.

Research orientations

The main research topic of ALGC concerns both the development of concepts and the application of DFT on concrete chemical problems (conceptual and computational DFT). Fundamental work is done on the development of density functional theory based descriptors of molecular charge distribution and reactivity (e.g. local hardness, shape function, spin polarized extensions) and on the development and/or testing related concepts (the Hard and Soft Acids and Basis Concept, the Maximum Hardness Principle). Applications are considered in organic, inorganic and biochemistry, both on kinetic and thermodynamic aspects, both on gas phase and solution systems. Substrates and topics studied, often in direct interaction with experimental groups, are catalytic and adsorption properties of zeolites, adsorption on silver surfaces, electronic and mechanical properties of fullerenes and nanotubes, acidity and basicity of organic functional groups, the use of DFT based descriptors in organic reactions. In biochemistry work has been delivered on the influence of mutation on the catalytic activity of subtilisin and RNAse T1 and the catalytic mechanism of arsenate reductase.



Equipment & Infrastructure

Expertise is offered in the modellisation of chemical reactions in various conditions (gas phase, solution, surfaces), using a variety of software packages (Gaussian03, Molden, Spartan, amongst others).

The hardware equipment includes both local and external computer configurations:

- 8 processor (R16000, 600 Mhz) Silicon Graphics Origin 350 Server (12 Gb RAM Memory and a total of 620 Gb Disc space)
- 2 dual processor DS20 Compaq-Alphaservers (1 Gb RAM Memory and a total of 620 Gb Disc space)
- Aster configuration at the VUB/ULB Computing Centre
- Moreover and very recently the ALGC group has acquired 16 dedicated dual core processors at the HYDRA configuration at the VUB/ULB Computing Centre

Collaboration

Intra-university

Organic Chemistry (ORGC), High resolution NMR (HNMR), Ultrastructure (ULTR), Chemical Engineering (CHIS), Metallurgy (META), Radiopharmacy (BEFY)

Inter-university & research centres

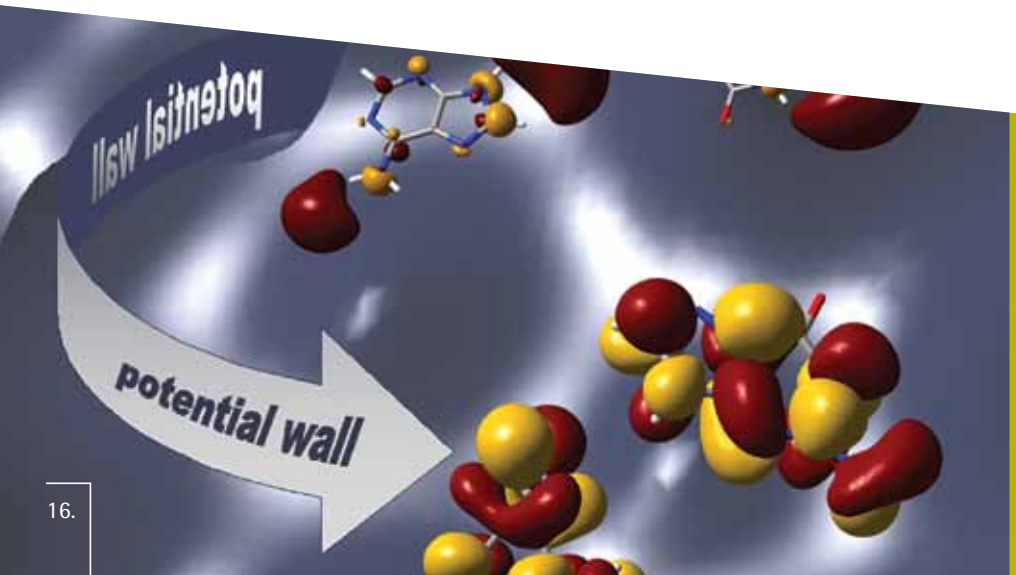
Universiteit Antwerpen, KULeuven, UGent, Université Libre de Bruxelles, University of North Carolina (USA), Jagiellonian University (Cracow, Poland), University of Exeter (UK), Universidad Autónoma Metropolitana - Iztapalapa (Mexico), Technical University of Wroclaw (Poland), University of Pune (India), Weizmann Institute (Israel), University of Hyderabad (India), University of Durham (UK), Mc Master University (Hamilton,Canada), University of Girona (Spain) amongst others

Industrial partners

ExxonMobil, Janssen Pharmaceutica, Mallinckrodt

Networks

The group is the nucleus of a **Scientific Research Network** of the Fund for Scientific Research (Flanders) **on Density Functional Theory**, a consortium of 9 Belgian and 8 Foreign groups. This consortium was also at the basis of the organization of the '10th International Conference on the Applications of Density Functional Theory in Chemistry and Physics', the most important conference worldwide in the field, held at the Vrije Universiteit Brussel in 2003. In 2005 a three day International Symposium on Theoretical Aspects of Chemical Reactivity was organized by this network in collaboration with the International Solvay Institutes for Physics and Chemistry.



High Resolution NMR Centre – HNMR

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Group HNMR: 4-6 people

Keywords

NMR, structure determination, one- and two-dimensional NMR, diffusion ordered NMR, high resolution magic angle spinning NMR, multinuclear NMR, material investigations

Objectives

The High Resolution NMR Centre is basically the NMR lab of the Vrije Universiteit Brussel providing all NMR spectra and NMR know how to any researcher in - or outside - the institution, needing NMR for purposes of chemical substance identification, structure determination or material characterization, either in scientific collaboration, or in service context, outside the bio-NMR sector.

Research orientations

The NMR Centre has profiled itself since 1990 in advanced chemical structure determinations by multinuclear 1D and 2D NMR methods, including its dynamic aspects. All small and medium-sized molecules can be addressed with a wide panel of state-of-the-art NMR methodologies. For the last ten years, the scientific interest of the HNMR team has expanded towards grafting organometallic compounds to cross-linked polymers, aiming at developing applications in the fields of catalysis in various ester related and/or industrially applied organic reactions. This novel field of interest has generated new developments for NMR applied to the heterogeneous solid-liquid interface. More specifically high resolution Magic Angle Spinning (hrMAS) and Diffusion Ordered Spectroscopy (DOSY) NMR are applied to the liquid component of interfaces, or, alternatively, to the component dipped into the liquid phase and interacting with the solid or (nano)particle surface. The group has acquired expertise in the assessment of diffusive properties of nanoparticles size-tailored with organic ligands, of nanometal oxide clusters or particle interactions with organic compounds in catalytic processes or particle growth technologies. The present field of expertise of the group is situated in ligand-substrate interactions at interfaces, and in the investigation of nano- and supramolecular constructions like micelles and micelle aggregates, with accurate particle size measurements and shape modelling using diffusion NMR related techniques.

Equipment & Infrastructure

Avance 2 Bruker 500 instrument equipped with:

- three channels for triple resonance experiments
- gradient pulse facilities
- triple 5 mm probe ^{1}H-^{15}N-^{13}C with z-gradient coil
- multinuclear 5 mm triple probe ^{1}H- dual ^{119}Sn/^{31}P-broad band with z-gradient coil
- multinuclear 5 mm triple probe ^{1}H-^{119}Sn-broad band with z-gradient coil
- dedicated triple high resolution Magic Angle Spinning (hr-MAS), 5 mm probe ^{1}H-^{13}C-^{119}Sn with z-gradient coil
- sample changers for standard and hr-MAS samples

AVANCE Bruker DRX 250 instrument, equipped with:

- sample changer and automation routine
- triple channel and gradient facilities
- solid state CP-MAS facility
- Quattro 5 mm probe ^{1}H-^{13}C-^{19}F-^{117}Sn with automatic X-nucleus switch and z-gradient coil
- multinuclear 5 mm triple probe ^{1}H-^{117}Sn-broad band (BB) from ^{109}Ag up to ^{31}P with z-gradient coil
- dedicated triple high resolution Magic Angle Spinning (hr-MAS), 5 mm probe ^{1}H-^{13}C-^{117}Sn with z-gradient coil

- BB 10 mm probe, all nuclei at resonance frequencies from ^{109}Ag up to ^{31}P
- ^{1}H-BB 7 mm CP-MAS probe with max. 7 KHz spinning rate from ^{109}Ag up to ^{31}P
- ^{1}H-BB 4 mm CP-MAS probe with max. 15 KHz spinning rate from ^{109}Ag up to ^{31}P
- ^{19}F-BB 4 mm CP-MAS probe with max. 15 KHz spinning rate from ^{109}Ag up to ^{31}P

AVANCE 2 Bruker 700 instrument, equipped with:

- sample changer and automation routine
- triple channel and gradient facilities
- gradient pulse facilities
- triple 5 mm probe ^{1}H-^{15}N-^{13}C with z-gradient coil
- multinuclear 5 mm triple probe ^{1}H- dual ^{119}Sn/^{31}P-broad band with z-gradient coil
- multinuclear 5 mm triple probe ^{1}H-^{119}Sn-broad band with z-gradient coil
- dedicated triple high resolution Magic Angle Spinning (hr-MAS), 5 mm probe ^{1}H-^{13}C-^{119}Sn with z-gradient coil
- sample changers for standard and hr-MAS samples

This instrument is located in the research group for NMR and Structural analysis at the UGent, and is shared by the Vrije Universiteit Brussel, UGent and Universiteit Antwerpen

Network of computers consisting of:

- multiple PC network for personal routine and more advanced NMR data processing, including for spectrometer control
- A4/A3/A0 network accessible printer/plotters on site

Software package including:

- TOPSPIN 2 NMR for acquisition and processing of the data
- PERCH, g-NMR for advanced spectrum simulations, including chemical exchange
- WIN-MAS, software for solid state spectra simulations
- GIFA DOSY interfaced to TOPSPIN

Collaboration

Intra-university

Other research units and/or departments of the Vrije Universiteit Brussel making use of the NMR know-how and services of HNMR on a regular basis: Organic Chemistry, Physical Chemistry and Polymer Science, General Chemistry, Mechanics of Materials and Constructions, Surface Engineering.

Inter-university & research centres

Close past and present collaboration with UGent, Université Mons-Hainaut, Universiteit Antwerpen, KULeuven, Université Libre de Bruxelles, Institut Pasteur Lille (France), Universidad Autónoma Metropolitana (Mexico), Technical University of Eindhoven (The Netherlands), Université Bordeaux 1 (France), Université Pierre et Marie Curie (Paris VI, France), Università di Bologna (Italy), Università di Salerno (Italy), Technical University of Pardubice (Czech Republic), Institute of Technology-Roorkee (India), North-Eastern Hill University (Umshing, Shillong, India), Université Cheikh Antal Diop (Dakar, Senegal), University of Bath (United Kingdom), Indian Institute of Technology (Hauz Khas, New Delhi, India), Jacobs University (Bremen, Germany), Université des Sciences et Techniques (Nantes, France), Bulgarian Academy of Science (Sofia, Bulgaria).

Industrial partners

Cytec (Drogenbos), Chemtura (Bergkamen, Germany) Dow Benelux (Terneuzen, The Netherlands), SGS House (Antwerpen), INEOS (Zwijndrecht), others on a more occasional basis.

Networks

FWO Scientific Research Community: 'Advanced NMR applications in Materials, Chemical and Biomedical Sciences'

Micro- & Photonelectronics (Laboratory for) – LAMI

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Group LAMI: 28 people

Keywords

microelectronics, photonelectronics, semiconductor materials, dielectric properties of materials

Objectives

In 1998 the Laboratory for Micro- & Photonelectronics became an associated research laboratory of IMEC (Interuniversitair Micro-Elekronica Centrum), after a 10 year close collaboration. Today, the scope of the research activities includes

- equalizing techniques for high speed electronic data communication
- 3D image acquisition
- high power detectors & modulators and passive optical components for the 10 µm wavelength region
- devices, quasi-optical components, technology and systems for millimeter wave imaging
- the study of the foundations of computing and of artificially created living systems

Research orientations

Semiconductor materials:

III-V materials and IV materials: Ge/Si

Investigation of solid-state properties of these materials in bulk, nano- and multilayer structures: electron transport properties, optical properties including surface plasmonics, scattering mechanisms, phonon properties and thermal properties.

Investigation of technological processes for the fabrication of semiconductor devices.

Domain area/sub-area II: Dielectric properties of materials at mm wave and THz frequencies

Characterization of a wide set of materials (today in the frequency range from 40 – 270 GHz):

- semiconductors and other technology related materials
- solids, liquids, powders of every day life (security applications)
- poled and non-poled polymers
- meta-materials, left-handed materials, ...

Equipment & Infrastructure

Clean room facilities: metallization, oxidation, wet and dry (RIE) etching, ellipsometry. This equipment is available in all labs involved in semiconductor processing.

CO_2 lasers: these lasers are not unique on the international level, but in Belgium there are not that many labs having these lasers at their disposal.

Quasi-Optical millimeter wave vector network analyzer (MVNA-3-350-2 of the company ABMillimetre) operating today between 40 and 270 GHz. It is a quite unique state-of-the-art diagnostic and spectroscopic instrument allowing quasi-optical as well as waveguide based measurements for the spectroscopic study of materials in this frequency range.

Collaboration

Intra-university

Semiconductor material characterization: Electrochemical and Surface Engineering (SURF)

Optical profilometry: Applied Physics and Photonics (TONA): white light interferometer, Atomic Force Microscopy

Vrije Universiteit Brussel spin-off

EqcoLogic NV

Inter-university & research centers

IMEC, INTEC-UG, UCL-EMIC, KULeuven-Telemic

Shared researchers with IRE-RAS (Institute of Radio Engineering and Electronics of Russian Academy of Sciences), Fryazino (Moscow Region, Russia) in the field of basic semiconductor material properties and experimental characterization.

Shared European project with University of Duisburg-Essen, Zentrum für Halbleiter Technik und Optoelektronik in the field of III-V semiconductor optoelectronics and THz devices.

Informal collaboration with the PTI-UAS (Physico-Technical Institute of the Uzbek Academy of Sciences), Tashkent, Uzbekistan in the field of nanosemiconductor material properties.

Shared European project in the field of EO-polymer characterization at high frequencies (30-300 GHz) with the Institut d'Electronique, de Micro-électronique et de Nanotechnologie, Université des Sciences et Technologies de Lille.

Industrial partners

Lambda Research Optics Europe: co-research and materials delivery - Epinova: materials delivery - Flanders Mechatronics Technology Centre (FMTC): co-research - ABMillimetre (Paris): testing

Networks

European network of Excellence on microwave photonics 'ISIS'

Mechanics of Materials and Constructions – MEMC

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Group MEMC: 32 people

Keywords

cement matrix composites, polymer composites, composite material characterization

Objectives

The department Mechanics of Materials and Constructions (MEMC) has a long history in the research of composite material systems with organic as well as cementitious matrices.

The current research activities focus on:

Area 1: Development of new material systems with cementitious matrix

Area 2: Characterization of mechanical properties of composites with organic and cementitious matrix under complex and extreme loading conditions

Research orientations

Area 1: Development of new material systems with cementitious matrix

New materials are developed, belonging to the class of special cements or chemically bonded ceramics, having properties which make them suitable as matrix for textile fibre reinforced composites: low viscosity and chemically neutral after hardening. In this way, composite materials with cementitious matrix can be produced with similar processes as polymer matrix composites. Properties are also comparable, except their absolute incombustibility, fire resistance and temperature stability. Applications can be found in building and construction, transport and industry. The research concentrates on the development and optimisation of the material systems, and on the design with these composite materials.

Area 2: Characterization of mechanical properties of composites with organic and cementitious matrix under complex and extreme loading conditions

Besides the conventional methods for the determination of mechanical properties, new inverse methods are developed for the estimation of mechanical parameters in material models under complex and extreme loading conditions. The developed inverse methods fully exploit the possibilities of advanced non destructive testing equipment including full field optical measurement techniques and vibration testing. The main goal of this research is the study of the long term behaviour (fatigue and damage) of composite materials in construction parts under realistic in-service loading conditions.

Equipment & Infrastructure

Major equipment: Conventional facilities available for this research activity are static and dynamic uni-axial and bi-axial test benches with a capacity up to 250kN (INSTRON and MTS), Dynamic mechanical Analysis equipment (IMASS), climatic chambers with temperature and humidity control with possible mounting on the test benches, strain gage measurement bridges, remote optical displacement and strain measurement devices, data-acquisition systems, ultrasonic c-scan, acoustic emission, Electronic Speckle Pattern Interferometry (ESPI), optical video microscopy and forced diffusion thermography (SPATE), dynamic modal analysis equipment (LMS).

Collaboration

Intra-university

The departments of Applied Mechanics (MECH), Architectural Engineering (ARCH) and Chemistry and Materials (MACH)

Vrije Universiteit Brussel spin-off

Symbion NV

Inter-university & research centres

MEMC shares grants and facilities with:

Mechanics of Materials and Constructions - UGent, Acoustics and Thermal Physics - KULeuven, Civil Engineering – Royal Military School (RMA), Belgian Building Research Institute (BBRI), Laboratoire LGCIE - Université Claude Bernard Lyon

Development of numerical models to predict fatigue life under complex loading is in cooperation with:

University of Patras (Greece), Risoe (Denmark), Lulea University of Technology (Sweden)

Standardisation activities related to biaxial testing in cooperaton with:

National Physical Laboratory - Middlesex (UK), Qinetiq - Farnborough (UK)

Design methods for cement matrix composites with textile reinforcement is in cooperation with:

Université Claude Bernard - Lyon (France)

Industrial partners

Area 1: More than 30 industrial co-research partners in EU-project Contex-T (see: contex-t.ditf-denkendorf.de). In Belgium: www.sioen.com, www.centexbel.be, www.bexco.be, www.bbri.be

Impacted industries: building component manufacturers, fire and blast protection, transport (railway), marine, decoration, amusement parks

Area 2: General Electric Deutschland Holding Gmbh, Fiberblade Eolica S.A., LM Glasfiber A/S, Samtech Sa, Shell Windenergy B.V., Repower Systems Ag, Vestas Asia Pacific A/S, Smart Fibres Ltd

Impacted industries: manufacturers of wind turbine blades, manufacturers of composite material parts in aerospace and automotive industries, producers of construction parts made of composite materials in civil engineering industry

Physical Chemistry and Polymer Science – FYSC

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Group FYSC: 14 people

Keywords

polymer characterization, advanced thermal analysis, nano-structured (reacting) polymer systems

Objectives

The research activities of Physical Chemistry and Polymer Science (FYSC) are focused on '(molecular and supramolecular) structure-processing-property' relations in polymers for developing materials with improved performance. An important collection of analytical techniques and characterization procedures is available for this purpose. New macromolecular microstructures are designed by polymer synthesis in collaboration with external partners.

A contribution to the international progress of thermal analysis for materials' characterization is aimed at, especially in the field of **Modulated Temperature DSC (MTDSC), spatially localised thermal analysis (Micro-TA and Nano-TA), (ultra) fast thermal analysis (Rapid-scanning DSC and Chip Calorimetry) and hyphenated thermal techniques (Rheo-DSC).**

Education and training in thermal analysis for the academic and industrial community is also an objective.

Research orientations

Structure-processing-property relationships are characterized in different classes of polymeric materials by means of state-of-the-art analytical techniques and characterization procedures based on a physical-chemical approach.

Current research projects in collaboration with academic and industrial partners are dealing with:

- **Thermosets:** reaction mechanism, kinetics, modelling, reaction-induced structure formation, IPNs, waterborne systems, pultrusion of thermoset composites
- **Inorganic polymers:** low-temperature synthesized materials, heterogeneous production mechanism and kinetics, molecular structure and thermal properties, hybrid systems
- **Bio(degradable) polymers:** thermal properties, barrier properties, slow crystallization processes, thermoplastic starch
- **Multi-phase polymers, polymer interphases and nano-structured polymer systems:** micro- and nanocomposites, blends, stimuli-responsive (aqueous) solutions, hydrogels, block copolymers, polymer/metal interfaces, smart polymer surfaces, self-healing polymers (coatings and bulk).

Recent and future activities are directed to:

- **Novel trends in polymer science and technology,** i.e. nanostructured (hybrid) polymers and supramolecular organisation in polymers and polymer (aqueous) solutions
- A **further extension of the thermo-analytical infrastructure** with specialised equipment of ultimate performance to allow nanoscale thermal analysis both in the bulk and at the surface of the polymer system
- A continued collaboration with other research teams, gathering expertise in polymer synthesis, characterization, theory, modelling, rheology and processing

Equipment & Infrastructure

FYSC has an extended infrastructure of thermal analysis equipment in combination with complementary techniques for the physical-chemical characterization of polymer systems:

- **Thermal Analysis:** DSC, MDSC, DDSC, (M)DSC with Tzero technology, TGA, TMA, DMA, DEA, Nano(micro)-TA with heat-cool stage, Nano(micro)-calorimetry with titration mode, Rheo-DSC, Rapid-scanning DSC, Chip calorimetry for fast scanning and AC-calorimetry
- **IR-Spectroscopy:** FT-IR, IR-microscopy, specular reflectance, HATR, NIR FT-Raman spectroscopy, TGA/FT-IR
- **Miscellaneous techniques:** GPC with viscometry, RI and PDA detectors, dynamic rheometry, optical microscopy and UV-Vis spectroscopy in combination with hot stage, High-resolution Ultrasound Spectroscopy, AFM

Collaboration

Intra-university

FYSC is part of the Department Materials and Chemistry (MACH) of the Faculty of Engineering of the Vrije Universiteit Brussel, together with the research units High Resolution NMR Centre (HNMR) and Electrochemical and Surface Engineering (SURF).

Inter-university & research centres

Polymer Synthesis (UGent), Theoretical Physical Chemistry (KULeuven), Polymer Synthesis (LUC), Nanocomposites (UMH), Textile Engineering (UGent), TU Eindhoven and TNO Eindhoven (The Netherlands), Loughborough University (UK), University College Dublin (Ireland), Moscow State University (Russia), University of Tennessee and Oak Ridge National Laboratory (USA), University of Helsinki (Finland), Ecole Nationale Supérieure de Chimie de Lille, ENSCL (France), Institute of Nuclear Chemistry and Technology (Poland), Université de Montreal (Canada), University of Rostock (Germany).

Industrial partners

AGFA, BEKAERT Composites, CENTEXBEL, CARGILL-CERESTAR R&D, CYTEC, DSM Research, ETEX REDCO, EXXON Chemical (European Technology Centre, Polymer Group), FINA Research, METTLER-TOLEDO, MILLIKEN, ORFIT, PERKIN ELMER, PROCTER & GAMBLE, RECTICEL, SHELL Research, SOLVAY, TA INSTRUMENTS.

Networks

Belgian Polymer Group (BPG)

Structural Biology Brussels – SBB

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Group SBB: 70 of which 40 researchers

Keywords

structural biology, biophysics, NMR, X-ray crystallography, bio-nanomaterials, crystallisation aides

Objectives

The understanding of the function of a protein, from its structure to its dynamics, remains the central theme of the lab. Our multidisciplinary team of about 40 researchers is housed in new laboratory facilities and combines extensive expertise in biophysics and molecular biology. We master genetic engineering, protein purification, enzymology, calorimetry, X-ray crystallography, surface plasmon resonance, atomic force microscopy and now also NMR. In addition to medically oriented structural biology projects, a new focus of the lab is also the study of self-organizing proteins with potential for nanomaterial developments.

Research orientations

Major research interests include biomedical targets, structural enzymology, bacterial virulence, bacterial cell surfaces, toxin-antitoxin systems and biomolecular NMR. Translational research is intrinsic to our programs, with possible applications in medicine. The discovery of heavy chain camelid antibodies has been one of the major hallmarks of our department.

In recent years, the scientific community has gained increased interest for the application of biological materials in bottom up approaches for nanotechnology developments. Many biological systems contain self-organizing molecules that condense in ordered networks with functions ranging from molecular motors, switches and pumps to regular 1D and 2D scaffolding materials. These systems contain intrinsic characteristics that could be harnessed for the fabrication of biosensors, lab-on-chip applications and nanoelectronic devices.

Part of the ongoing research in the group Structural & Molecular Microbiology, a division of Structural Biology Brussels and VIB, looks at the structural organization of proteinaceous polymers found on bacterial cell surfaces. These can be found to form regular filamentous or two-dimensional arrays formed of repetitive units assembled in defined conformations. Such polymers can be functionalized by chemical or genetic modification and thus form the basis for high density, topologically ordered display of the desired functionality. Depending on down-stream application, the polymers can be displayed on biological (life bacteria, membranes etc.) or non-biological surfaces (plastics, glass, metals). Through the knowledge of the atomic, tri-dimensional structure of the protein building blocks and the way these associate inside the polymers, one can come to the targeted insertion of the functionalizations in a topologically idealized manor. In this way, high density, bifunctionalized arrays at regular intervals will be made possible.

The systems under study in the lab include chaperone/usher pili and curli, linear non-covalent polymers made up of immunoglobulin-like domains and cross-beta interactions of amyloid-like subunits, respectively, as well as bacterial S-layers, forming non-covalent, two-dimensional protein arrays.

A second emerging topic concerns the functionalisation of organic or anorganic materials (polymers, membranes, nanoparticles, ...) with nanobodies. The occurrence of bona fide antibodies devoid of light chains in Camelidae by Emeritus Prof. Raymond Hamers was one of the major

discoveries within our department. Nanobodies are the recombinant minimal-sized intact antigen-binding domains from such camel heavy-chain antibodies. Like conventional antibodies, nanobodies show high target specificity, high affinity for their target end low inherent toxicity. Nanobodies can be expressed efficiently in bacteria as active, soluble, and robust proteins and are amenable to applications beyond therapeutics including applications in material sciences.

Equipment & Infrastructure

Protein research requires technologically advanced techniques such as genetic engineering, protein purification, enzymology, calorimetry, X-ray crystallography and Nuclear Magnetic Resonance (NMR).

Protein purification: Our lab is equipped with a complete up-to-date Äkta purification platform (2 Explorers, 4 Basics, 1 FPLC, 2 Prime) to cover medium-pressure purification up to 100 ml/min and a high-pressure Waters HPLC system. We support purification process design from crude extract to highly pure protein.

Enzymology: Our expertise includes steady-state and pre-steady-state kinetics. We have a stopped flow apparatus (Applied Photophysics SX18.MV) including sequential mixing capabilities and quenched flow equipment up and running.

Calorimetry: The laboratory is equipped with an Omega isothermal titration calorimeter (ITC), as well as a VP-DSC differential scanning calorimeter (DSC), both from MicroCal. The ITC instrument is used for the detailed thermodynamic analysis of biomolecular binding events, whereas the DSC system provides quantitative data on the stability of individual proteins and their complexes. Calorimetric studies provide an excellent complement to our structural and biochemical methodologies.

X-ray Crystallography: The lab is presently equipped for structural biology with a Rigaku RU200 X-ray generator, a MAR image plate detector, an Oxford Cryosystem cooling device. These will be updated to a state-of-the-art microfocus rotating anode generator equipped with CCD detector in 2010. In addition, beamtime for macromolecular crystallography is available on a regular basis at ESRF (Grenoble, France), SOLEIL (Gif-sur-Yvette, France), SLS (Swiss) and DESY (Hamburg, Germany)

Bio-NMR: The lab is equipped with 600 and 800 Mhz magnets with cryoprobes, housed in the Jean Jeener NMR centre.

Surface plasmon resonance spectroscopy: For the study of dynamic interactions with high sensitivity for a minimal amount of materials (picograms), we have a Biacore 3000 from Biacore International AB, Uppsala, Sweden, up and running. The apparatus is equipped with an automatic sampler and a recovery unit for ligand fishing applications. Surface plasmon resonance real-time kinetic measurements are performed without the requirement for labeling of the interacting partners, which can be anything from proteins, carbohydrates, lipids, nanovesicles up to small cells like bacteria.

Atomic force microscopy: Our lab is equipped with a Multimode Nanoscope IIIa AFM from Veeco. Expertise is available to look at proteins, protein crystal growth, DNA (fragments, plasmids), lipid layers, as well as the binding of proteins to DNA or lipid membranes.

Membrane research: Specific technology on membrane and membrane protein research includes a planar lipid bilayer machine from BioLogics connected to an ADI converter which allows us to measure channel forming proteins. A surface balance apparatus (Kibron) can be used to study interactions of different molecules with lipid monolayers. This machine is further equipped with a Langmuir-Blodgett lipid deposition device that can be used in Atomic Force Microscopy studies. The laboratory also has a Lipofast extruder (Avestin) to prepare uni-lamellar vesicles.

Nanobody technology: Camel heavy-chain antibodies bind antigens solely with one single variable domain, referred to as Nanobody (Nb). Methods were developed in the lab to clone the nanobody repertoire of an immunised llama in phage display vectors, and to select the antigen-specific nanobodies from these 'immune' VHH libraries.

Collaboration

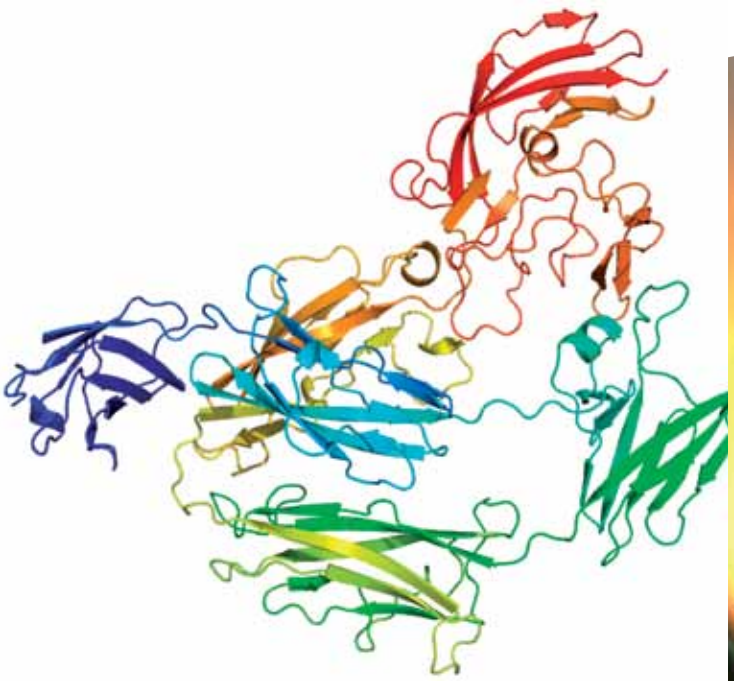
Inter-university & research centres

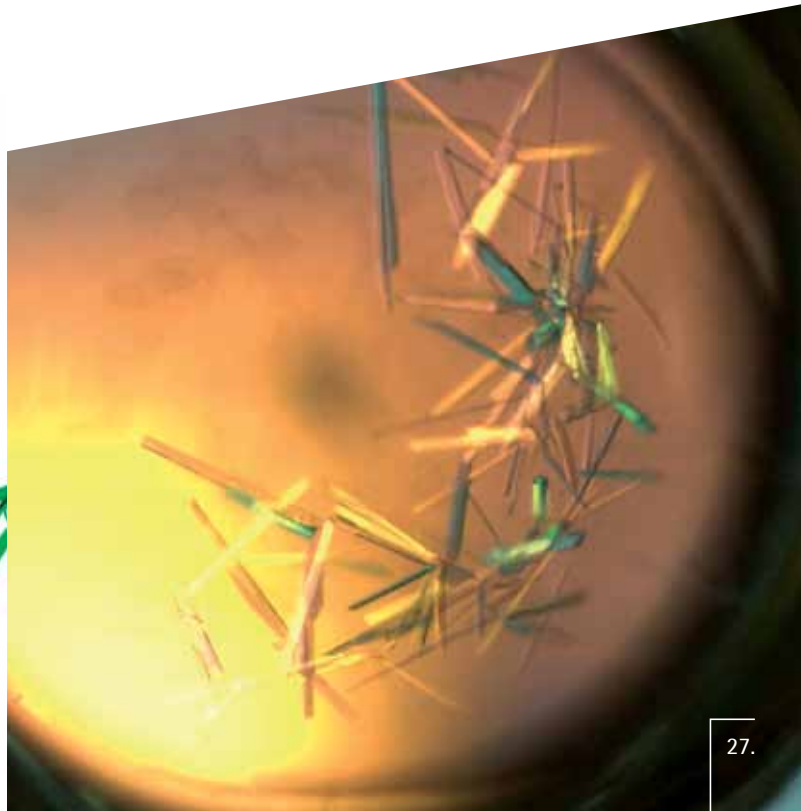
SBB is part of one of the Flanders Institute for Biotechnology (VIB) departments.

The lab also maintains many fruitful international collaborations including groups at the Biochemistry Department - Cambridge (UK), Chemistry Department – UCL (UK), Washington Univeristy School of Medicin, St. Louis (US).

Industrial partners

Galapagos (Belgium), Ablynx (Belgium), Roche (Swiss), Novo Nordisk (Denmark)





Spin-offs of the Vrije Universiteit Brussel in the field of materials

Symbion NV

www.vubonite.com

Symbion has an exclusive licence for **'Inorganic Phosphate Cement' (IPC)**, commercialized as **vubonite**.

Vubonite is a new material which combines the flexibility in design of resins (like polyester) with the properties of a ceramic. Vubonite is a two component system which hardens spontaneously at room temperature. The result of the reaction between powder and liquid components is a hard and white ceramic material. Vubonite is appropriate as a matrix for absolutely incombustible fiber reinforced composites. The usual manufacturing techniques for composites are applicable. Vubonite prices are comparable to those of fire retardant polyester.

Elsyca NV

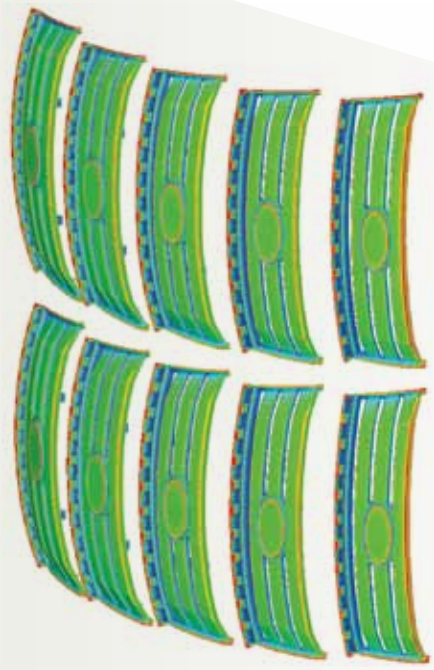
www.elsyca.com

Elsyca is specialised in **modelling, simulating and optimising of electrochemical processes.**

Through its unique software technology and engineering competencies, Elsyca is capable of designing and optimising electroplating, -forming, -etching, -polishing, ECM, anodizing and corrosion protection processes.

Elsyca delivers unique, ready-to-use solutions, consisting of engineering services, high performance hardware tooling and embedded software.

Elsyca has built up an impressive international customer reference list. The added value of the Elsyca solutions for the customers can be directly measured and results in substantial savings across the whole value chain, improved productivity, faster time-to-market and improved product quality and process control.



NMDG NV

www.nmdg.be

NMDG develops and commercializes products and services that **'characterize and analyse beyond S-parameters'** the behaviour of **active high-frequency (HF) electrical components** under realistic test conditions. The main focus is on the non-linear behaviour of these components.

NMDG strives to provide the best solutions for active component characterization and integration to a wide range of customers in high-frequency electronics and communications to make technological advancements that drive and optimize productivity.

Through partnerships and co-operations with leading academic and research institutes, NMDG is committed to empower the research engineer with the advanced tools that provide the competitive advantage.

EqcoLogic NV

www.eqcologic.com

EqcoLogic specializes **in high speed, low power analogue and mixed-signal integrated circuits.**

EqcoLogic developed a range of innovative Equalizer circuits for data communication - in CMOS technology. These designs are adaptive, coping with wide ranges of data rates and cable distances; they offer state-of-the-art input sensitivity, exceptionally low output jitter, low power consumption and flexibility to work with a broad range of transmitters. Ultimately, the use of CMOS technology makes it feasible to integrate the EqcoLogic circuits into larger devices.

There are now EqcoLogic Equalizer solutions for a variety of applications, with data rates from 125Mbit/s to more than 3 Gbit/s. These can be used with appropriate cable configurations, including coax, twisted pair - as well as PCB traces in backplanes.

This makes EqcoLogic equalizers an excellent choice for designers to increase both the transmission speed and reach on their systems.

EqcoLogic is targeting video, audio, automotive and server applications with a number of business partners.

Technological entrepreneurship and business development at the Vrije Universiteit Brussel.

Higher education, entrepreneurship and technology go together well at the VUB. These subjects have deep roots at our institution: extensive experience in innovative entrepreneurship education at the business department; second-to-none scientific and technological faculty; an active and widely respected tech transfer interface.

Under the impulse of the team Technological Entrepreneurship these partners collaborate to develop an encompassing approach to fostering, teaching and supporting technological entrepreneurship. The team focuses especially on the educational aspects, while pooling resources with partners in order to obtain critical mass. During its startup phase the project was funded by the Flemish government and industry partners[1]. The project is part of the General Strategic Plan of the VUB.

Some highlights of the project are:

- introductory courses on entrepreneurship and business, offered to a wide range of (technological and other) Master studies, to young professionals at and around the VUB. We also offer advanced Master classes in (technological) entrepreneurship.

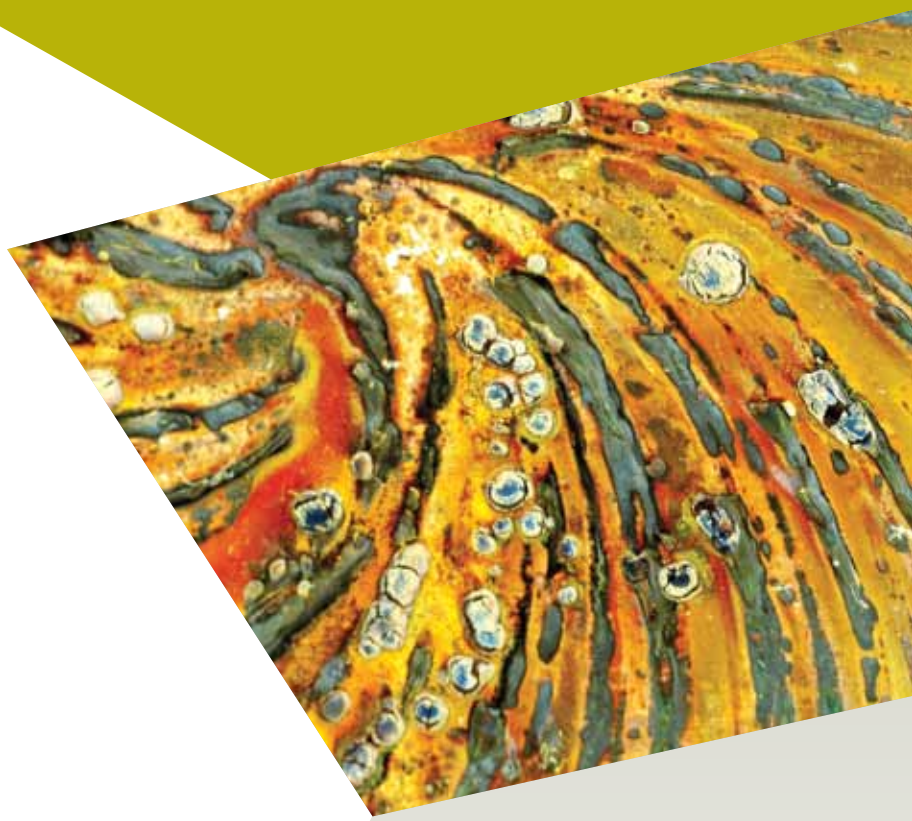
- focus on real life experience with business development. Business and engineering students work on project emanating directly from the research labs, as part of their curriculum.

- focus on building expertise in specific technological sectors, such as biotech, photonics, microelectronics, materials, software. We also strategically choose to share resources with our technological partner groups to jointly fund a full-time specialist in the business/entrepreneurial aspects of the given technological domain. This 'valorisation person', amongst other things, performs business development tasks for the technological department. Today we have active collaborations with 4 research departments.

[1] Amgen, Bank Degroof, Bekaert, Ethias, Fundus, IBM, Participatiemaatschappij Vlaanderen, Sirris, Solvay, Tyco Electronics, Yakult

Our team today (see photo from left to right):

- Tom Guldemont, our photonics industry expert is active as business developer at 'Applied Physics and Photonics'.
- Kevin Douven, our microelectronics/ICT specialist is shared with the department 'Electronics and Informatics' of the VUB.
- Marc Goldchstein is our project leader.
- Leen Lauwers, our materials girl is shared with the research group 'Electrochemical and Surface Engineering'.
- Thomas Crispeels, our biotech man, does assignments for our life sciences research partners.
- Prof. Ilse Scheerlinck, our latest member, also active at Vesalius College, will develop the domain of sustainable energy.



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Universiteit
Brussel

Technology
Transfer
Interface
Brussels

The Technology Transfer Interface of the Vrije Universiteit Brussel: unique entry point and vital link between the university's research & expertise and the industry.

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