



Rethinking Propulsion.

Austrian Association for
Advanced Propulsion Systems

Imprint

A3PS – Austrian Association for
Advanced Propulsion Systems

A3PS is a Public Private Partnership (PPP) between Austrian companies, R&D institutions and the Austrian Federal Ministry for Transport, Innovation and Technology (bmvit) promoting the development and market introduction of alternative propulsion systems and energy carriers.

The representatives of the members form the general assembly of the association. The general assembly elects the executive board of the association.

ZVR.: 133482831, registered at Bundespolizeidirektion Wien, Büro für Vereins-, Versammlungs- und Medienrechtsangelegenheiten.

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A3PS – Austrian Association for
Advanced Propulsion Systems
Österreichische Plattform zur Förderung von
innovativen Antriebssystemen und -technologien
für mobile Anwendungen sowie deren
Energieversorgung und -speicherung

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October 2016 Edition

Design:
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Jägerstraße 24/20
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Photos and figures:
Members of A3PS, Shutterstock

Content

Page

4 Preface

A3PS Members

6	ACStyria
7	AIT Austrian Institute of Technology
8	ANDATA GmbH
9	Automotive Cluster Upper Austria
10	AVL List
11	Bioenergy 2020+ GmbH
12	Biovest Consulting
13	Bosch-Gruppe
14	FH Joanneum
15	FRONIUS International GmbH
16	Graz University of Technology – Institute for Internal Combustion Engines and Thermodynamics
17	Graz University of Technology – Institute of Chemical Engineering and Environmental Technology
18	Graz University of Technology – Institute of Electrical Measurement and Measurement Signal Processing
19	HyCentA – Hydrogen Center Austria
20	IESTA – Institute for Advanced Energy Systems & Transport Applications
21	JOANNEUM RESEARCH
22	Magna
23	Miba Group
24	Montanuniversität Leoben – Department General, Analytical and Physical Chemistry
25	OMV Refining & Marketing GmbH
26	RIC (Regionales Innovations Centrum)
27	Széchenyi István University – Department of Internal Combustion Engines
28	Vienna University of Technology – Institute for Powertrains and Automotive Technology
29	Vienna University of Technology – Institute of Chemical Engineering
30	Vienna University of Technology – Institute of Energy Systems and Electrical Drives
31	VIRTUAL VEHICLE Research Center

Preface

Goals, structure and main focus areas of A3PS



The Austrian automotive industry – or more precisely – automotive supply industry represents a significant value for Austria. Austria exports higher values in automotive parts and components than it imports new, complete vehicles. Furthermore, the automotive sector has the highest share of researchers – about 14%. Austrian universities and research institutions enjoy an excellent international reputation.

In order to maintain this favorable position and to secure Austria's competitiveness in this field, the industry, research institutions and the responsible Austrian authorities need to collaborate very closely. The common goal is to support the successful market launch of innovative, advanced vehicle technologies including new energy carriers. Therefore, the bmvit founded the A3PS in 2006 to support an active technology policy of the ministry and to strengthen Austria's research and development activities.

Since its foundation, A3PS has developed into a well-established strategic public-private partnership (PPP), serving as a reliable partner for the ministry as well as for the partner companies and scientific institutions.

Our key priorities in the area of road transport are to support clean, sustainable, affordable and safe mobility. A3PS helps the officials understand the current technology trends and the R&D requirements of the Austrian stakeholders in this field of expertise. This flow of information provides valuable input for the Austrian technology and funding policy. On the other hand, for the A3PS community, the understanding of Austrian policies is an essential basis for their long-term research planning which provides them with planning security even in technologically risky areas.

A3PS addresses all advanced drive train and vehicle technologies (for example advanced ICE technologies, hybrid, battery electric and fuel cell vehicles, as well as advanced fuel technologies including bio fuels and active safety measures like ADAS and autonomous driving) and it supports the whole innovation cycle (research, development, deployment).

Objectives and Tasks

► Cooperation

Regular joint activities to enable cooperation and common projects for member institutions.

► Networking

Stimulating R&D cooperation which embeds the Austrian industry and research institutions into new national and international value chains in leading positions.

► **Information**

Strengthening the competence of Austrian enterprises and research institutions by collecting, compiling and disseminating information on advanced propulsion systems and new energy carriers. Information for the public on the potentials and the state development of advanced propulsion systems.

► **Competence Presentation**

Presenting the Austrian technology competence to national and international conferences and initiatives.

► **Representation of Interests**

Supporting the representation of Austrian interests on international committees and initiatives of the EU and the IEA.

► **Orientation**

Establishing a common vision between industry, research institutions and technology policy by developing a common strategy, roadmaps and position papers for reinforcing technology development.

► **Advisory function**

Providing fact-based consultancy and recommendations for policy makers to support the optimization of their policy instruments (funding programs, regulations, standards, public procurement, etc.) and informing the public of the opportunities and perspectives of these new technologies.

A3PS offers its members the following broad portfolio of

Activities

- creation of concerted technology roadmaps and position papers
- technology foresight and assessment
- analysis of international R&D strategies
- advisory service for members and the ministry
- organization of a yearly international conference
- organization of internal workshops
- issue of a subject-specific newsletter
- stimulation of research projects
- studies, publications and articles
- representation of members in international/European projects
- excursions to international technology sites and potential partners
- coordination of cluster initiatives (for example FCH Cluster Austria)
- participation in the Technology Collaboration Programmes of the IEA
- marketing for Austrian technology competence

I invite all interested Austrian, European and international institutions to join A3PS on the common path to a cleaner and more efficient mobility of the future.

Wolfgang Kriegler
Managing Director & Chairman of the Board



ACStyria Autocluster



ACStyria

on the way to the mobility cluster

As Austria's premier autocluster, ACStyria has considered its task to be linking up business, industry, research and public institutions in the mobility sector for 20 years.

The Styrian Automotive Cluster ACStyria was founded in 1995 with the goal of promoting automobile-industry competency in Styria, Austria. In order to strengthen the position of Styria as a leading mobility-region, ACStyria Autocluster has strategically widened its field of action to Aerospace and Rail Systems in 2012 and 2013 respectively. ACStyria's seven shareholders with their know-how and economic power represent a central pillar for the Styrian automotive cluster. With these partners, ACStyria Autocluster is perfectly geared up for today's and future challenges.



The seven shareholders are:

- ▶ AVL
- ▶ CROSS Industries
- ▶ Krenhof Schmiedetechnik
- ▶ Magna Steyr
- ▶ SFG
- ▶ TCM International
- ▶ voestalpine

The mission

The mission of ACStyria Autocluster is to integrate stakeholders from the business, industrial, academic, and political communities into a robust network, and to identify areas that are ripe for innovation and synergy. As Austria's premier automotive cluster, ACStyria has set itself the goal of optimizing the innovative capacities of its members and to consolidate Styria's outstanding position as one of Europe's leading regions for research, development, and production.

Enabling information and technology sharing through cross-disciplinary projects and events, as well as establishing well-directed activities in training and qualification are among the core competencies of ACStyria Autocluster.

ACStyria Clean Mobility

In order to be prepared for the future, a common strategic alignment among the partners of ACStyria has been elaborated. "Strategy 2020" can be summed up by the title "CLEAN MOBILITY", which encompasses three clearly defined areas of emphasis: ECO-Powertrains (alternative powertrain technologies), ECO-Materials (environmentally friendly and resource-saving materials) and ECO-Design & Smart Production (cost-efficient and intelligent production systems).

ACStyria Aerospace

In the Styrian aerospace industry, around 1.200 employees achieve a turnover of approximately 250 million Euros each year. Among the leading companies are Pankl Aerospace, Böhler Schmiedetechnik and Magna Steyr Aerospace.

ACStyria Rail Systems

In Styria most of the companies that operate in the rail industry, are part of the Styrian Autocluster ACStyria. Among them are world leaders such as Siemens Rail Systems Graz, voestalpine Schienen and voestalpine VAE.

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AIT Austrian Institute of Technology

The AIT Austrian Institute of Technology, Austria's largest non-university research institute, is among the European research institutes a specialist in the key infrastructure issues of the future. As an Ingenious Partner to industry and public institutions, AIT is researching and developing emerging and next-generation technologies, tools, methods and processes for mobility system based on system competence and interdisciplinary approaches.

AIT Mobility

We develop efficient, safe and green mobility solutions, with a focus on improving road and rail transport infrastructures, advancing low-emission transport means as well as planning and managing multi-modal mobility systems – based on sophisticated models and numerical simulations as well as prototyping and testing. Our research and development for low-emission vehicles rests on two key technological approaches: powertrain electrification as well as functional lightweight materials and components.

Electric Drive Technologies: development centre for electric drive concepts

Various hybrid technology-based or purely electrically-driven vehicles are paving the way for environmentally-friendly mobility. In recent years, AIT Mobility has positioned itself as a recognised development centre for electric drive concepts and systems, helping both manufacturers and suppliers adapt to the hybrid/electric era. Our team of specialists is focused

on optimising the entire powertrain (energy storage, power electronics, etc.) or ultimately the full vehicle to yield maximum efficiency. To this end, we use sophisticated simulation tools to combine thermal, electrical and mechanical properties of components.

Light Metals Technologies: cutting-edge simulation tools and unique research infrastructure

The use of lightweight materials is one of the fastest growing trends in the automotive industry and shows an increased use in vehicle design. The use of light alloys instead of steel offers a significant reduction in weight, which in turn offers improvements in energy efficiency and reduces CO₂ emissions. AIT Mobility uses both cutting-edge simulation tools and a unique research infrastructure to develop and prototype new metal alloys and customized processes for metal forming and the casting of lightweight components.

New battery materials laboratory – battery components for tomorrow's electric era

This Laboratory provides the automotive industry, materials developers, battery and cell manufacturers with high-level scientific expertise in cell chemistry, materials characterization and testing. The range of services ranges from materials synthesis, optimization and analysis to the selection of optimal battery cells through to cell assembly and testing. The services are complemented by expertise in early diagnosis of battery ageing and post-mortem analysis to provide high-content information about the remaining service life and second life of cells.



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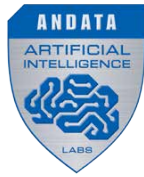
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ANDATA GmbH

Salzburg-based technology company Andata is a leading player in the development of intelligent vehicles and traffic systems. The specialists from Hallein have been making vehicles safer and more intelligent for over 10 years now. They ensure that by the development of predictive algorithms for the control of air-bags, crash mitigation and avoidance systems as well as algorithms for automated driving and traffic control. This is founded on disciplines such as artificial intelligence, machine learning, data mining, numerical simulations and virtual sensors.

In 2009, following several years of collaboration, Audi and Andata founded a joint venture, Automotive Safety Technologies GmbH (ASTech). With Andata's technological approach and the knowledge base of the Audi Vehicle Safety division, software solutions are being developed here for integrated vehicle safety.

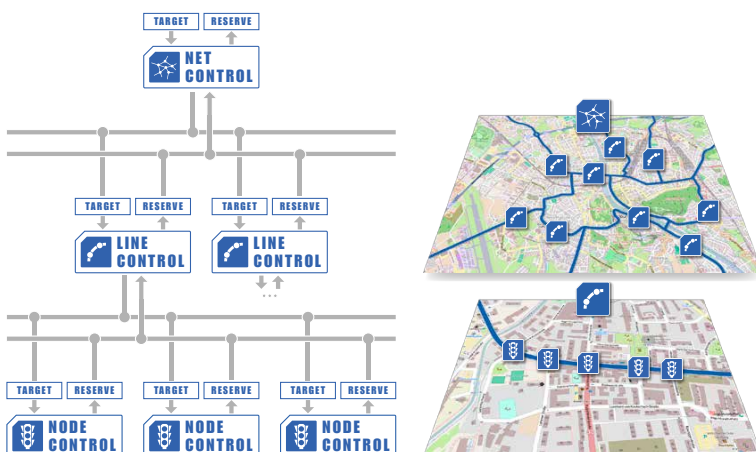
Driver assistance systems have for a long time been indispensable in many vehicles. Above all they have become an integral element in the prevention of accidents. Thanks to the linking of data from the vehicle itself with information from environmental sensors, the driver is firstly warned of potential hazards and then assistance systems can also intervene automatically if necessary. It is not easy to teach assistance systems how to identify potential hazards in traffic. Consequently,

complex simulations for every conceivable situation are played through in the high-performance computers, so that the necessary virtual experience can be drawn upon if the worst comes to the worst. Safety systems can only compute hazards if the relevant data and information is available. This is why Andata deals extensively with sensor technology. Data mining is used to process mountains of sensor data in order to detect the patterns that typically occur with hazards. Actions initiated in good time allow the risk of injury for both driver and other parties involved to be decreased.

In future, cars will not only be equipped with sensors; vehicles must also communicate and cooperate with one another, with traffic management systems and other traffic participants. This paves the way for the networking of all road users, which Andata is working towards. The company has developed a construction kit for traffic control and management that goes by the name of Veronet.

The key lies in the structure of the system architecture: Veronet is decentralised, because the volume of data arising cannot be processed centrally with a reasonable amount of effort. Specifically, this means: The Veronet solution model is based on swarm intelligence. The benefits of this are not only reaped by road users, who experience less traffic congestion, but also by towns and cities, whose infrastructure can be better exploited.

Further information can be found at www.andata.at and www.veronet.eu.



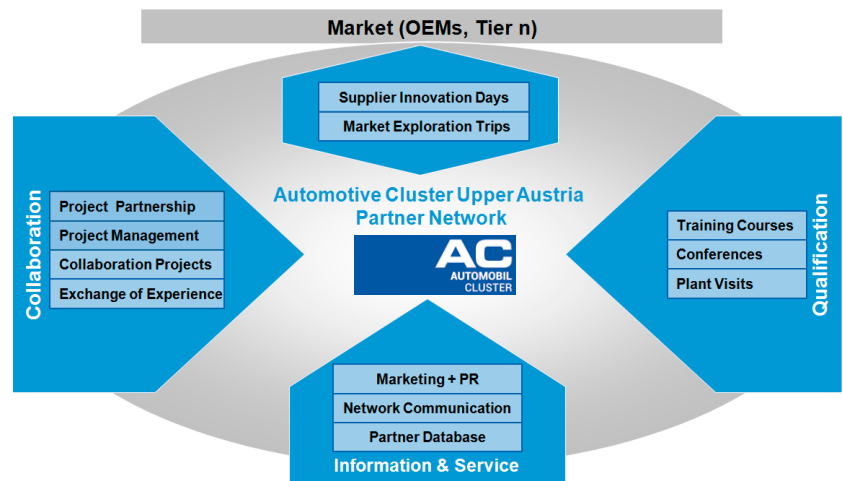
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Automotive Cluster Upper Austria

The Automotive Cluster (AC) is the largest company network of the Austrian automotive industry. Cluster members operate in several sectors of the industry, ranging from the production of parts and assemblies to plant engineering, tool making and applied research. Moreover, OEMs such as BMW, MAN, KTM, BRP-Powertrain, CNH and Rosenbauer play an active part in the network. The majority of the cluster members are highly innovative companies of small and medium size.

In addition to conventional networking and information services, the AC provides specific supportive activities in the fields of cross-company collaboration, internationalization and automotive qualification. Bringing together the right competencies for innovative projects and encouraging companies to work together have always been key goals of the Automotive Cluster. Due to popular demand, certified automotive training courses are offered throughout the year.



Transferring Suppliers' Innovations to OEMs

With great success, the Automotive Cluster launched its Supplier Innovation Days, where cluster members can exclusively present their innovations and new technologies to OEMs' developers and buyers, directly at the OEMs' premises. Typically, these highly efficient one-day-events are composed of in-house expositions, complementary technical presentations and various highlights. The Automotive Cluster puts a lot of effort in the preparatory stages to ensure the best possible matching of technological needs and solutions.

Connected Mobility – the smart future

The aim of the new cooperation platform is the networking of various industry sectors to encourage exchange and to support the development of new products and services in the field of "smart mobility". Successful networking and interdisciplinary collaboration take place between partner companies of the Automotive- and IT-Cluster and R&D institutions, as well as companies & start-ups from inside and outside the sector, public organizations and institutions.

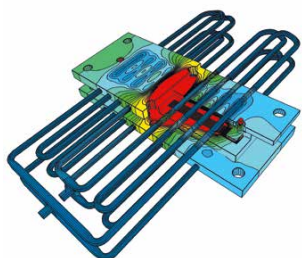
A2LT – Austrian Advanced Lightweight Technology

Together with the Mechatronics- and Plastics-Cluster as well as the ACstyria Autocluster, the Automotive Cluster launched the platform A2LT and linked industrial sectors which deal with lightweight technologies. Lightweight solutions in this platform are influenced by different sectors, such as mechanical engineering, surface coating and technical textiles, as well as the construction industry. Leading companies like voestalpine, AMAG, MAGNA, FACC, Fill and Fronius are also part of the A2LT plenum, as well as small and medium-sized enterprises (SME) along the value chain.

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AVL List



AVL is the world's largest independent company for development, simulation and testing technology of powertrains (hybrid, combustion engines, transmission, electric drive, batteries and software) for passenger cars, trucks and large engines.

Development of Powertrain Systems

AVL develops and improves all kinds of powertrain systems and is an expert partner to the engine and automotive industry. In addition AVL develops and markets the simulation methods which are necessary for the development work.



Engine Instrumentation and Test Systems

The products of this business area comprise all the instruments and systems required for engine and vehicle testing.

Advanced Simulation Technologies

The developed simulation software is focusing on design and optimization of powertrain systems and covers all phases of the development process.

Research Activities

AVL's research focuses on improving fuel economy, reducing emissions and the development of test systems and methods to reach the ambitious goals with greatest accuracy within the shortest possible time frame. Research activities cover petrol, gas and diesel engines as well as all kind of transmissions for

applications ranging from two-wheelers to stationary power generation. Electronics and system integration are key aspects. Hybrid technology and transmission activities as well as simulation tools have a high priority. In the field of fuel cells, the main objectives are simplification and economy, durability and reliability of peripheral system components. On a system level, the activities concentrate on control and fuel cell stack diagnosis with a special technique, AVL THDA™ (Total Harmonic Distortion Analysis).

AVL is particularly active in the sector of electrification of all types of powertrains, also by providing development methods, processes and test systems. This includes in particular the development and optimization of battery systems, electric motors and electronic control for all types of hybrid and electric powertrains.

Instrumentation and test system research focuses on the creation of a seamless, open and integrated development platform covering in-depth simulation on component level as well as simulation of complex powertrain systems. This platform further includes test facilities, sensor technologies, battery test systems, real time calibration tools and the related instrumentation.

Employees: More than 8.050 worldwide (3.450 in Graz)

Affiliates: 45 worldwide

Export quota: 96%

Proportion of company-financed research:

approx. 10% of the turnover

Turnover 2015: 1.27 Billion Euros



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Bioenergy 2020+ GmbH

The Bioenergy 2020+ GmbH is the leading Austrian Institute in pre-competitive research in the field of biomass for energy. The main focus of the company lies on the energetic utilization of biomass. The company carries out R&D on biomass combustion, gasification and fermentation technologies, and provides a wide range of market services such as contract research, studies and analyses, consulting as well as market research.

In the field of conventional biofuels, Bioenergy 2020+ focuses on vegetable oil, biodiesel and bioethanol production technologies and product quality and provides basic concepts. In addition, innovative feedstock such as Jatropha, Algae and waste derived feedstock as well as availability of biomass resources, sustainability, life cycle assessment and certification is of particular interest. In the field of advanced biofuels such as drop-in biofuels (including biofuels for aviation) Bioenergy 2020+ focuses on a number of promising technologies. One of these is the conversion of the product gas from biomass gasification to synthesized biofuels. Bioenergy 2020+ is continuously working on the development and market implementation of FT synthesis for the production of FT fuels. Besides FT synthesis, synthetic natural gas, bio-hydrogen and mixed alcohols are other options which are investigated and developed. Most of these activities are carried out at our testing facilities at the thermal biomass gasification plant in Güssing.

Besides the utilization of product gas obtained by gasification, the upgrading of biogas from fermentative processes is a promising alternative. Bioenergy 2020+ has already successfully demonstrated upgrading processes with the use of membranes within a side stream in a large-scale biogas plant. The optimization of biogas production and plant efficiency in industrial scale are other activities.

Bioenergy 2020+ is actively involved in national and international networks for the deployment of biofuels. Bioenergy 2020+ participates in the international networks IEA Bioenergy Task 39 (Commercializing 1st- and 2nd-Generation Liquid Biofuels from Biomass), Task 33 (Thermal Gasification of Biomass), Task 37 (Energy from Biogas and Landfill Gas). Furthermore it participates in the European Technology Platform "Biofuels" and holds the secretariat of the Advanced Motor Fuels Implementing Agreement of the IEA. These participations allow Bioenergy 2020+ to obtain information on research projects and their results, on the production and the use of biofuels and on the political framework in other countries. Besides other activities, Bioenergy 2020+ has developed and regularly updates a data base on advanced biofuels pilot and demonstration plants (<http://demoplants.bioenergy2020.eu>), which impressively shows the worldwide efforts to develop renewable bio-based transport fuels.



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BIOVEST CONSULTING

Biovest Consulting

Biovest GmbH was incorporated in Vienna in 2002. Biovest focuses its work on market analyses as well as project design and coordination in the field of hydrogen technology and renewable energy. In addition, Biovest is responsible for sales and service in Austria of fully automated PEM electrolyzers made by Proton OnSite.

Biovest participates in research and demonstration projects and assists – Europe-wide – government agencies and power utilities with the integration

of wind power and hydrogen into their energy development master plans. Biovest has installed fully automated PEM electrolyzers at two Austrian hydrogen fuelling stations in Sattledt and Graz.

Recently we have participated in an extensive study proving the technical and financial feasibility of supplying heat to an entire urban district of 20.000 inhabitants by means of hydrogen-containing “Green City Gas” generated from renewable electricity.



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BOSCH

Technik fürs Leben

Bosch-Gruppe

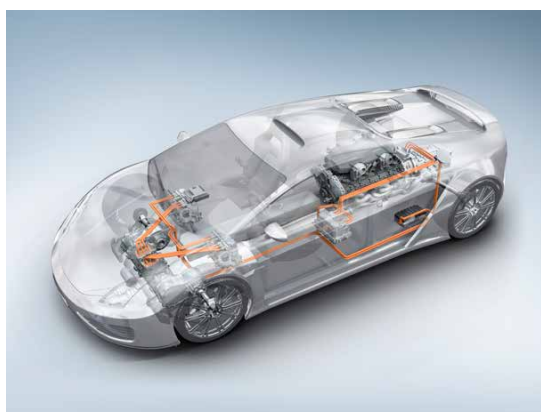
The Bosch Group is a leading global supplier of technology and services. It employs roughly 375,000 associates worldwide. The company generated sales of 70,6 billion euros in 2015. The Bosch Group's strategic objective is to create solutions for a connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life."

Mobility Solutions by Bosch

Mobility Solutions is the largest Bosch Group business sector. In 2015, its sales came to 41,7 billion euros, or 59 percent of total group sales. This makes the Bosch Group one of the leading automotive suppliers. The Mobility Solutions business sector combines the group's expertise in three mobility domains – automation, electrification, and connectivity – and offers its customers integrated mobility solutions. Its main areas of activity are injection technology and powertrain peripherals for internal-combustion engines, diverse solutions for powertrain electrification, vehicle safety systems, driver-assistance and automated functions, technology for user-friendly infotainment as well as car-to-car and Car2X communication, repair-shop concepts, and technology and services for the automotive aftermarket. Bosch has been responsible for important automotive innovations, such as electronic engine management, the ESP anti-skid system, and common-rail diesel technology.

Complementary developments

Bosch is pursuing three development paths, toward driving that is electric, automated, and connected. Whether electrification, automation, or connectivity – all three development paths make personal mobility both sustainable and appealing. That means they are also compatible with contrasting pictures of the future – with both the "green world" and "fun for everyone." But more than that: the three paths complement each other. Drivers will be more at ease if they know they can use the internet to find and reserve not only the nearest parking space, but also the nearest charge spot. Driving becomes even safer once automation allows vehicles to warn each other of intersections with limited visibility or congestion ahead. Our developments interconnect with each other in a coherent way.



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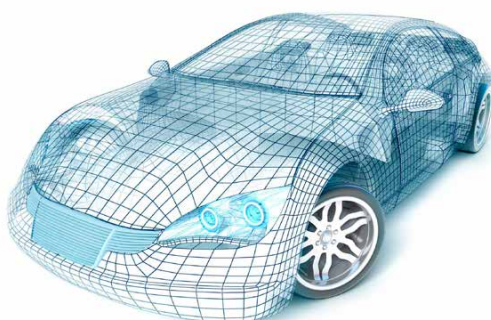


The Institute of Automotive Engineering at the University of Applied Sciences FH JOANNEUM stands for innovative vehicle concepts and sustainable mobility. The focus is firmly set on the entire vehicle, with particular emphasis on virtual system development (modelling and simulation) and testing (mechatronic control systems and application, component and full vehicle tests). The "Automotive Engineering" study programme at the FH JOANNEUM is unique amongst Austrian tertiary institutions and prepares tech-savvy young people for successful careers in engineering, both in Austria and abroad.

Within the framework of customer and R&D projects, the research center at the Institute of Automotive Engineering is involved in a variety of activities ranging from virtual product development through simulation and technical optimization as well as application of computer-aided methods to technical testing of individual components and tests with complete vehicles.

The main pillars of applied research are:

- **Design** (methodology, analysis, conceptualization, feasibility)
- **Technical calculation and simulation** (FEM calculation, computational fluid dynamics, multibody system methods)
- **Control systems and application** (development, design/presentation & optimization of mechatronic systems)
- **Testing** (test procedures, measurement signal acquisition & processing, analysis)



Since early 2000, the Institute of Automotive Engineering has had an accreditation for emission tests according to the international standard EN 17025 (General requirements for the competence of testing and calibration laboratories). Our comprehensive quality management system enables us to maintain the quality of services for partners and clients at the highest level. The test facility is equipped with two engine test benches with exhaust gas measurement, a chassis dynamometer, a skid resistance tester, a tilting bed, a transmission and clutch test bed, two drivetrain test beds, a climate chamber (-50° to +50° C for cold-start tests and investigations of automotive air conditioning) and a SHED system (for performing evaporative-emissions tests on vehicles, tank systems and components).

The chassis dynamometer as well as the laboratory for the SHED system are accredited to European and US standards. A measurement laboratory, a rapid-prototyping facility and automotive workshops are also available. A tensile testing machine, a hardness tester (Vickers, Rockwell, shore-A), equipment for the preparation of metallographic samples, an incident light microscope and a stereomicroscope are available for the characterization of materials. The test facilities are used both for teaching purposes as well for research partnerships with the automotive industry. The Institute of Automotive Engineering employs 35 people, including lecturers, researchers and testing facility as well as administrative staff. A further 50 experts from industry also teach at the Institute. With 11 full-time lecturers for approximately 280 students, we offer an excellent student-staff ratio.

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SHIFTING THE LIMITS

FRONIUS International GmbH

High-tech Power Electronics

Technology development, manufacturing and sales of high-tech power electronics is the core competence of Fronius. About 3700 Fronius employees worldwide are working in the 3 divisions: Solar Electronics, Welding and Battery Charging Systems.

Renewable Energy

Early in the nineties Fronius started its activities in the renewable energies sector with the development of solar inverters for photovoltaic power generation. Today the Solar Electronics Division is the fastest growing business area within the company.



Hydrogen Technology

Technology developments for the emerging hydrogen and fuel cells market, presently underway, will contribute to further improve the leadership of Fronius. For the innovative HyLOG Project (i. e. hydrogen fuel cells drive a transport vehicle) Fronius received amongst others the Energy Globe Award 2007 and the VDI Innovation Price for Logistics 2010. Currently a new fleet demonstration project for a logistic service provider in Austria is on the way.



This vehicle is driven by the Fronius fuel cell technology (HyLOG-Fleet) instead of battery

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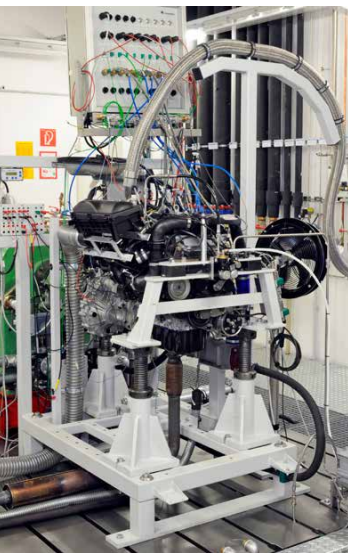
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Graz University of Technology – Institute for Internal Combustion Engines and Thermodynamics



The core objective of the Institute for Internal Combustion Engines and Thermodynamics at Graz University of Technology is to carry out innovative and internationally recognized research and teachings within the interrelated fields of energy, engine technology, transport and environment. Thereby a strong focus is set on the development of sustainable technological concepts to contribute to the reduction of anthropologic environmental burden.

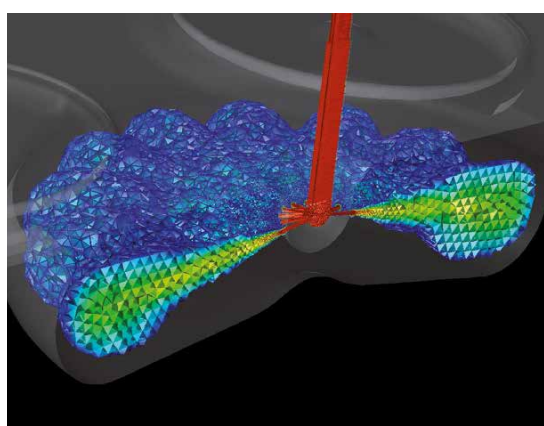
Within the department “Engine Research” the entire variety of challenges in the field of the Internal Combustion Engine can be met. This likewise refers to the layout of entire vehicle concepts from scratch including engineering and design all the way to prototype manufacturing and subsequent testing, as well as to the development of novel and innovative combustion processes for engines within the entire size range of ICEs. Thereby a strong focus is set not only on increasing engine efficiency and minimizing emissions for conventional gasoline- and diesel-type combustion systems, but also on developing combustion processes for alternative fuels, amongst which natural gas and biofuels are as likely to play a key role in the future.

Having participated in successful projects – amongst these the EC-funded HyICE project and the national A3-project H2BVplus or the A3plus-projects Hy2 and MuD (combined motor and steam drive for transport vehicles) – the institute has developed into a recognized authority in the field of gas- and dual-fuelled ICEs.

The equipment for experimental research includes 14 test beds for engines from about 50 cm³ up to 30 dm³, roller test benches and an optical research engine, all equipped with the latest in measurement instrumentation. 3D-CFD simulation in combination with laser-optical measurement techniques finally allows for in-house closed-loop R&D processes.

The department “Thermodynamics and Emission” not only deals with general thermodynamic aspects of numerous applications within the field of engineering sciences, but also with the environmental impact of motor-vehicle emissions, with the ventilation of road tunnels, with the dispersal of pollutants in the air – especially in urban areas – and with the respective measurement and simulation methods.

Last but not least the department “Teachings” provides students with a wide variety of high-quality lectures. Furthermore, interesting subjects for both diploma and doctoral theses are continuously offered, allowing young engineers to deepen their expertises within the framework of premium research projects carried out in cooperation with considerable industrial partners.



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Graz University of Technology – Institute of Chemical Engineering and Environmental Technology

The Laboratory for Fuel Cell Systems at Graz University of Technology is conducting research and development in the areas of hydrogen production and low-temperature fuel cells.

Fuel cells

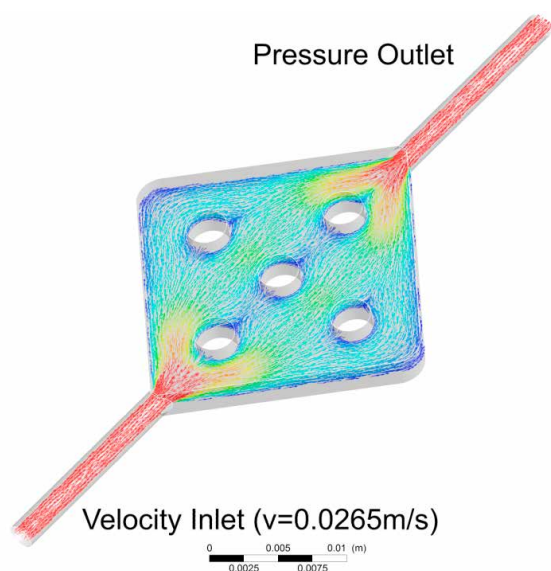
In cooperation with national and international partners R&D in the areas component degradation, alkaline fuel cells, platinum based and platinum free catalysts as well as direct liquid fuel cells is promoted. Since 2014 the group of 15 interdisciplinary scientists occupies a new lab facility that is provided with newest and most up-to-date equipment. The equipment allows the comprehensive investigation on a molecular basis of the catalysts up to short fuel cell stacks in a power range of 500 W. Additionally the complete analysis of the exhaust gas, current distribution with segmented cells and accelerated stress tests are conducted.

Degradation prevention of operational fuel cells is a major topic for which the scientific basis for an online

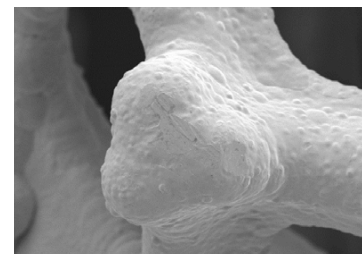
monitoring method has been developed. Within the material research of the laboratory, a technique for the production of carbon nanofiber electrodes has been established, which leads to higher electrochemical corrosion resistance.

Hydrogen production and storage

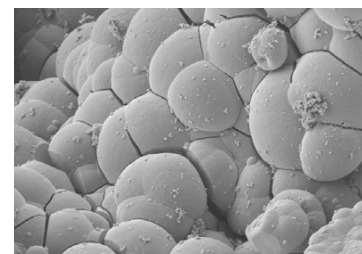
The research focuses on stationary hydrogen production and purification for mobile fuel cell applications. For small scale production of high-purity hydrogen a new process based on the cyclic reduction and oxidation of metallic oxides has been developed. The research on fuel processors is in the field of catalyst development and reaction engineering. The scientific basics of catalysts for ethanol reforming and optimum process conditions for an ethanol to hydrogen reforming process are explored. Reformer components on basis of micro reactor technology are built and tested comprehensively, whereas methods for catalyst coating of metallic microstructures are developed.



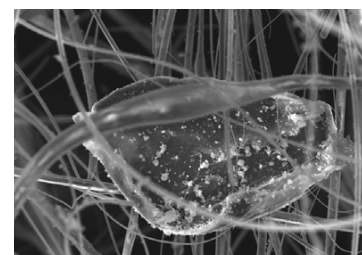
CFD simulation of novel flow field for direct liquid fuel cells



Electron microscopy image of a nickel foam acting as support material for various catalysts



Electron microscopy image of a cobalt based catalyst for hydrolysis of borohydride

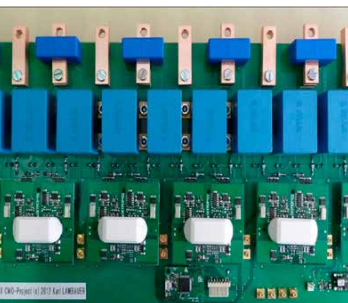


Graphitized carbon particle in ceramic wool originating from carbon deposition during the steam iron process

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Graz University of Technology – Institute of Electrical Measurement and Measurement Signal Processing



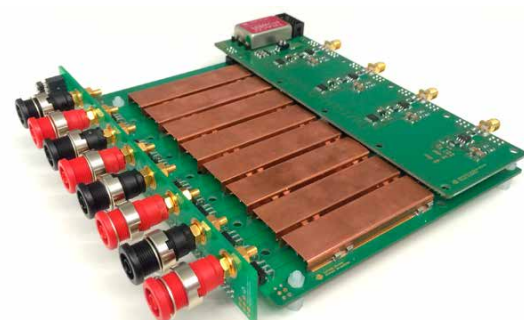
The research activities of the Institute of Electrical Measurement and Measurement Signal Processing (EMT) located at Graz University of Technology are focused on two topics:

Automotive and Industrial Sensor Design

The research interests of EMT focus on the design and optimization of sensors for operation in harsh environments (e.g. online condition monitoring of industrial processes, power grid applications, sub-surface applications etc.). Our research experience covers modeling and simulation of physical sensor effects, analog circuitry design and the development of dedicated digital signal processing methods including statistical approaches for measurement uncertainty quantification. To create cost affordable sensors, non-contacting sensing principles are favored, e.g. capacitive or optical sensing principles. EMT also develops signal processing methods for virtual sensing. Hereby different measurements are combined by means of sensor models, in order to create additional sensing functionality, e.g. to estimate quantities without a dedicated sensor.

Energy Storage Systems

Current research on energy storage components includes both development and evaluation of battery models characterizing the entire life-time of batteries as well as the current charge condition. The models are parameterized/ verified by experimental methods assessing fundamental physical quantities (e.g. pressure, temperature).



In addition to device modelling, alternative energy storage devices are developed and evaluated at the Institute: Current research is focused on the increase of the specific energy and power density of electro-mechanical flywheel systems applied for passenger cars and public transport. This includes the enhancement of the efficiency of the active magnetic parts as well as the application of modern composite materials allowing for an increased rotational speed. In order to optimize the flywheel power converter circuitry, the expertise of the Institute in the field of power electronics is exploited. In this area, we provide support for our industrial partners in both power converter simulation and design, ranging from thermal optimization and EMC compliance verification for electronic circuits to the development of control strategies with regard to modern powertrain topologies.



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HyCentA – Hydrogen Center Austria

Austrian Research Center for Hydrogen with Test Stands and Filling Facility

The HyCentA serves as a focus for Austrian hydrogen related research and development activities with expertise in questions of production, storage and application of hydrogen, including safety, standards and regulations.

Facilities

- ▶ Hydrogen infrastructure with test stands
- ▶ Testing and measuring equipment for hydrogen applications
- ▶ Most advanced fuel cell system test bed in Europe
- ▶ Specialized personnel
- ▶ Filling facility for gaseous hydrogen up to 350 bar

Project partners

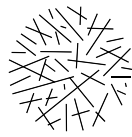
- ▶ Graz University of Technology
- ▶ Forschungsgesellschaft für Verbrennungskraftmaschinen und Thermodynamik mbH,
- ▶ MAGNA STEYR Fahrzeugtechnik AG & Co KG,
- ▶ OMV Refining & Marketing GmbH.

Activities

- ▶ Customer-specific hydrogen test setups and experiments with hydrogen
- ▶ Expertise in questions of safety, standards and regulations
- ▶ Thermodynamic, economical and ecological analyses of hydrogen processes and systems
- ▶ Research and development of PEM fuel cell systems and electrolyzers
- ▶ Conceptual design, development and construction of compressed hydrogen gas-systems, e.g. a power-to-gas plant with different electrolysis technologies
- ▶ Scientific research, lecturing and publications



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IESTA

IESTA – Institute for Advanced Energy Systems & Transport Applications



Comprehensive View of E.-Mobility, Source: Flagship project VECEPT, supported by IESTA)

IESTA is a combined industrial/academic research and consulting association for innovative mobility and energy systems. The institute creates strategic partnerships between innovative Austrian and European enterprises, top listed research facilities and policy-makers in the area of research, technology development and innovation. IESTA offers state of the art methodology for systematic creation of solutions. Its strength lies in effective and efficient management of the whole innovation process from basic and applied research, development, testing, prototyping and demonstration, to communication, dissemination and exploitation of results.

The IESTA portfolio comprises:

Comprehensive R&D Project Management Services

- ▶ Initiation of multi-firm consortia
- ▶ Coordination & authoring of funding proposals
- ▶ Execution, monitoring and controlling of european, national and regional projects
- ▶ Handling of large consortia and large project volumes

Platform for Innovation and Communication

- ▶ Utilization of systematic innovation methods
- ▶ Formation of consortia on national and international level

Studies and Consulting services on

- ▶ Smart/Cooperative Mobility
- ▶ Alternative Propulsion Technologies
- ▶ Energy Conversion and Energy Efficiency Analyses

In the last few years IESTA has successfully supported both industry and academia with:

- ▶ 5 EU projects: Overall budget over 160 Mio Euro
- ▶ 11 projects on national level: Overall budget over 30 Mio Euro

One of the most recent projects, which IESTA is coordinator of, is the Austrian E.-Mobility Flagship project „eMPROVE“ – Innovative solutions for the industrialization of electrified vehicles.

eMPROVE aims at innovative solutions for the industrialization of electrified vehicles, increasing both energy and cost efficiency, with particular focus on possibilities for future industrial mass production. This will be accomplished by improving dedicated vehicle components (e.g. transmission, energy storage systems), by using novel methods, processes and materials for new components (e.g. for battery housing, gear box and thermoelectric heating), and by integrating requirements and recommendations regarding recycling and second life of battery systems into the development and product cycle. Eventually, two tangible integrated demonstrators, a PHEV full vehicle and a modularized battery pack system, will show the functionality of technological solutions of eMPROVE. By this, eMPROVE significantly contributes to the reduction of the main barriers of electro mobility, i.e. range anxiety and high vehicle prices.



The renowned partners of eMPROVE are: IESTA (Coordinator), AVL List GmbH, Samsung SDI Battery Systems GmbH, Saubermacher Dienstleistungs AG, REDUX Recycling GmbH, Zörkler Gears GmbH & Co KG, 4a manufacturing GmbH, ATT advanced thermal technologies GmbH, AIT Austrian Institute of Technology GmbH, Montanuniversitaet Leoben, Leichtmetallkompetenzzentrum Ranshofen GmbH, and VIRTUAL VEHICLE Research Center.

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JOANNEUM RESEARCH

JOANNEUM RESEARCH is one of the largest non-university research institutions in Austria. Our role as an innovative partner for business and administration is reflected in our wide range of services from applied research and development to custom-designed technical business consulting. Eco-mobility is one of the main research areas of the research group "Future Energy Systems and Lifestyle", part of LIFE – Centre for Climate, Energy and Society. Based on our broad technical know-how, we offer development and assessment of eco-mobility, its integration into future renewable energy systems and the evaluation of effects of energy lifestyles to reach the 1.5° C target in the year 2100, as set out in the Paris Agreement.

Eco-mobility

Our activities in eco-mobility cover the entire range of transport systems based on renewable fuels – biofuels, renewable electricity and hydrogen. We develop and analyze technical concepts for biofuel production based on various biomass resources: biodiesel, bioethanol from sugar and starch, biofuels from algae, biomethane from biogas and synthetic biofuels, bioethanol and Fischer-Tropsch diesel from wood and straw and biofuels from biorefineries in co-production with biochemicals and biomaterials. In close cooperation with industry partners we provide technical and sustainability assessments of mobility and hydrogen demonstration activities, based on renewable and fossil energy carriers. Analysis of user behavior, acceptance and lifestyle aspects of innovative transport technologies complement our research profile.

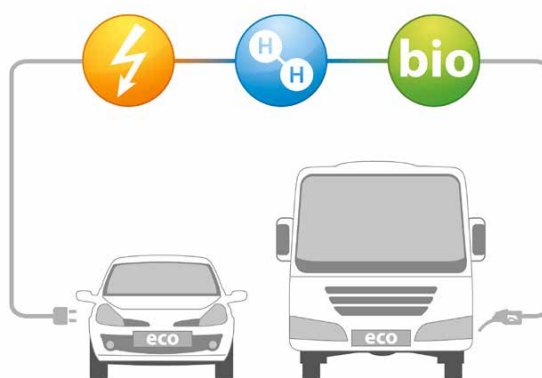
Life Cycle Sustainability Assessment

We offer Life Cycle Sustainability Assessment (LCSA), where we analyze and assess environmental, economic and social aspects of transportation systems. The systematic analysis of the sustainability effects of products and services is covering the entire lifetime, from their production, to their use and disposal. We offer our expertise to industry partners and

public authorities during the research and development phase of eco-efficient and sustainable transport systems, including the entire diversity of power trains, energy supply chains and related bandwidth of environmental effects as well as the influence of various lifestyles.

International Energy Agency

Our activities are connected with the International Energy Agency (IEA) by representing Austria in the Implementing Agreement "Hybrid and Electric Vehicles" in the following Tasks: Task 27 "Electrification of transport logistic vehicles", Task 30 "Environmental effects of electric vehicles" and Task 33 "Battery electric busses".



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Magna



Magna Steyr and Magna Powertrain are companies of Magna International Incorporated. Magna International Inc. is a leading global supplier of technologically advanced automotive components, systems and modules. The company has over 152,000 employees and operates 309 manufacturing operations and 99 product development and engineering/sales centers in 29 countries. In Austria, Magna International Inc. runs 15 manufacturing/assembly locations and 7 engineering/product development & sales divisions.

With its range of services, Magna Steyr covers the product groups:

- Engineering Services: From systems and modules to complete vehicle engineering
- Contract Manufacturing: World Class flexible solutions from niche to volume production
- Fuel Systems: Energy storage systems made of steel, plastic and aluminum

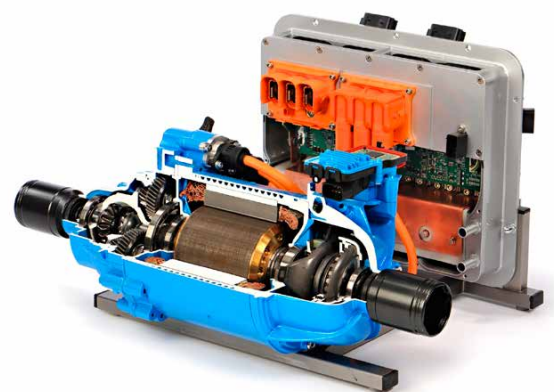
The Engineering Center Austria is organized into the following technical areas: Complete Vehicle, Vehicle Safety, Vehicle Architecture, Body/Doors & Closures, Exterior/Interior, Electrics/Electronics, Chassis/Powertrain, Design House, Prototype Shop, Testing. Our services include complete vehicle engineering as well as the development of modules and subprojects for diverse OEMs. With regard to the future, we focus on innovations in the fields of sustainable mobility, lightweight technologies and materials, electric & electronic system integration, efficient processes, vehicle concepts and production technologies.

Magna Steyr is furthermore a system supplier for lightweight gas storage systems for hydrogen/natural gas. We adapt other modules and furthermore systems for the best possible implementation into the respective vehicle according to customer requirements. In the field of zero emission mobility and besides battery electric vehicles, the potential of fuel cell vehicles is the large driving range and short hydrogen refueling time. Magna Steyr is well positioned to take advantage of future developments in this industry. We offer a wide range of innovative products at hydrogen components, high pressure storage

systems for mobile or stationary applications and liquid hydrogen tank systems for aviation. Our long term experience at fuel cells presents us as strong partner in the field of testing and integration of modules or entire systems.

Magna Powertrain is a premier supplier for the global automotive industry with full capabilities in powertrain design, development, testing and manufacturing. In line with increasing environmental pressure, many of Magna Powertrain's innovations focus on electronically controlled technologies, supporting the quest for improved efficiency and reduced emissions.

Magna Powertrain is an active participator in the shift to electrification in the powertrain market and has taken a leading position in the awareness and development of new drive concepts.



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Innovation in Motion



Miba Group

Miba is an international group that produces technologically advanced and highly resilient power train components. Our products make vehicles, trains, ships, airplanes and power stations more powerful, efficient and environmentally friendly.

Miba engineers customized solutions in close collaboration with its customers. Miba researchers and developers get involved at the early stages of the development phase, and make essential contributions to the overall power train design and its future developments. Our expertise has its solid foundation in decades of experience with materials, applications technology and highly efficient production processes.

Products and solutions

Miba Sintered Components

High-precision, high-strength sintered components are used in car engines and transmissions. The key advantage is that they reduce weight due to their complex design and precisely tailored density. This creates significant potential for increasing efficiency and reducing fuel consumption. Moreover, recently developed solutions for low-noise gear drives meet high acoustic requirements. Soft magnetic sintered components and modules for electrical machines that feature high power density can be used in hybrid and electrical drives as well as in auxiliary components.

Miba Bearings

Engine bearings are crucial components that significantly affect engine function and service life. They are used in diesel and gas engines, for example in heavy-duty vehicles. Miba bearings withstand highest ignition pressures, thus increasing engine efficiency.

Miba Friction Materials

Friction materials are decisive performance elements in vehicle clutches and brakes, optimizing speed and power and facilitating new functions. They are used in cars, including most modern hybrid and other alternative power train systems, as well as in motorcycles

or trucks. Miba Friction Group components reduce weight and transmission size.

Miba Power Electronics Components

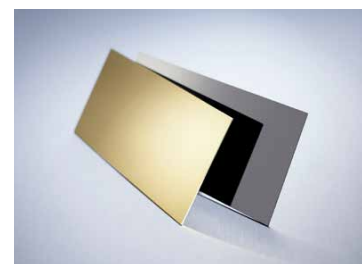
Miba develops and produces resistors and heat sinks. High performance resistors (high power respectively high voltage) are for instance part of power supplies and recuperation systems for hybrids and battery electric vehicles, where they are used e.g. for (de-)charging of capacitors, balancing potential in battery modules or as protective resistors. Miba heat sinks and heat pipes protect active and passive power electronic components against overheating and are used, for instance, in frequency converters and power supplies for electric power trains as well as for battery packs.

Miba Special Machinery

Miba special machinery enables high-precision and swift mechanical production of small to very large components. Miba Automation Systems is leading in stationary and mobile special machinery, especially for the energy sector.

Miba Coatings

Miba develops customized coating solutions comprising special low-friction, wear, low noise, corrosion or electric conductivity characteristics. These coatings ensure maximum service life and optimum functionality. They are used in components for engines, transmissions and other highly sophisticated applications including the area of fuel cell bipolar plates.



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Montanuniversität Leoben – Department General, Analytical and Physical Chemistry

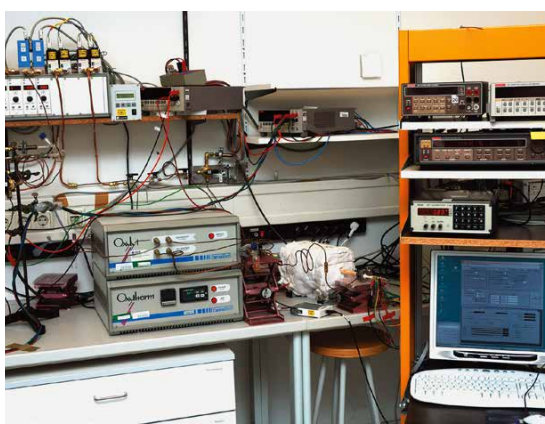
Chair of Physical Chemistry

Research activities at the Chair of Physical Chemistry of Montanuniversität Leoben concentrate on basic aspects of mass and charge transport properties of electroactive materials – ionic and mixed ionic-electronic conducting materials, especially oxides – with respect to defect chemistry including the grain boundary properties. Special attention is paid to the oxygen surface exchange process between gas phase and oxide ceramics. Emphasis is put on basic problems as well as on aspects of application like **cathodes/anodes** and **electrolytes** for **solid oxide fuel cells (SOFCs)/solid oxide electrolysis cells (SOECs)** and interfacially controlled **electroceramic materials**.

Know-how was gained within a number of regional, national and European **research projects** in the field of Solid Oxide Fuel Cells. Presently, the long-term stability and life-time improvement of SOFC-cathodes (oxygen exchange properties) and electrolytes (bulk and grain boundary properties) under real cell operating conditions are goals of the research in the field of SOFCs (including mobile applications) in cooperation with AVL List GmbH Graz, PLANSEE SE Reutte, Research Center Juelich (FZJ), and Fraunhofer Institute for Ceramic Technologies and Systems (IKTS), Dresden. Moreover, additional projects concentrate on interfacially controlled electroceramic materials in cooperation with EPCOS OHG, Deutschlandsberg.

Infrastructure includes equipment for characterization of ionic and mixed ionic-electronic conducting materials, primarily oxides: set-ups for conductivity and conductivity relaxation measurements, impedance spectroscopy, thermal analysis (precision thermogravimetry with mass spectrometry, differential scanning calorimetry, dilatometry), scanning electron microscopy with EDX-detector, equipment for the mechanical machining of samples, chemical laboratories for synthesis, access to XRD (including high-temperature XRD) and analytical methods (RFA, ICP-MS, AAS).

Teaching is focused on lectures and laboratory courses in physical chemistry and electrochemistry e.g. electrochemical energy conversion and storage.



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OMV Refining & Marketing GmbH

With Group sales of EUR 23 bn and a workforce of around 24,100 employees in 2015, OMV Aktiengesellschaft is one of Austria's largest listed industrial companies. In Upstream, OMV focuses on three core regions – CEE (Romania, Austria), North Sea as well as Middle East and Africa – and selected development areas. 2015 daily production stood at approximately 303kboe/d. In Downstream, OMV has an annual refining capacity of 17.8 mn tonnes and approximately 3,800 filling stations in 11 countries as of end of 2015. OMV operates a gas pipeline network in Austria and gas storage facilities in Austria and Germany. In 2015, gas sales volumes amounted to 110 TWh.

Sustainability at OMV

The OMV sustainability strategy Resourcefulness brings together our commitments on health, safety, security, environment, diversity, business ethics, human rights and stakeholder engagement. It is expressed in three key focus areas: Skills to Succeed, Eco-Efficiency and Eco-Innovation.

Eco-Innovation

In order to meet the challenges of the future, we invest in the research and development of new technologies and energy sources. The attention of our activities is directed towards improving the efficiency and use of future sources of energy, with a focus on building the required infrastructure for hydrogen mobility and the production of advanced biofuels.



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RIC (Regionales Innovations Centrum)



RIC (Regionales Innovations Centrum) A state-of-the-art technological research and training hotspot!

The RIC (Regionales Innovations Centrum) GmbH in Gunskirchen is a subsidiary of BRP-Rotax GmbH & Co KG. BRP-Rotax covered 75% of the costs; 24.5% came from the municipality of Gunskirchen, representative of the Upper Austrian Government, the city of Wels and the municipalities of the Wels-Land district; as well as a contribution (0.5%) from the Oberbank Wels. RIC is a platform for the exchange of creative ideas between universities and the industry to increase knowledge and foster innovation.



Altogether, RIC will drive the development of the region and support the Upper Austrian business community. The Regionales Innovations Centrum has a twofold mandate. First of all to focus on designing and developing efficient powertrain technologies to reduce the carbon footprint of existing products and to provide students and apprentices, through a partnership with the University of Graz and the University of Applied Sciences in Wels, Upper Austria, with top-of-line training from experienced people driven by product innovation to stay ahead of technological trends.

Innovation and Qualification Projects

On the one side there will be the next generation of engine technologies with power but overall efficiency as well. The main focus will be on fuel economy, emission reductions, noise, vibration and electronic management control. On the other side there are various projects and activities in the area of "Youth and Technology" for kids and teenagers to awake their enthusiasm for science and technology in the future supported by RIC.

- flyRIC
- Smart Future 4 TEC2move
- Kart 4 U 3 E-Mobility 4 U
- Technic Box for primary schools
- Physical Experience Box
- McTEC for teachers (MfT)
- Fly DOO



The projects flyRIC, Smart future 4 TEC2move, Kart 4 U, E-Mobility 4 U and fly DOO are initiatives within the framework "talents regional" powered by the Ministry for Transport, Innovation and Technology (bmvit).

"In cooperation with BRP-Rotax, these projects help us to get kids and teenagers into science and technology", says Ing. Josef Furlinger, General Manager of RIC, "the projects are best practice examples for a good cooperation between companies and schools to detect young talents and increase the number of engineers in the region." The RIC believes in innovation and qualification and sees itself as an impulse generator in the region. More information on www.ric.at.

BRP-Rotax GmbH & Co KG

BRP-Rotax the subsidiary of BRP in Gunskirchen is a leader in the development and production of innovative premium powertrains for BRP products such as Ski-Doo and Lynx snowmobiles, Sea-Doo watercraft, Can-Am all-terrain and side-by-side vehicles, Can-Am Spyder roadsters as well as for motorcycles, karts, ultra-light and light aircraft. Over the past 50 years, the company has developed more than 350 engine models for recreational products and produced more than 7 million engines.

www.rotax.com

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Széchenyi István University – Department of Internal Combustion Engines

The mission of the Department of Internal Combustion Engines is dual: education and research. We educate students in the field of internal combustion engines, race engines and vehicle technologies. The main research topics lay in the field of engine mechanics and tribology.

The experts at the department are able to answer a wide range of questions in the field of tribology and engine mechanics through many different approaches. Our Ph.D. students perform research in the field of cylinder liner, chains drives, surface characteristics, wear simulation, turbo chargers, and alternative drive systems.

One of our unique capabilities is wear assessment through Radionuclide technology (RNT) that finds a wide range of application from tribometer tests through engine dynamometer tests. The main focus of our work is the reduction of friction and wear in modern combustion engines. The laboratories of the department include a full function engine dynamometer, a friction dynamometer, an oscillation tribometer, and a pin-on-disc-tribometer. A second engine dynamometer, as well as a hot gas and a cold gas turbo charger test equipment are under construction along with a number of component testing equipment.

For the analysis of engine components and failure analysis, we can use microscopy laboratory that includes from standard stereo microscopes through raster electron microscope to Energy-dispersive X-ray spectroscopy (EDX). For investigations of the flow processes in engine components we have a particle image velocimetry (PIV) test equipment.

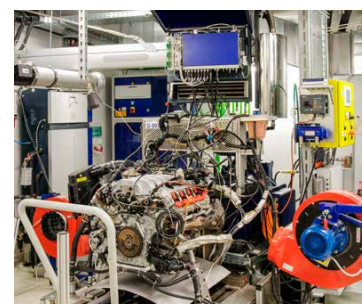
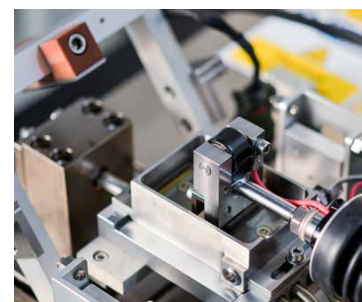
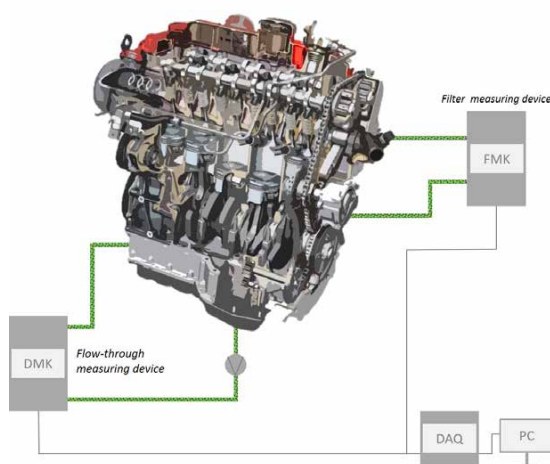
Not all of our students can be involved in the engine dynamometer measurements therefore we developed a virtual test bench for educational reasons. In every semester we offer a presentation series, where colleagues from the industry and universities present interesting topics from their expert field.

Another highlight is the Tribology Conference of Győr, which happens every second year. About 140

colleagues from all over the world attend to present their research in the field of experimental methods to determine friction and wear, simulations of friction, wear, blow-by, component loads and technological approaches for friction and wear reduction.

The Department of Internal Combustion Engines is committed to coaching and hosting a student team, which is developing a race engine for the formula student competition series. The one-cylinder-engine is specifically developed for formula student race cars to optimize the performance and drivability of the vehicle.

All these activities center around one vision: to become a tribology cluster not only in the field of engines.



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Vienna University of Technology – Institute for Powertrains and Automotive Technology



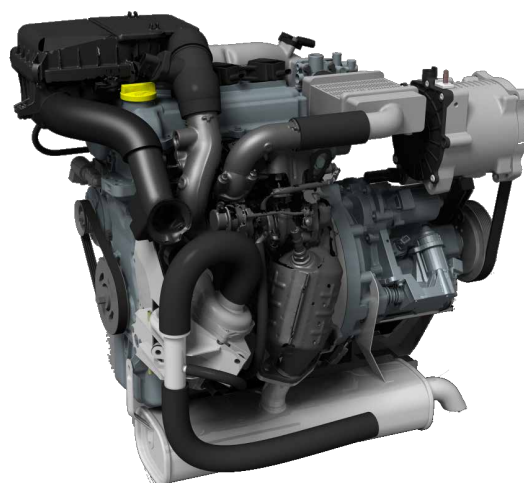
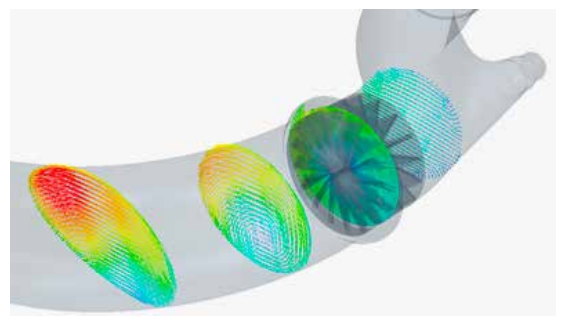
The main tasks of the Institute for Powertrains and Automotive Technology are the **scientific education** for students at the Vienna University of Technology as well as **research work** and consultant activities. For this purpose are approximately 60 employees available, of which one half represents scientists and the second half specialised staff.

The research work concerns all aspects of engineering and improvement of vehicles with special **emphasis to "power train"**. Beside in-house basic research, applied research occupies an eminent part within the work of the institute, by order of important enterprises, like vehicle manufacturers.

The expansive field of work within the scope of **conventional vehicle improvement** contains components development for mixture preparation, ignition, exhaust gas after treatment, thermal management, etc. Therefore **modern developing tools** are used, which include particularly one- and three-dimensional flow simulation (3D-CFD), special measuring devices like fast exhaust emission measuring devices, optical investigation equipment and so on.

A further focus is set on **alternative drive train technologies** and their future applications. Alternative drive train concepts of different **hybrid concepts** including **fuel cells** are investigated and optimized concerning performance and emission characteristics. Therefore, a wide range of vehicle measurement equipment is available and in addition, a battery simulator guarantees a fundamental analysis of the electric hybrid devices. New operating and combustion processes for alternative biofuels of 1st and 2nd generation including hydrogen are developed as well. This work is completed by evaluating the state of technology concerning future environmental impacts.

At last with the test equipment, inclusive climatic chambers with option for cooling down to -35°C , the requirements are fulfilled to generate expertises by quantifying the engine performance, the efficiency and exhaust emissions of vehicles of different kinds, as well as to verify fuel characteristics. By means of a forecast instrument created at the institute the influence of future technologies can be predicted concerning emission development.



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Vienna University of Technology – Institute of Chemical Engineering

The Institute of Chemical Engineering at the Vienna University of Technology is one of the leading research institutes in the field of biomass utilization in Austria. Furthermore, the Institute is integrated into the international scientific society by the partnership in European projects and the representation of Austria in IEA Bioenergy (International Energy Agency). The Institute is shareholder at the competence centre bioenergy 2020+, and holds also the position of a key researcher in the Area “Gasification” in this competence centre.

Currently 25-30 scientific employees are engaged in different projects in the field of biomass utilization. Both conversion routes the thermal as well as the biological are investigated. The character of the projects can be partly considered as fundamental research but also a lot of precompetitive applied projects are carried out. Besides a lot of experimental research work also modelling and simulation of single process steps as well as overall processes is a core expertise at the Institute.

During the last decade a novel process based on biomass gasification for the combined heat and power production has been developed together with Austrian boiler manufacturers and plant operators. A demonstration plant according to this process was started up in 2002 and successfully operated since

that time in Güssing and a second plant is in operation since 2008 in Oberwart. In the last years this technology has been applied also internationally in German and Sweden in the size range of 15 to 33 MW. The producer gas from this steam blown gasification process is well suited as synthesis gas for the production of BioSNG (Synthetic Natural Gas), BioFiT (liquid biofuels from the Fischer Tropsch Synthesis) mixed Alcohols or Hydrogen. All these synthesis processes are currently intensively investigated in the frame of European as well as national projects. An EU-demonstration project was successfully carried out to build and operate a 1 MW plant for the production of BioSNG. Another advanced process based on the Güssing gasification process is currently developed with the aim to integrate the removal of tars and dust inside the gasifier.



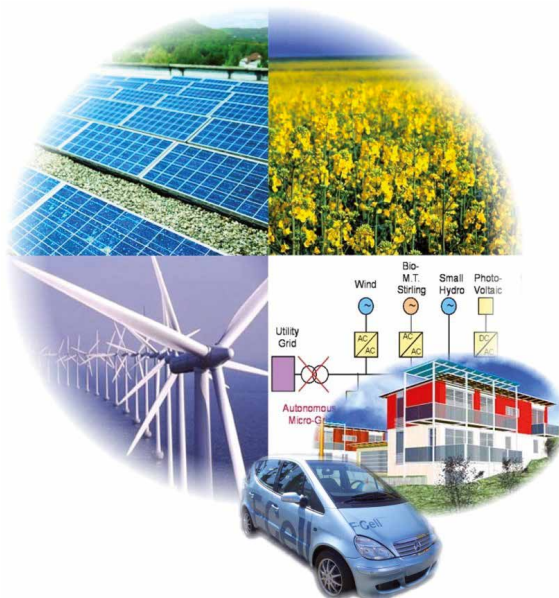
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Vienna University of Technology – Institute of Energy Systems and Electrical Drives

The Institute of Energy Systems and Electrical Drives focuses on three main topics:

- ▶ Electrical power systems
- ▶ Electrical drives and machines
- ▶ Energy economics

The institute covers – in research and teaching – the whole range from analyzing global energy systems to investigating optimal solutions for power systems including power plants and grids to specific applications of technologies like electric drives and power electronics for industry and transport applications.



Finally, our objective is to support the transition of our energy system into a sustainable one. We work on optimal solutions in the whole energy chain incl. supply, generation, transmission, distribution and highly efficient energy conversion in electric and hybrid vehicles.

From the point of view of Alternative Propulsion Systems we can assist you in topics like

- ▶ How should an autonomous distributed regenerative energy system be implemented. Which issue does a sustainable energy system play. What are the effects for the supply guarantee or for the reliability of our power systems.
- ▶ What does it mean if you get your fuel from the wall socket for the energy markets. How does future energy mix look like. Which kind of human machine interfaces are best for both, the consumer and the market.
- ▶ Which components should be used for the Propulsion Systems themselves (permanent magnet synchronous machines, induction machines, reluctance motors) and how should they be controlled (control law, inverter system). Is it possible to substitute the speed sensor even at low speed and standstill (e.g. with INFORM-method)

The Institute of Energy Systems and Electrical Drives offers research cooperations with national and international industrial companies. Should you have interest in a cooperation please contact us.

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VIRTUAL VEHICLE Research Center

The VIRTUAL VEHICLE Research Center is an independent, international platform for research and development in the automotive and rail industry, located in Graz/Austria.

VIRTUAL VEHICLE addresses "smart mobility" and, in particular, the vehicles of tomorrow, which should be safe, environmentally-friendly and affordable. Hence, cutting-edge research and technology development is essential, and simulation is a key opening completely new possibilities. VIRTUAL VEHICLE provides a close linkage of numerical simulation and experimental validation, and offers comprehensive system simulation up to the complete vehicle. Its project landscape ranges from thorough investigation of individual technologies up to combining various individual aspects to create a comprehensive vehicle perspective.

VIRTUAL VEHICLE and its research network is characterized by

- Over 80 international industry partners including leading OEM's, tier 1+2 suppliers and SW vendors
- More than 40 scientific partner institutions worldwide
- More than 200 employees focusing on the development of new technologies, methods and tools for the full vehicle system

Long-term funded industry-oriented research

VIRTUAL VEHICLE is the holding company of "K2-Mobility – Sustainable Vehicle Technologies", an ambitious research program ranging over 10 years. The COMET K2 program provides the basis for funded research activities until at least the end of 2017. In addition, VIRTUAL VEHICLE is currently active in more than 20 EU projects, leading seven of them. A broad portfolio of commissioned research and services rounds off our activities.

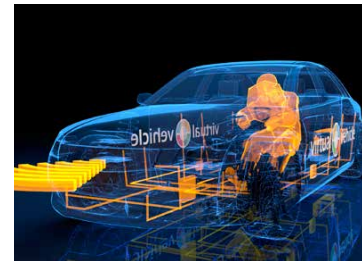
Clustered Competence

VIRTUAL VEHICLE offers a unique added value:

- Sophisticated simulation capabilities (full vehicle

simulation) in the areas of Safe & Secure Mobility, Comfortable Mobility, Green Mobility and Rail Systems as well as outstanding know-how in the area of Efficient Development & Production.

- Measurement and test rigs combined to one comprehensive experimental environment – from complex systems down to subsystems to single components.
- A renowned international network of scientific and industrial partners.



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