HRVATSKA AKADEMIJA ZNANOSTI I UMJETNOSTI

CROATIAN ACADEMY OF SCIENCES AND ARTS

SCIENTIFIC COUNCIL FOR OIL AND GAS ECONOMY AND POWER SUPPLY

and

SCIENTIFIC COUNCIL FOR TRAFFIC

in cooperation with research projects

INSIGHT – Intelligent Data Models for the Battery Cells Production, a cooperation project between the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb and BMW Group,

LIONbat – Development of New Materials and Advanced Innovative Technologies to Produce Lithium-Ion Batteries[1], a cooperation project between the Faculty of Chemical Engineering, University of Zagreb, Ruđer Bošković Institute and the company Sunceco**, and**

MLBattProt - Machine Learning Based Battery Cell Aging Model Used in Computational Geometry for On-line Battery Pack Integrity Protection[2], a cooperation project between the Faculty of Electrical Engineering and Computing, University of Zagreb and the company Rimac Technology

organize and invite you to

SCIENTIFIC CONFERENCE ON NEW METHODS AND TECHNOLOGIES OF BATTERY SYSTEMS FOR ELECTRIC VEHICLES

on Friday, March 28, 2025, from 10:00 to 13:00,

in CASA Library Hall, Zagreb, J.J. Strossmayer Square 14

Scientific conference programme

10:00-10:05	**Welcome speech** / ***Ignac Lovrek,*** F.C.A., *Secretary of the Department of Technical Sciences of CASA*
10:05-10:10	**Conference opening and introduction** / ***Ivan Petrović****, F.C.A., Chair of the Scientific Council for Oil and Gas Economy and Power Supply, and the Scientific Council for Traffic of the CASA*
10:10-10:30	**The Strategic Orientation of Promoting Manufacturing and Recycling Steps with Data Mining Algorithms Using the Example of Prototype Cell Production** / ***Moritz Poremba****, Dipl.-Ing., BMW Group*
10:30-10:40	**Challenges in AI Modelling for Battery Cell Production and Recycling** / ***Ivan Rumenović****, BMW Group*
10:40-10:50	**State of the Art in AI Modelling for Battery Cell Production and Current Research Progress** / ***Marko Švaco****, Ph.D. Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb*
10:50-11:10	**Can the Development of Batteries Keep Pace with the Increasing Demands of Electric Vehicles and Mobile Devices?** / ***Zoran Mandić****, Ph.D. Faculty of Chemical Engineering and Technology, University of Zagreb*
11:10-11:30	**Progress and Challenges of Silicon Anodes in Lithium-Ion Batteries** / ***Matea Raić****, Ph.D., Ruđer Bošković Institute*
11:30-12:00	**Break**
12:00-12:20	**Protective Sets Methodology for Battery Cells of Electric Vehicles** / ***Mario Vašak****, Ph.D., Faculty of Electrical Engineering and Computing, University of Zagreb*
12:20-12:40	**Experimental Approach and BMS Implementation of Protective Sets** / ***Matija Matijašić****, Rimac Technology d.o.o.*
12:40-13:00	**Discussion**
13:00	**Closing of the scientific conference** / *Ivan Petrović, F.C.A.*

Chair of the Scientific Council for Oil and Gas Economy and Power Supply, and the Scientific Council for Traffic of the CASA: Ivan Petrović, F.C.A.

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[2] *The project is financed with the European Union Funds of the National Recovery and Resilience Plan under the number: NPOO.C3.2. R3-I1.04.0263*

Trg Nikole Šubića Zrinskog 11, HR-10000 Zagreb - www.hazu.hr - telefon: +385 1 4895 111 - telefaks: +385 1 4819 979 - e-adresa: kabpred@hazu.hr

About the speakers and topics of the scientific conference

MORITZ POREMBA After graduating from the Technical University of Munich with a specialization in Production Management and Product Development, Mr. Poremba earned the title of *Diplom-Ingenieur* (Dipl.-Ing.). In 2003, he joined the BMW Group. He started as a planner in the department of Assembly Process Planning for High-Performance Motors. In 2013, he became the Head of Production for Special Motors and Logistics at the BMW plant in Dingolfing.

From February 2016 to June 2018, Mr. Poremba served as the project leader for engine S58. In June 2018, he left the BMW Group and took on the role of Director of Motor-ReMan and Supply Chain Management. In this position, he oversaw the planning and production of remanufactured engines for BMW AG. In January 2020, Mr. Poremba returned to BMW as the Head of Periods Controlling, where he was responsible for plant controlling and resource management at the Dingolfing, Regensburg, Leipzig, and Landshut plants. In June 2022, he took on responsibility for Battery Cell Technology Development and Recycling at the BCCC plant. In April 2024 the Battery Recycling was separated and he became the Head of Battery Cell Recycling, where he is responsible for the new BMW Cell Recycling Competence Center.

Lecture: The Strategic Orientation of Promoting Manufacturing and Recycling Steps with Data Mining Algorithms Using the Example of Prototype Cell Production

Abstract: According to new market sales simulation analysis the sales of electric vehicles will surpass two-thirds of global car sales by 2030. Since battery is the most significant component of electric vehicles and battery cell most significant component of battery implicates this, that the battery cell and expertise in battery production will be the most important distinguishing feature in the automotive industry. To gain a competitive advantage, automotive and battery cell manufacturers are fighting to achieve the best possible cell properties at low manufacturing costs. When talking about production costs, the recycling process must not be ignored. Due to ever higher raw material prices, the recycling process is becoming increasingly important.

Battery recycling and battery cell production must therefore be regarded as a uniform process. The two processes combined result in an enormously high number of parameters, which can hardly be optimized using classic trial and error methods. Instead, AI-based prediction models or so-called digital twins should be used, which are able to predict the outputs of individual intermediate and finished products. By accurately predicting output parameters, the digital twins can contribute to cost reduction, process acceleration and quality improvement and thus lead to a competitive advantage.

IVAN RUMENOVIĆ After receiving the bachelor's degree at the University of Zagreb, and completing the internship at BMW Group, Mr. Rumenović started his career path in the BMW Group as a development engineer in the vehicle thermal management division. He worked on overheating tests, measures to prevent it, as well as on the optimization of the measurement analysis process, automating numerous manual procedures.

At the end of 2015, he started with a master’s study at the Technical University of Munich, with a specialization in mechanical engineering and management. During his master’s study, he worked in the combustion engine research and development division, where he was responsible for the development of components for prototype vehicles.

After graduating from the Technical University of Munich in 2018, he became the project manager of the adaptive recuperation function for mild hybrid vehicles. In January 2023, he became the project manager for the production logistics ordering system in the battery cell competence centre. From January 2024, he is leading a project on AI Modelling in Battery Cell Production. The project is being carried out in cooperation with the University of Zagreb.

Lecture: Challenges in AI Modelling for Battery Cell Production and Recycling

Abstract: For AI-based prediction models to be used, several challenges must be overcome. First, all necessary parameters must be recorded. Sometimes it is even necessary to adapt the processes so that parameters can be recorded. IT requirements must therefore be considered when designing battery production processes.

Since AI-based models have the disadvantage of requiring large amounts of data, the number of input quantities in the AI models must also be reduced by using the physically based models. Due to the high complexity of the process, the modelling of processes is a research issue. Therefore, it was decided to include academic support in the project, and a cooperation with the University of Zagreb was established.

MARKO ŠVACO is an assistant professor at the Department of Robotics and Automation of Production Systems at the Faculty of Mechanical Engineering and Naval Architecture (FSB), University of Zagreb. He is the head of the Chair of Autonomous Systems and Computer Intelligence and the head of the Regional Centre of Excellence for Robotic Technology (CRTA). He has been employed at the FSB since 2010, where he received his doctorate in 2015. During his doctoral studies, he was a visiting researcher at KTH, Sweden. His scientific research focus is on the field of medical robotics and autonomous systems. He teaches many courses in the field of robotics and autonomous systems. Since 2024, he has been the head of the undergraduate and graduate study of mechatronics and robotics at FSB. As an associate or researcher, he participated in more than 20 projects and is currently a principal investigator of two scientific and three research projects. As an author or co-author, he published 19 papers in international journals and more than 30 papers at international conferences. As one of the main members of the research team, he was involved in the development of the RONNA robotic system for use in neurosurgery, which is the first neuronavigation robotic system developed in the Republic of Croatia. He is one of the co-founders of MedTech startup RONNA Medical. He was awarded numerous domestic and foreign awards, notably the award for the best young researcher "Vera Johanides" of the Croatian Academy of Technical Sciences (HATZ) in 2019. He is a member of the scientific and editorial boards of two scientific journals and participates as a member of different boards of four scientific conferences. He actively uses the English language in speech and writing.

Lecture: State of the Art in AI Modelling for Battery Cell Production and Current Research Progress

Abstract: Artificial intelligence (AI) is revolutionizing battery cell production, offering innovative solutions to optimize efficiency, sustainability, and performance in manufacturing processes. State-of-the-art AI techniques, such as machine learning and deep learning, are being applied to critical stages like material selection, cell design, production monitoring, and quality control. Predictive models enable real-time adjustments, reducing defects and material waste, while advanced algorithms support the discovery of new materials with enhanced energy densities and longer lifespans. AI also facilitates process automation, enabling scalable and cost-effective production. By integrating AI into battery production pipelines, manufacturers

can meet the growing demand for high-performance batteries in applications such as electric vehicles and renewable energy storage. This talk will explore how cutting-edge AI tools and predictive modelling could shape the future of battery technology, ensuring sustainable production. The talk will give a brief overview of the current research conducted at CRTA and BMW Group.

ZORAN MANDIĆ is a professor at the University of Zagreb Faculty of Chemical Engineering and Technology. He has a background in electrochemistry and electrochemical engineering fields. In the last ten years, his work has focused on the development of advanced electrode materials for energy storage applications, particularly batteries and supercapacitors. The development of electrochemical methods in performance testing and predicting cycle life and SoH is also of increasing interest in his research. He has led several international and national projects, published more than 50 papers in international journals, 3 patents and had many invited lectures at international conferences and events.

Lecture: Can the Development of Batteries Keep Pace with the Increasing Demands of Electric Vehicles and Mobile Devices?

The development of electric vehicles and consumer electronics places increasing demands on battery systems in terms of energy and power density, cycle life and operating temperature range. The properties and performance of single battery cells depend on the chemical composition of the cell, the rate of electrochemical reactions that occur during discharge/charge and the design of the cell. In the development of battery cells, it is necessary to combine knowledge of chemical and material engineering, electrochemical and electrical engineering. This lecture will discuss the current state of the composition and functioning of single cells, their chemistry and new trends in their development.

MATEA RAIĆ is an external associate at the Ruđer Bošković Institute. Her scientific work focuses on the synthesis and characterization of materials, as well as electrochemistry. She completed her PhD the Ruđer Bošković Institute, specializing in the development of advanced anode materials for lithium-ion batteries. During her postdoctoral training at the National Institute of Chemistry in Ljubljana, Matea worked on developing electrolytes for aluminium and magnesium batteries. Her research interests are focused on the development of electrode materials with advanced electrochemical properties. She published nine peer-reviewed scientific papers, five of which she published as first author. Additionally, she has actively participated in numerous international conferences and science popularization activities.

Lecture: Progress and Challenges of Silicon Anodes in Lithium-Ion Batteries

Abstract: Silicon anodes have great potential for increasing the capacity and energy density of lithium-ion batteries, making them crucial for future applications such as electric vehicles and energy storage systems. The lecture will present the main challenges of silicon anodes, including volumetric expansion, structural degradation, and instability of the solid electrolyte interphase (SEI), and will introduce innovative solutions such as nanostructuring and the development of composite materials. The lecture will conclude with an overview of future directions and opportunities for the application of silicon anodes in commercial battery systems.

MARIO VAŠAK is a full professor tenure at the Department of Control and Computer Engineering, University of Zagreb Faculty of Electrical Engineering and Computing (UNIZG-

FER) and he is heading UNIZG-FER's Laboratory for Renewable Energy Systems. His research interests are in the domain of dynamic systems predictive control with applications to systems from the low-carbon energy sector. In the past 15 years he led more than 20 research projects on UNIZG-FER dealing with predictive control in green energy systems. He authored more than 30 journal and in total more than 150 internationally reviewed research papers, with received more than 1000 citations according to Web of Science.

Lecture: Protective Sets Methodology for Battery Cells of Electric Vehicles

Abstract: In terms of expected lifespan, batteries are one of the most expensive and weakest links in electric vehicles, and it is necessary to ensure their exploitation in conditions that degrade them as little as possible. The need for the fastest possible charging, the greatest possible energy recovery during braking, and the best possible dynamic performance of the vehicle subjects the batteries in different modes of vehicle use to stress that impairs their integrity to a greater or lesser extent, depending on the established battery loading profiles. Therefore, the battery integrity protection system needs to be optimally integrated into the vehicle management system so that, while the battery lifespan is extended, the vehicle performance is least possibly degraded or in the best case not degraded at all.

The presentation focuses on protection sets that include as many points as possible in the space of battery cell states and battery charge/discharge current or power profiles that ensure compliance with all limitations for the battery cell longevity. By protective sets, predictive control and set theory are applied to a battery cell model, and with their use in the operation of the battery management system acceptable battery load profiles are dynamically and continuously located in a set that depends on the estimate of the current state of battery cells. This set localization of the admissible battery loading profiles is then used in different vehicle subsystems to ensure vehicle exploitation with respected battery longevity constraints.

MATIJA MATIJAŠIĆ is employed full-time at Rimac Technology as a Battery Cell Modelling Engineer. His main tasks include numerical modelling of battery cells, estimating cell aging, evaluating the performance of battery cells as well as entire battery packs, and designing fast-charging profiles for batteries. Over the past six years at RT, he has worked on numerous projects, including Rimac Nevera, Aston Martin Valkyrie, Pininfarina Battista, and others.

Lecture: Experimental Approach and BMS Implementation of Protective Sets

Abstract: For reliable, efficient, and optimal utilization of an electric vehicle battery, both hardware and software elements are essential. The hardware component is the so-called "brain" of the battery – the Battery Management System (BMS), which collects and monitors the key parameters of the cells and manages their operation. The software comprises algorithms responsible for keeping the battery within safe operating limits, regardless of whether it involves charging, discharging, or regenerative braking.

To achieve high accuracy and reliability, mathematical models tailored for operation on the BMS are being developed. Their creation involves extensive testing under various conditions—from different current and temperature variations to different stages of cell health. In some cases, it is also necessary to take a closer look inside the cell itself, i.e., measure its electrochemical properties to ensure maximum accuracy and efficiency of the algorithms.

This presentation will focus on the process of creating these models and their more advanced versions, as well as on how they are implemented together with battery state monitoring

algorithms on BMS. Additionally, it will demonstrate the introduction of protective sets on the BMS, along with the challenges and advantages of this approach. Finally, a new project (MlBattProt) relying on machine learning-based models will be presented.