"Toward Carbon Neutral Transportation by Electrification"

Program & Abstracts

EVTeC 2023

THE 6TH INTERNATIONAL ELECTRIC VEHICLE TECHNOLOGY CONFERENCE

MAY 22-24 2023

PACIFICO YOKOHAMA, JAPAN (Hybrid: In-Person and Virtual)

Organized by Society of Automotive Engineers of Japan, Inc. (JSAE)

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Contents

Welcome Remarks

Keiichiro Kondo

Waseda University
Chairperson of EVTeC2023

"Toward Carbon Neutral Transportation by Electrification"

Organized by JSAE, most highly valued Japanese academic society of automotive engineers in the world, EVTeC is a conference that focuses on BEVs, HEVs, FCEVs, PHEVs and various other related technologies. The first EVTeC was held in May 2011 with great success. Despite being held immediately after the Great East Japan Earthquake, it featured 66 presented papers and was attended by 230 participants. The second EVTeC was successfully held in May 2014, featuring 90 papers and 264 participants. The third EVTeC in May 2016, was also a success with 101 papers and 293 participants. The fourth was held jointly with EVS organized by JARI as EVS 31 & EVTeC in October 2018 in Kobe, with the scale expanding to 317 papers and 1160 participants in the symposium. After this joint EVS, the fifth EVTeC in May 2021 was held independently online, and attracted 90 papers and 250 participants, even under the circumstances of the COVID-19 pandemic.

EVTeC2023 at Pacifico Yokohama, is held basically with a style of face-to-face alongside the JSAE Annual Spring Congress including a 100,000 person-scale exhibition. Participation in the Spring Congress and exhibition is free of charge for EVTeC participants, and these events provide an excellent opportunity to experience the front line of activities in Japan firsthand.

Countries around the world are pinning much hope on the electrification of vehicles and putting much effort to enhance the related technologies, toward "carbon neutral transportation" as an effective means and a strong policy to cope with global warming problems. As part of these initiatives, along with innovative advances in batteries and other component technologies, the evolution towards vehicle traction electrification has been steadily promoted.

In recent years, in addition to partnerships with electric power systems, we have also started exploring the potential creation of value and provision of services based on new perspectives such as CASE (connected, autonomous, shared, and electric) on the back of advances in information technology.

We trust that EVTeC2023 will fulfill its promise as a prestigious forum for international discussion on the topics of new mobility contributing to carbon neutrality and smart society.

Let's make this meeting worthwhile and enjoy the networking at the historic port town!

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Minoru Kamata (Japan Automobile Research Institute (JARI), Japan)
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Keiji Ohtsu (Honda Motor Co., Ltd. /Society of Automotive Engineers of Japan, Japan)
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Seiji Sano (TOYOTA MOTOR CORPORATION)
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Japan EV Club (Japan)
The Japan Institute of Power Electronics (JIPE, Japan)
The Japan Society of Mechanical Engineers (JSME, Japan)
The Japanese Society for AI (JSAI, Japan)
The Korean Society of Automotive Engineers (KSAE, Korea)
New Energy and Industrial Technology Development Organization (NEDO, Japan)
Next Generation Vehicle Promotion Center (NeV, Japan)
The Norwegian Electric Vehicle Association (Norway)
SAE International (USA)
The Society of Instrument and Control Engineers (SICE, Japan)
World Electric Vehicle Association (WEVA)

General Information

Event
The 6th International Electric Vehicle Technology Conference (EVTeC2023)

Date
May 22-24 2023

Venue
PACIFICO YOKOHAMA, JAPAN (Hybrid format)

Registration Desk
Monday, May 22	8:30-18:00
Tuesday, May 23	8:30-17:30
Wednesday, May 24	8:30-16:30

Official Language
English

Badge
All participants are kindly requested to wear their badges during the conference.

Coffee Break
Coffee and bottles of water will be served during the conference in front of the session rooms.

Internet Access (within the venue)
SSID: EVTeC2023
Password: yokohama_ev2023

Certificate of Attendance
Contact at the Check-in Desk and staffs will issue your certificate upon your request.

Lost and Found
Inquiries regarding lost and found articles can be made at the registration desk.

Cloakroom
Please drop off your baggage at the registration desk.

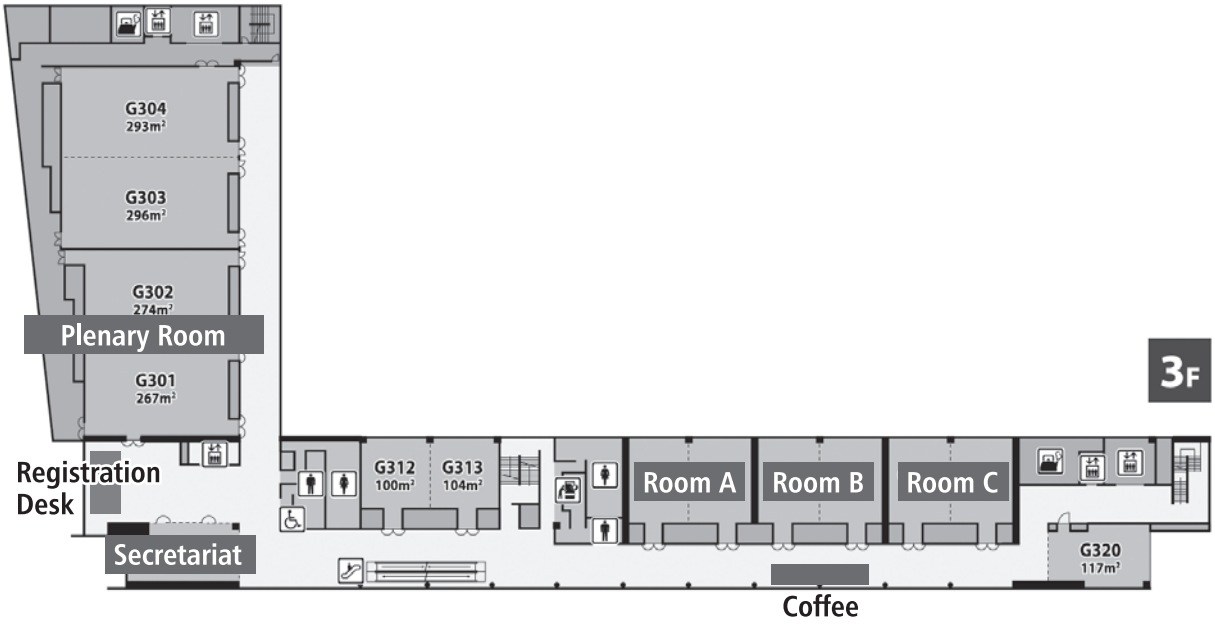
Photography and Recording
All Participants except an official photographer are NOT allowed to take photos or screenshots of any live presentation. The official photographer will be present at the venue to take pictures for recording. Please note that the pictures will be published at the website and used for other communications activities after the event.

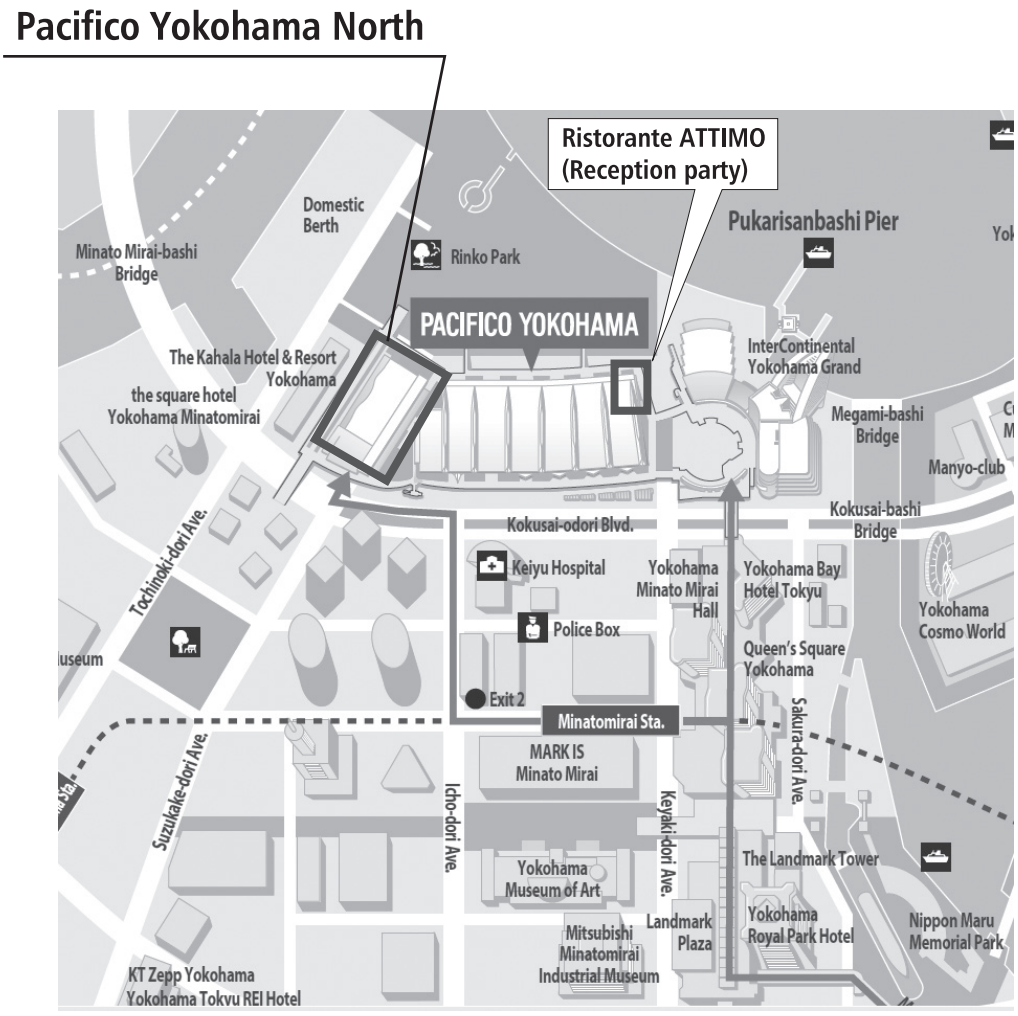
Reception Party (pre-booked only)
Date & Time: 18:00-20:00, Tuesday, May 23, 2023
Place: Ristorante ATTIMO (on the ocean side of the Exhibition Hall 2F) *see the next page

Young Investigator Awards & Closing Ceremony
The events will be held at Room C in May 24, 2023. Young Investigator Awards Winners should be announced during the ceremony.

Map

Conference venue: 3rd Floor, Pacifico Yokohama North

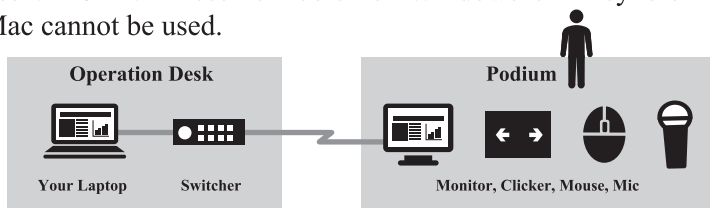




Guidelines for Presenters

Presentation time

20 min total (15 min for presentation, 5 min for discussion)

In-person Presenter	**20 minutes prior to your session** (during coffee break)	You are requested to come and bring your laptop with you to your session room **20 minutes** prior to the start of a session (during coffee break).
		Place your laptop on the operation desk next to the podium. Your laptop is connected to the switcher and your slides can be displayed to a screen and a monitor on the podium. You are able to control your slides by a mouse or clicker at the podium. If your laptop is not allowed to connect to other devices, please hand over your USB flash drive including your slides to the desk. NOTE: "Presenter tools" of Windows or "Keynote" of Mac cannot be used. 
	Session Starts	Stand by near the podium
	At your presentation	Check your presentation slides on the monitor of the podium and start your presentation.
	Discussion	A chair opens the floor including the virtual venue to any questions.
	End	The chair closes your presentation and turn back to your seat.
Virtual Presenter	**20 minutes prior to your session** (during coffee break)	You are requested to enter to your virtual session room **20 minutes** prior to the start of a session (during coffee break). First, enter the virtual venue (https://smartconf.jp/content/evtec2023) and select your session room and click the button "Watch the Live Streaming ". Zoom launches and put your display name with your Session ID (e.g., A11-EP_John Smith) on Zoom.
		An operator contacts you via Zoom, and then the operator checks whether you are able to share your screen and your mic is working.
	Session Starts	Stand by in front of your PC.
	At your presentation	You may start your presentation and share your screen after the chair introduces you.
	Discussion	Chair opens the floor including the virtual venue to any questions.
	End	Chair closes your presentation, and you stop sharing your screen.

In case of no-show

If you are a no-show and don't give a presentation during the session, we cannot issue the Certificate of Presentation to you. A pre-recorded presentation video cannot be acceptable without your attendance.

The Young Investigator Awards

The award ceremony will be held at the closing ceremony in May 24. The winners will be announced at the ceremony.

	DAY 1 May 22 MONDAY			DAY 2 May 23 TUESDAY		
Room / Time	Plenary Room			Plenary Room		
	G301+G302			G301+G302		
9:20	Opening Ceremony					
9:30	**Plenary Session 1** **"Nissan's Challenges for Future Mobility"** Toshihiro Hirai (Nissan Motor Co., Ltd.) Moderator: Keiichiro Kondo (Waseda University)			**Plenary Session 4** **"Toyota's Strategy toward Carbon Neutral Transportation"** Mitsumasa Yamagata (TOYOTA MOTOR CORPORATION) Moderator: Toshifumi Takaoka (TOYOTA MOTOR CORPORATION)		
10:10	**Plenary Session 2** **"Rare Metals Essential for Next Generation Vehicles: Current and Future Problems"** Toru H. Okabe (The University of Tokyo) Moderator: Yoichi Hori (Tokyo University of Science)			**Plenary Session 5** **"The Future Society Engendered by Lithium-ion Batteries"** Akira Yoshino (Asahi Kasei Corp.) Moderator: Daichi Imamura (Japan Automobile Research Institute (JARI))		
10:50	**Plenary Session 3** **"Introduction on Sustainable Development Standards for Automotive Industry in China"** Tongzhu Zhang (China Automotive Technology & Research Center Co., LTD.) Moderator: Yoshitaka Asakura (KABUSHIKIKAISHA AYE)			**Plenary Session 6** **"Sweden Plans for Electrified Road Systems, ERS"** Jan Pettersson (Swedish Transport Administration) Moderator: Takamitsu Tajima (Honda R&D Co., Ltd.)		
11:30	Lunch by own 11:30-12:50					
Room / Time	Room A G314+G315	Room B G316-G317	Room B G318-G319	Room A G314+G315	Room B G316-G317	Room B G318-G319
12:50	**A11-EP** Technologies for Transpotation System and New Service Chair: Osamu Shimizu (The University of Tokyo), Yujin Gotoda (DENSO Corp.) 20231010 20231011 20231012 20231013	**B11-MOT** Performance Improvement of Electric Machines Chair: Hiroya Sugimoto (Tokyo Denki University) 20231023 20231024 20231025	**None**	**A21-EP** Technology for In-wheel and Novel Drive Systems Chair: Osamu Shimizu (The University of Tokyo), Shintaro Ohshio (Powertrain and EV Engineering Division) 20231043 20231044 20231045 20231046	**B21-WPT** Dynamic Wireless Power Transfer 1 Chair: Katsuhiro Hata (The University of Tokyo), Keisuke Kusaka (Nagaoka University of Technology) 20231055 20231056 20231057	**C21-PE** Motor Drive Technologies Chair: Kenta Emori (Nissan Motor Co., Ltd.), Kentaro Hirose (TOYOTA MOTOR CORPORATION) 20231066 20231067 20231068 20231069
14:10	Break (20min)			Break (20min)		
14:30	**A12-EP** Technologies of Next Generation Charging System Chair: Osamu Shimizu (The University of Tokyo), Takashi Majima (IHI Inspection & Instrumentation Co.,Ltd.) 20231014 20231015 20231016 20231017	**B12-PE** Power Electronics System Technologies Chair: Tomohiro Fukazu (HONDA R&D Co., Ltd.), Satoshi Yasuda (TOYOTA MOTOR CORPORATION) 20231026 20231027 20231028 20231029	**C12-BAT** Energy Storage Devices & Systems: Systems & Applications Chair: Takaji Umeno (Toyota Central R & D Labs., INC.), Daichi Imamura (Japan Automobile Research Institute) 20231034 20231035 20231036 20231037	**A22-EP** Battery Management and Grid Connectiing Systems Chair: Hiroshi Senoh (National Institute of Advanced Industrial Science and Technology (AIST)), Takeshi Kato (Honda R&D Co.,Ltd.) 20231047 20231048 20231049 20231050	**B22-WPT** Dynamic Wireless Power Transfer 2 Chair: Ryosuke Ota (Tokyo Metropolitan University), Takehiro Imura (Tokyo University of Science) 20231058 20231059 20231060 20231061	**C22-MOT** Permanent Magnet Machines in Transportation Applications Chair: Junichi Asama (Shizuoka University), Kohei Aiso (Shibaura Institute of Technology) 20231070 20231071 20231072 20231073
15:50	Break (20min)			Break (20min)		
16:10	**A13-EP** Modeling and Evaluation for EV Systems Chair: Hiroshi Nishimura (Vitesco Technologies Japan K.K.), Takashi Majima (IHI Inspection & Instrumentation Co., Ltd) 20231018 20231019 20231020 20231021 20231022	**B13-PE** Power Electronics Component Technologies Chair: Kenta Emori (Nissan Motor Co., Ltd.), Satoshi Yasuda (TOYOTA MOTOR CORPORATION) 20231030 20231031 20231032 20231033	**C13-BAT** Energy Storage Devices & Systems: Batteries & Capacitors Chair: Manabu Watanabe (Nissan Motor Co., Ltd.), Noriko Yoshizawa (National Institute of Advance Industrial Science and Technology) 20231038 20231039 20231040 20231041 20231042	**A23-EP** Autonomous Drive Technologies Chair: Hisashi Imanaga (Japan automobile research institute), Yoshitaka Asakura (KABUSHIKIKAISHA AYE) 20231051 20231052 20231053 20231054	**B23-WPT** Wireless Power Transfer - EMC Chair: Masahiro Hanazawa (UL Japan), Yukio Yokoi (Takuhsoku Univ) 20231062 20231063 20231064 20231065	**C23-MOT** Future Trend and Challenges in Electric Machines Chair: Hideaki Arita (Mitsubishi Electric Corporation), Kyohei Kiyota (Tokyo Institute of Technology) 20231074 20231075 20231076 20231077
17:30				Move to the party venue		
17:50						
18:00				Reception Party 18:00-20:00		

DAY 3 May 24 WEDNESDAY

Room / Time	Plenary Room G301+G302		
9:20			
9:30	**Plenary Session 7** **"Drivetrain Power Electronics Developments in the UK"** Philip Mawby (University of Warwick) Moderator: Satoshi Yasuda (TOYOTA MOTOR CORPORATION)		
10:10	**Plenary Session 8** **"Decarbonizing Motor Vehicles' Power Systems, Fuels and Energy toward 2050"** Yasuhiro Daisho (Waseda University) Moderator: Makoto Uchida (University of Yamanashi)		
10:50	**Plenary Session 9** **"Honda's Vision for Carbon Neutrality in 2050"** Keiji Ohtsu (Honda R&D Co., Ltd.) Moderator: Kenji Natori (Chiba University)		
11:30	**Lunch by own 11:30-12:50**		
Room / Time	Room A G314+G315	Room B G316-G317	Room B G318-G319
12:50	**A31-EP** Control for Drive Systems Chair: Daisuke Gunji (NSK Ltd.), Giuseppe Guidi (SINTEF Energi AS) 20231078 20231079 20231080 20231081 20231082	**B31-WPT** Wireless Power Transfer 1 Chair: Keisuke Kusaka (Nagaoka University of Technology), Katsuhiro Hata (The University of Tokyo) 20231087 20231088 20231089 20231090 20231091	**C31-FC** Hydrogen and Fuel Cell Technology Chair: Kiyoshi Yamaura (Mitsubishi Motors Corporation), Seiji Sano (TOYOTA MOTOR CORPORATION) 20231096 20231097 20231098 20231099 20231100
14:30	**Break (20min)**		
14:50	**A32-EP** Eaxle and Powertrain System Chair: Takashi Hirose (SUBARU Corporation), Takeshi Kato (Honda R&D Co.,Ltd.) 20231083 20231084 20231085 20231086	**B32-WPT** Wireless Power Transfer 2 Chair: Yukio Yokoi (Takushoku University), Ryosuke Ota (Tokyo Metropolitan University) 20231092 20231093 20231094 20231095	**C32-FC** Hydrogen and Fuel Cell Technology Chair: Makoto Uchida (University of Yamanashi), Shigeki Oyama (Honda R&D Co., Ltd.) 20231101 20231102 20231103 20231104
16:10			Young Investigator Awards, **Closing Ceremony**
16:30			

Plenary Sessions

Day 1 May 22

Plenary Session 1
Plenary Room (G301+G302) 9:30 -

Nissan's Challenges for Future Mobility

Senior Vice President
Toshihiro Hirai
Nissan Motor Co., Ltd.

Plenary Session 2
Plenary Room (G301+G302) 10:10 -

Rare Metals Essential for Next Generation Vehicles: Current and Future Problems

Director General and Professor
Toru H. Okabe
Institute of Industrial Science, The University of Tokyo

Plenary Session 3
Plenary Room (G301+G302) 10:50 -

Introduction on Sustainable Development Standards for Automotive Industry in China

Dr.
Zhang Tongzhu
Auto Standardization Research Institute, China Automotive Technology & Research Center Co., LTD.

DAY 2 May 23

Plenary Session 4
Plenary Room (G301+G302) 9:30 -

Toyota's Strategy toward Carbon Neutral Transportation

Powertrain Company President
Mitsumasa Yamagata
Toyota Motor Corporation

Plenary Session 5
Plenary Room (G301+G302) 10:10 -

The Future Society Engendered by Lithium-ion Batteries

Honorary Fellow
Akira Yoshino
Asahi Kasei
The Nobel Prize in Chemistry 2019

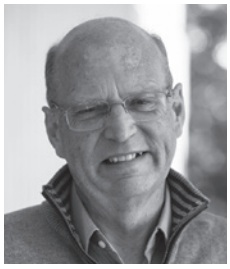
Plenary Session 6
Plenary Room (G301+G302) 10:50 -

Sweden Plans for Electrified Road Systems, ERS

Director Swedish Electrification Program
Jan Pettersson
Swedish Transport Administration

Plenary Sessions

Day 3 May 24



Plenary Session 7

Plenary Room (G301+G302) 9:30 -

Drivetrain Power Electronics Developments in the UK

Professor
Philip Mawby
University of Warwick

Plenary Session 8

Plenary Room (G301+G302) 10:10 -

Decarbonizing Motor Vehicles' Power Systems, Fuels and Energy toward 2050

Professor Emeritus
Yasuhiro Daisho
Waseda University

Plenary Session 9

Plenary Room (G301+G302) 10:50 -

Honda's Vision for Carbon Neutrality in 2050

President and Representative Director
Keiji Ohtsu
Honda R&D Co., Ltd.
JSAE President

Program

Day 1 (Monday, May 22)

Opening Ceremony

Plenary Room (9:20-9:30)

OP **Welcome Remarks**
Keiichiro Kondo (Chair, Steering Committee, Waseda University)

Plenary Session 1

Plenary Room (9:30-10:10)

Chair: Keiichiro Kondo (Waseda University)

20231001 **Nissan's Challenges for Future Mobility**
Toshihiro Hirai
(Nissan Motor Co., Ltd.)

Plenary Session 2

Plenary Room (10:10-10:50)

Chair: Yoichi Hori (Tokyo University of Science)

20231002 **Rare Metals Essential for Next Generation Vehicles: Current and Future Problems**
Toru H. Okabe
(The University of Tokyo)

Plenary Session 3

Plenary Room (10:50-11:30)

Chair: Yoshitaka Asakura (KABUSHIKIKAISHA AYE)

20231003 **Introduction on Sustainable Development Standards for Automotive Industry in China**
Tongzhu Zhang
(China Automotive Technology & Research Center Co., LTD.)

Lunch by own (11:30-12:50)

A11-EP **Technologies for Transportation System and New Service**

Room A (12:50-14:10)

Chair: Osamu Shimizu (The University of Tokyo), Yujin Gotoda (DENSO Corp.)

20231010 **Dynamic Modeling and Control of Motoring-gear for Automated Guided Vehicle Powertrain Application**
Yu-Chin Hsu[1], Mi-Ching Tsai[1], Jia-Sheng Hu[2], Liang-Yi Hsu[1], Chin-Yang Chang[1], Chi-Yang Chang[1], Chinweze U. Ubadigha[1]
([1]National Cheng Kung University, [2]National University of Tainan)

20231011 **Vehicle to Grid assisted 100% renewable energy supported electric grid system in Japan**
Shemin Sagaria[1], Mart van der Kam[2], Tobias Boström[1]
([1]UiT - The arctic University of Norway, [2]University of Geneva)

20231012 **High Power and Power Density Inductive Charging System for Busses and Heavy-Duty Vehicles**
Giuseppe Guidi[1], Jon Are Suul[1,2]
([1]Sintef Energy Research, [2]Norwegian University of Science and Technology (NTNU)

20231013 **Bi-level Network Design for UAM Vertiport Allocation Using Activity- Based Transport Simulations**
Sebastian Brulin[1], Markus Olhofer [1]
([1]Honda Research Institute Europe GmbH)

B11-MOT **Performance Improvement of Electric Machines**

Room B (12:50-14:10)

Chair: Hiroya Sugimoto (Tokyo Denki University)

20231023 **Measurement of Vibration and Acoustic Noise Generated by Magnetostriction in Three Stator Cores Made of High Silicon Steel, Amorphous Iron, and Conventional Silicon Steel**
Yifei Cai[1], Akira Chiba[1], Fares S. El-Faouri[1], Naoki Saikawa[1], Yoshizaki Soichiro[2]
([1]Electrical and Electronics Engineering Department of Tokyo Institute of Technology, [2]Steel Research Laboratory of JFE Steel Corporation)

20231024 **Development of a High-Torque Motor with Superior Noise and Vibration Characteristics**
Yoshimasa Kaneda[1], Masashi Matsuda[1], Yuki Mawatari[1], Suzune Mizuno[1]
([1]DENSO CORPORATION)

20231025 **Experimental Consideration on Mode Electricity Consumption of Permanent Magnet Synchronous Motor with Torque Ripple Suppression Control Considering Magnetic Saturation**
Taiki Mikami[1], Keitaro Kawarazaki[1], Nobukazu Hoshi[1]
([1]Tokyo University of Science)

Break (14:10-14:30)

A12-EP **Technologies of Next Generation Charging System**

Room A (14:30-15:50)

Chair: Osamu Shimizu (The University of Tokyo), Takashi Majima (IHI Inspection & Instrumentation Co.,Ltd.)

20231014 **450-kW Conductive Dynamic Charge System**
Takamitsu Tajima[1], Wataru Noguchi[1], Hiroka Shigi[1]
([1]Honda R&D Co., Ltd.)

20231015 **Optimizing the Positions of Battery Swapping Stations - Pilot Studies and Layout Optimization Algorithm -**
Tobias Rodemann[1], Hiroaki Kataoka[2], Thomas Jatschka[3], Günther Raidl[3], Steffen Limmer[1], Hiromu Meguro[2]
([1]Honda Research Institute Europe, [2]Honda R&D, [3]TU Wien)

20231016 **Evaluation of Energy Transfer Efficiency and Path-Tracking Performance for an Autonomous Truck Model with Dynamic Wireless Charging**
Mats Jørgensen[1], Giuseppe Guidi[2], Jon Are Suul[1,2]
([1]Norwegian University of Science and Technology, [2]SINTEF Energy Research)

20231017 **Activation Timing Control Using On-board Camera for Dynamic Wireless Power Transfer Under Circuit Parameter Variations**
Ryo Matsumoto[1], Hiroshi Fujimoto[1]
([1]The University of Tokyo)

B12-PE **Power Electronics System Technologies**

Room B (14:30-15:50)

Chair: Tomohiro Fukazu (HONDA R&D Co., Ltd.), Satoshi Yasuda (TOYOTA MOTOR CORPORATION)

20231026 **A Study on Auxiliary Circuit for Floating Bidirectional Power Flow Controller based on Partial Power Conversion**
Yohei Sasaki[1], Kenji Natori[1], Yukihiko Sato[1]
([1]Chiba University)

20231027 **Next generation Electric Drive Units with Multi-level GaN Inverter for Highest HV EV Performance and Efficiency**
- Comparison of 2-level and 3-level inverter topologies -
Philipp Matt[1], Thomas Hackl[1]
([1]hofer powertrain)

20231028 **A Model-Based Study on a DCDC Converter Reactor Miniaturization using a Variable Bias Magnet Suitable for Vehicle Drive Applications**
Shunya Sakamoto[1], Kensuke Sasaki[1]
([1]Nissan Motor Co., Ltd)

20231029 **Development of the power control unit for the new hybrid system**
- Action of the system loss minimization -
Yoshihiro Shamoto[1], Hiroyuki Oyanagi[1], Ryoji Sato[1], Ryoji Hironaka[1]
([1]TOYOTA MOTOR CORPORATION)

C12-BAT **Energy Storage Devices & Systems: Systems & Applications**

Room C (14:30-15:50)

Chair: Takaji Umeno (Toyota Central R & D Labs., INC.), Daichi Imamura (Japan Automobile Research Institute)

20231034 **Development of Ultralow-Floor All-Electric Light-Duty Truck**
Akira Hashito[1], Manabu Masuda[1], Hisashi Higashi[1], Yu Yaguchi[1]
([1]Hino Motors, Ltd.)

20231035 **Experimental Verification of Control Method to Increase Motor Power of Rail Vehicle with Onboard Energy Storage System**
Hiroyasu Kobayashi[1], Ryuichi Tsutani[1]
([1]Chiba University)

20231036 **Power control strategies Based on Peak and Frequency for Hybrid Type Batteries**
Ryo Kimura[1], Yuki Hiratsuka[1], Keiichiro Kondo[1], Shunya Sakamoto[2], Kensuke Sasaki[2]
([1]WASEDA University, [2]Nissan Motor Co., Ltd.)

20231037 **High heat-resistant Lithium-ion Capacitor Module for HINO TEAM SUGAWARA Dakar HEV**
- Super-durable, excellent output performance and vibration resistance -
Takumi Mio[1], Yukihiro Komatsubara[1], Hisato Kobayashi[1], Naoki Ohmi[1], Hideyuki Hasegawa[1], Akitsugu Yamaguchi[1], Koji Nishi[1]
([1]JTEKT Corporation)

Break (15:50-16:10)

A13-EP **Modeling and Evaluation for EV Systems**

Room A (16:10-17:50)

Chair: Hiroshi Nishimura (Vitesco Technologies Japan K.K.), Takashi Majima (IHI Inspection & Instrumentation Co., Ltd)

20231018 **High-Precision Evaluation System of EV Motors in Low-speed Conditions for Improving Motor Control**
Keita Inagawa[1], Takuma Nagashio[1], Yusuke Takeda[1], Koji Sato[1]
([1]ONO SOKKI CO., LTD.)

20231019 **Distributed Validation and Testing of EV Systems**
- Results of the European Project XILforEV -
Valentin Ivanov[1], Viktar Beliautsou[1], Florian Büchner[1]
([1]Technische Universität Ilmenau)

20231020 **Application of Thermal CAE Analysis to Electric Drive Module for xEV**
Michinari Fukuoka[1], Yuki Fujita[1], Masahiro Takemoto[1], Yoshiyuki Kimura[1]
([1]DENSO CORPORATION)

20231021 **Cooling Performance of Lubricating Oils for Liquid-Cooled Motor and Battery Thermal Management System in EVs**
Keiichi Narita[1], Yasuhito Nakahara[1], Kazushige Matsubara[1], Hiroyuki Tatsumi[1] Daisuke Takekawa[1]
([1]Idemitsu Kosan Co., Ltd.)

20231022 **Investigation of Internal Deformation of Lithium-ion Battery and Simulation Model for Internal Short Circuit**
Shinichi Amano[1], Hiromichi Ohira[1], Nobuhiro Matoba[2], Yasuhito Aoki[2]
([1]JSOL Corporation, [2]Toray Research Center, Inc.)

B13-PE **Power Electronics Component Technologies**

Room B (16:10-17:50)

Chair: Kenta Emori (Nissan Motor Co., Ltd.), Satoshi Yasuda (TOYOTA MOTOR CORPORATION)

20231030 **Automotive Power Electronics Technology**
Masashi Kosuga[1], Hideyo Suzuki[1]
([1]Hitachi Astemo, Ltd.)

20231031 **Lowering Carbon Emission with Autonomous Driving Vehicles**
- Increasing Energy Savings with Advanced Power MOSFETs -
Martina Giuffrida[1], Giusy Gambino[1], Carmelo Mistretta[1], Giuseppe Longo[1], Filippo Scrimizzi[1]
([1]STMicroelectronics)

20231032 **Direct Power Semiconductor Cooling – Potentials, Challenges and Development Approaches**
Benjamin Pessl[1], Gregor Gaßner[1], Hannes Hofstetter[1], Michael Haider-Peterseil[1]
([1]Magna Powertrain / Engineering Center Steyr)

20231033 **Side Gate HiGT That Realizes the High Power Density of IGBT Modules**
Yujiro Takeuchi[1], Masayuki Kamikawa[2], Yukihiro Kumagai[2], Takashi Wada[2], Toshiki Tanimura[2], Takayuki Ouchi[1], Hisayuki Tsuruoka[2], Seiichi Hayakawa[2], Takayuki Kushima[2], Yutaka Kato[2], Masaki Shiraishi[2], Tetsuo Oda[2]
([1]Hitachi, Ltd., [2]Hitachi Power Semiconductor Device, Ltd.)

C13-BAT **Energy Storage Devices & Systems: Batteries & Capacitors**

Room C (16:10-17:50)

Chair: Manabu Watanabe (Nissan Motor Co., Ltd.), Noriko Yoshizawa (National Institute of Advance Industrial Science and Technology)

20231038 **Material Search of Oxide-Based Lithium Ionic Conductors for Next- Generation All-solid-state Lithium Battery**
Kota Suzuki[1], Ryoji Kanno[1]
([1]Tokyo Institute of Technology)

20231039 **Exploration of New Materials for All-solid-state Lithium-ion Batteries by Materials Informatics**
Makoto Saito[1], Koki Nakano[1], Hisatsugu Yamasaki[1], Kunihiro Nobuhara[1]
([1]Toyota Motor Corporation)

20231040 **Effects of Step Length to Failure Mode about Micro Penetration of Traction Batteries**
Zhipeng Sun[1], Hua Ma[2], Fang Wang[1], Xiuling Gao[2], Weijian Hao[1], Shiqiang Liu[1], Yuechao Zhang[2], Yue Xu[1], Weina Wang[1] Tianyi Ma[1]
([1]China Automotive Technology and Research Center Co., Ltd., [2]Tianjin EV Enegies Co., Ltd.)

20231041 **Separation Technologies for the Resource Recycling of Lithium-ion batteries**
Chiharu Tokoro[1,2]
([1]Waseda University, [2]The University of Tokyo)

20231042 **Development of Next Generation Battery for Hybrid Electric Vehicle - Development Status in Vehicle Energy Japan -**
Yasuo Arishima[1], Shuichi Suzuki[1]
([1]Vehicle Energy Japan Inc.)

Day 2 (Tuesday, May 23)

Plenary Session 4

Plenary Room (9:30-10:10)

Chair: Toshifumi Takaoka (TOYOTA MOTOR CORPORATION)

20231004 **Toyota's Strategy toward Carbon Neutral Transportation**
Mitsumasa Yamagata
(TOYOTA MOTOR CORPORATION)

Plenary Session 5

Plenary Room (10:10-10:50)

Chair: Daichi Imamura (Japan Automobile Research Institute (JARI))

20231005 **The Future Society Engendered by Lithium-ion Batteries**
Akira Yoshino
(Asahi Kasei Corp.)

Plenary Session 6:

Plenary Room (10:50-11:30)

Chair: Takamitsu Tajima (Honda R&D Co., Ltd.)

20231006 **Sweden Plans for Electrified Road Systems, ERS**
Jan Pettersson
(Swedish Transport Administration)

Lunch by own (11:30-12:50)

A21-EP **Technology for In-wheel and Novel Drive Systems**

Room A (12:50-14:10)

Chair: Osamu Shimizu (The University of Tokyo), Shintaro Ohshio (Powertrain and EV Engineering Division)

20231043 **Verification of Centrifugal Pawl Clutch (CePaC) on Two-speed Transmission by Vehicle Test**
Takafumi Hagita[1], Shinji Okada[1], Takaya Yamada[1]
([1]NSK Warner K.K.)

20231044 **Thermal Evaluation of Direct Cooling Technology for In-wheel Drive System**
Tetsuya Suto[1], Makoto Ito[1], Akeshi Takahashi[1], Ryuichiro Iwano[1], Takafumi Hara[2]
([1]Hitachi, Ltd., [2]Hitachi Astemo, Ltd.)

20231045 **Magnetic Characteristics of High-power-density In-wheel Motor using Halbach Magnet Array**
Makoto Ito[1], Tetsuya Suto[1], Akeshi Takahashi[1], Takafumi Hara[2], Ryuichiro Iwano[1]
([1]Hitachi, Ltd., [2]Hitachi Astemo, Ltd.)

20231046 **Development of Noise and Vibration Reduction Technology for In-Wheel Motor Vehicles**
Kazumasa Shimode[1], Nobuhide Nishigaki[1], Kenji Yamada[1], Takashi Kawai[1]
([1]TOYOTA MOTOR CORPORATION)

B21-WPT **Dynamic Wireless Power Transfer 1**

Room B (12:50-14:10)

Chair: Katsuhiro Hata (The University of Tokyo), Keisuke Kusaka (Nagaoka University of Technology)

20231055 **Report of Burial Technology Applicable to Traffic Zone N6 in Dynamic Wireless Power Transfer**
Takehiro Imura[1], Koki Hanawa[1], Yoichi Hori[1], Hiroyuki Mashito[2], Nagato Abe[2]
([1]Tokyo University of Science, [2]Toa Road Corporation)

20231056 **Verification of the Effects of Cross-Coupling on Dynamic Wireless Power Transfer for Heavy-Duty Vehicles Using Double-LCC Circuits**
Takahiro Kawakami[1], Takehiro Imura[1], Yoichi Hori[1]
([1]Tokyo University of Science)

20231057 **Development of Integrated On-board Converter for Wireless Power Transfer**
Ryosuke Ota[1], Ryohei Okada[2], Nobukazu Hoshi[2]
([1]Tokyo Metropolitan University, [2]Tokyo University of Science)

C21-PE **Motor Drive Technologies**

Room C (12:50-14:10)

Chair: Kenta Emori (Nissan Motor Co., Ltd.), Kentaro Hirose (TOYOTA MOTOR CORPORATION)

20231066 **Novel Flux Weakening Control for Improving Current Response and Stability of EV Motor**
Yasumasa Hamabe[1], Yoshiyasu Takase[1], Hengbin Rui[1], Shinya Morimoto[1], Koji Higashikawa[1], Akira Yamazaki[1]
([1]Yaskawa Electric Corporation)

20231067 **Dry Run Detection Method of Sensorless Brushless Motor in Motor Speed Feedback Control System**
Naoki Onosaka[1], Takeru Yamamoto[1]
([1]AISIN Co., Ltd.)

20231068 **PWM Control Method to Improve the Voltage Utilization Rate of the Inverter.**
Takeshi Kuroda[1], Ryota Maeno[1], Takahiro Akahori[1], Akihiro Odaka[1]
([1]Fuji Electric Co., Ltd.)

20231069 **Flying-start Strategy for Permanent-Magnet-Synchronous-Motor Under Position Sensorless Control with Initial Speed Estimation**
Rongjiao Hao[1], Shinji Doki[1], Kazuki Asahina[2], Akira Ide[2]
([1]Nagoya University, [2]Toyota Industries Corporation)

Break (14:10-14:30)

A22-EP **Battery Management and Grid Connectiing Systems**

Room A (14:30-15:50)

Chair: Hiroshi Senoh (National Institute of Advanced Industrial Science and Technology (AIST)), Takeshi Kato (Honda R&D Co.,Ltd.)

20231047 **Development of Predictive SOC Management Control for PHEV in Cooperation with Connected Services**
- Control architecture and benefit -
Yuki Yamada[1], Keisuke Morisaki[1], Vedang Rajyaguru[2]
([1]Toyota Motor Corporation, [2]Toyota Motor Europe)

20231048 **Feasibility Study of Three-Phase Power Supply Using Hybrid / Plug-In Hybrid Electric Vehicles**
Chikara Dodate[1], Masayuki Imoto[1], Naofumi Magarida[1], Mitsuhiro Tabata[1], Takashi Kawasaki[1]
([1]TOYOTA MOTOR CORPORATION)

20231049 **A Simplified Electric Vehicle Battery Degradation Model Validated with the Nissan LEAF e-plus 62-kWh**
Mattia Marinelli[1], Lisa Calearo[2], Jan Engelhardt[1]
([1]Technical University of Denmark, [2]Ramboll Danmark A/S)

20231050 **DC Charging Infrastructure**
- Towards achieving carbon neutrality -
Osamu Maruta[1], Tomomi Hakomori[1]
([1]CHAdeMO Association)

B22-WPT **Dynamic Wireless Power Transfer 2**

Room B (14:30-15:50)

Chair: Ryosuke Ota (Tokyo Metropolitan University), Takehiro Imura (Tokyo University of Science)

20231058 **Optimal Location Model of In-motion Wireless Power Transfer System for Trips in Urban-scale Region by Electric Vehicles**
Yudai Honma[1], Daisuke Hasegawa[1], Katsuhiro Hata[1], Takashi Oguchi[1]
([1]The University of Tokyo)

20231059 **A Demonstration of Wireless Power Transfer Roadway System based on Electric Field Coupling**
Sonshu Sakihara[1], Tetsuo Endo[1], Takefumi Shindo[1], Masakazu Jomoto[2], Minoru Mizutani[3], Takashi Ohira[3]
([1]Taisei Corporation, [2]Taisei Rotec Corporation, [3]Toyohashi University of Technology)

20231060 **Interoperability of Wireless Power Transfer**
Juergen Meins[1], Ralf Effenberger[2]
([1]Technical University of Braunschweig, [2]INTIS GmbH)

20231061 **Challenge of Innovative Electric Roadway System Featuring Capacitive Coupling Wireless Power Transfer**
Yukio Yokoi[1], Ryuji Mizouchi[1], Takashi Ohira[2]
([1]Fujiwaves Co., Ltd, [2]Toyohashi University of Technology)

C22-MOT **Permanent Magnet Machines in Transportation Applications**

Room C (14:30-15:50)

Chair: Junichi Asama (Shizuoka University), Kohei Aiso (Shibaura Institute of Technology)

20231070 **High Power Density Technologies for the Driving Motors in Electric Vehicles**
Takeshi Kitayama[1], Hiroyuki Hattori[1], Keiji Takizawa[1]
([1]TOYOTA MOTOR CORPORATION)

20231071 **On-line Torque Estimation Using Flux Approximation Surfaces for Torque Feedback MTPA Control**
Sota Kawashima[1], Keiichiro Kondo[1], Kazuhiko Matsunami[2], Shinji Nakazono[2]
([1]WASEDA University, [2]Suzuki Motor Corporation)

20231072 **HREE-free Hot-deformed Nd-Fe-B Magnets for xEV**
- Highly controlled techniques of shape and orientation-direction -
Takanori Kajiwara[1], Naoto Murase[1], Takashi Oikawa[1], Hiroshi Miyawaki[1]
([1]Daido Steel Co., Ltd.)

20231073 **Magnetic Form which applies C Shaped Magnet for Hybrid Electric Vehicle**
Shingo Soma[1], Daiki Atsuda[1]
([1]Honda R&D Co, Ltd.)

Break (15:50-16:10)

A23-EP **Autonomous Drive Technologies**

Room A (16:10-17:30)

Chair: Hisashi Imanaga (Japan automobile research institute), Yoshitaka Asakura (KABUSHIKIKAISHA AYE)

20231051 **Roadside Multi-vehicle Tracking under Different Occlusion based on Improved Siamese Network and Trajectory Correlation**
Shuai Wang[1], Yafei Wang[1]
([1]Shanghai Jiaotong University)

20231052 **Steering Angle Control of Front Wheel Independent Steering System for Cornering Maneuverability Enhancement**
Junnian Wang[1], Ruihao Fan[1], Zidong Zhou[1], Zhenyu Wang[1], Fang Yang[2]
([1]Jilin University, [2]New Energy Development Institute of China FAW Group Co., Ltd.)

20231053 **Next-Level Enhanced Collaborative Scene Understanding**
Ehsan Moradi-Pari[1], Hossein Nourkhiz Mahjoub[1], Ryoji Igarashi[1]
([1]Honda Research Institute USA, Inc.)

20231054 **A Noise-Shaped Signaling Method for Vehicle-to-Everything Security based on Channel State Information**
Dongryul Park[1], Seongho Woo[1], Sungryurl Huh[1], Seungyoung Ahn[1]
([1]Korea Advanced Institute of Science and Technology)

B23-WPT **Wireless Power Transfer - EMC**

Room B (16:10-17:30)

Chair: Masahiro Hanazawa (UL Japan), Yukio Yokoi (Takuhsoku Univ)

20231062 **High Efficiency 10kW Class Wireless Power Transmission Using Electric Field Coupling - High Efficiency 10kW Class Wireless Power Transfer by CPT -**
Naoki Tsurutani[1]
([1]Furukawa Electric Co., Ltd.)

20231063 **Evaluation of Human Exposure to EMF in the Wireless Charging Environment for Electric Vehicles**
- Evaluation of the human exposure to EMF according to coil topology and human model position -
Jaewon Rhee[1], Hongseok Kim[2], Seongho Woo[1], Changmin Lee[1], Sanguk Lee[1], Seunghyun Han[3], Seokhyeon Son[3], Seungyoung Ahn[1]
([1]Korea Advanced Institute of Science and Technology, [2]Clear Signal Solutions, Inc., [3]Hyundai Motors Company)

20231064 **Minimizing Method of Leakage Magnetic Field in Wireless Power Transfer Systems for Electric Vehicles**
Seongho Woo[1], Sungryurl Huh[1], Dongryul Park[1], Jaewon Rhee[1], Seungyoung Ahn[1]
([1]Korea Advanced Institute of Science and Technology)

20231065 **Leakage Magnetic Field Suppression Method Using the Next Transmission Coil as a Cancel Coil with Ferrite and Shield in Dynamic Wireless Power Transfer**
Yuto Ito[1], Takehiro Imura[1], Yoichi Hori[1]
([1]Tokyo University of Science)

C23-MOT **Future Trend and Challenges in Electric Machines**

Room C (16:10-17:30)

Chair: Hideaki Arita (Mitsubishi Electric Corporation), Kyohei Kiyota (Tokyo Institute of Technology)

20231074 **Modeling of Direct Cooling Method with Forced Convection Boiling Phenomena considering Liquid Phase Behavior of Liquid Gas Two-Phase Refrigerant for Vehicle Traction Application PMSM**
Tatsuya Morimoto[1], Kensuke Sasaki[1], Takashi Kato[1]
([1]Nissan Motor Co., Ltd.)

20231075 **Effects of Conductor Materials for Reducing Winding Loss in Permanent Magnet Synchronous Machines**
Hiroya Sugimoto[1], Yuto Yamada[1]
([1]Tokyo Denki University)

20231076 **Downsized 48V Motor Winding Structure for an EV Powertrain**
- Compact, High-output Motor Built with Double-layer, Short-pitch, Distributed Windings -
Daiki Tanaka[1], Akira Suwabayashi[1], Junichi Asama[2]
([1]JATCO Ltd, [2]Shizuoka University)

20231077 **Development of A Novel In-Wheel Motor System Integrated of Magnetic Gear and Multiple High-Speed Motors**
Kohei Aiso[1], Kan Akatsu[2], Yasuaki Aoyama[3]
([1]Shibaura Institute of Technology, [2]Yokohama National University, [3]Hitachi, Ltd.)

Reception Party

Ristorante ATTIMO (18:00-20:00)

Day 3 (Wednesday, May 24)

Plenary Session 7

Plenary Room (9:30-10:10)

Chair: Satoshi Yasuda (TOYOTA MOTOR CORPORATION)

20231007 **Drivetrain Power Electronics Developments in the UK**
Philip Mawby
(University of Warwick)

Plenary Session 8

Plenary Room ((10:10-10:50)

Chair: Makoto Uchida (University of Yamanashi)

20231008 **Decarbonizing Motor Vehicles' Power Systems, Fuels and Energy toward 2050**
Yasuhiro Daisho
(Waseda University)

Plenary Session 9

Plenary Room (10:50-11:30)

Chair: Kenji Natori (Chiba University)

20231009 **Honda's Vision for Carbon Neutrality in 2050**
Keiji Ohtsu
(Honda R&D Co., Ltd.)

Lunch by own (11:30-12:50)

A31-EP **Control for Drive Systems**

Room A (12:50-14:30)

Chair: Daisuke Gunji (NSK Ltd.), Giuseppe Guidi (SINTEF Energi AS)

20231078 **Flux-based Cascade Vector Control for xEV Applications - Reduction of Calibration Time for Torque Response -**
Shun Taniguchi[1], Kentaro Matsuo[2], Kazuaki Tobari[1], Toshiyuki Ajima[1], Kenichi Yoshida[2], Eigo Kishimoto[2]
([1]Hitachi, Ltd., [2]Hitachi Astemo, Ltd.)

20231079 **Enhancement of xEV Motor Driving Force Control**
Haibo Liu[1], Kazuya Enokizono[1], Masaru Kubota[1], Sadahiro Akama[1], Keisuke Kawai[1]
([1]DENSO CORPORATION)

20231080 **Regenerative Brake Controller based on Vehicle Behavior prediction**
Viktar Beliautsou[1], Ilnaz Giliazov[1], Aleksandra Beliautsou[1], Valentin Ivanov[1]
([1]Technische Universität Ilmenau.)

20231081 **Effective Modeling and Controller Design for Two-Input-Two-Output Torque Difference Amplification Motor Drive System**
Hiroyuki Fuse[1], Guangzhi Yu[1], Hiroshi Fujimoto[1], Kaoru Sawase[2], Naoki Takahashi[2], Ryota Takahashi[2], Yutaro Okamura[2], Ryosuke Koga[2]
([1]The University of Tokyo, [2]MITSUBISHI MOTORS CORPORATION)

20231082 **Investigations on the Energy Saving Potential of X-by-wire Chassis Systems and Advanced Integrated Control Strategies**
Marius Heydrich[1], Christopher Hamatschek[1], Markus Gundlfinger[2], Christian Eichhammer[2], Claus Lechner[3], Christoph Fachbach[3], Florian Büchner[1], Valentin Ivanov[1], Sebastian Gramstat[2], Eric Armengaud[3,4]
([1]University of Technology Ilmenau, [2]AUDI AG, [3]AVL List GmbH, [4]Armengaud Innovate GmbH)

B31-WPT **Wireless Power Transfer 1**

Room B (12:50-14:30)

Chair: Keisuke Kusaka (Nagaoka University of Technology), Katsuhiro Hata (The University of Tokyo)

20231087 **Wireless Charging is Now**
- Bringing automated wireless charging to accelerate EV adoption -
Tom Okada[1]
([1]WiTricity)

20231088 **Evaluation of a Communication-less and Load-independent Resonance Mismatch Compensation Method for Wireless Power Transfer at Close Coil-to-Coil Distances Using LCC-S Circuits**
Yuki Ouchi[1], Takehiro Imura[1], Yoichi Hori[1]
([1]Tokyo University of Science)

20231089 **Sheet Coil and Ultra-thinner VA Unit Used in EV-WPT**
Akane Arakawa[1], Masato Okabe[1], Junya Otsuki[1], Kenichi Miyazaki[1], Hiroyuki Hase[1]
([1]Dai Nippon Printing Co., ltd.)

20231090 **Coupling Coefficient Extraction between Transmitter Coils and Receiver Coil in Wireless Power Transfer System for Automatic guided vehicles**
Sungryurl Huh[1], Seongho Woo[1], Dongryul Park[1], Seungyoung Ahn[1]
([1]Korea Advanced Institute of Science and Technology)

20231091 **Applicability of HD-PLC / PaWalet Link Technology to WPT system**
Naohiro Kawabata[1], Hisao Koga[1], Toshiyuki Wakisaka[1]
([1]Panasonic Holdings Corporation)

C31-FC **Hydrogen and Fuel Cell Technology**

Room C (12:50-14:30)

Chair: Kiyoshi Yamaura (Mitsubishi Motors Corporation), Seiji Sano (TOYOTA MOTOR CORPORATION)

20231096 **CAE Application Method for Determining Basic Structure to Improve Performance of Electrochemical Hydrogen Compression Stacks**
Toru Honda[1], Koki Tamura[1], Yohei Kataoka[1], Daimon Hayato[1], Hiroto Yoshimura[1], Eiji Haryu[1], Shinichi Takahashi[1]
([1]Honda R&D Co., Ltd.)

20231097 **Optimal Energy Management Strategy for a Light-Duty Fuel Cell Hybrid Electric Vehicle**
Tianhong Wang[1], Qi Li[1], Weirong Chen[1], Alexandre Ravey[2], Elena Breaz[3], Fei Gao[2]
([1]Southwest Jiaotong University, [2]FEMTO-ST Institute FCLAB, Univ., UTBM, CNRS, [3]Technical University of Cluj-Napoca)

20231098 **New regulatory framework for type approval and certification of hydrogen- powered vehicles and their components in the European Union after repeal of regulation (EC) 79/2009**
Martin Sekura[1], Thomas Frohn[2]
([1]TÜV SÜD Product Service GmbH, [2]TÜV SÜD Auto Service GmbH)

20231099 **A Study on the Performance Stability and the Water management of PEFC with Interdigitated Gas Flow Channels formed on a Gas Diffusion Layer - Improvement of Performance Stability under high & low humidification conditions and clarification of the mechanisms by experimental and numerical analysis -**
Tatsuya Inoue[1,2], Daiki Sakai[1], Kazuyuki Hirota[1], Koichi Sano[1], Naoki Hirayama[3], Mitsunori Nasu[3], Takahiro Suzuki[4], Shohji Tsushima[4], Junji Inukai[2], Masahiro Watanabe[2], Akihiro Iiyama[2], Makoto Uchida[2]
([1]Suzuki Motor Corporation, [2]University of Yamanashi, [3]Enomoto Co., Ltd., [4]Osaka University)

20231100 **X-ray Imaging and Numerical Simulation for Optimization of PEFCs with Advanced Materials**
Takahiro Suzuki[1], Kanae Kinose[1], Mitsunori Nasu[2], Naoki Hirayama[2], Masahiro Watanabe[3], Katsuyoshi Kakinuma[3], Makoto Uchida[3], Akihiro Iiyama[3], Shohji Tsushima[1]
([1]Osaka University, [2]Enomoto Co., Ltd., [3]University of Yamanashi)

Break (14:30-14:50)

A32-EP **Eaxle and Powertrain System**

Room A (14:50-16:10)

Chair: Takashi Hirose (SUBARU Corporation), Takeshi Kato (Honda R&D Co.,Ltd.)

20231083 **Challenges of the Development of an Axle Drive Platform in a Disruptive Environment - SCALABLE PLATFORM FOR AN EFFICIENT 400-VOLT AXLE DRIVE -**
Hirofumi Yudahira[1], Takahiro Kato[1], Hiroshi Nishimura[1]
([1]Vitesco Technologies, Japan K.K.)

20231084 **Series Concept of an Externally Excited Synchronous Machine as a Magnet- Free Option in the integrated E-Axle Platform EMR4**
Gunter Muehlberg[1], Nico Daun[1], Hilko Hakvoort[1], Takahiro Kato[2], Hiroshi Nishimura[2]
([1]Vitesco Technologies Germany GmbH, [2]Vitesco Technologies, Japan K.K.)

20231085 **Development of e-AWD Parallel Hybrid System**
Shoichi Kuwayama[1], Kensuke Kamichi[1], Manabu Ishimoto[1]
([1]Toyota Motor Corporation)

20231086 **Technology of BEV Powertrain for Mid-Size SUV**
Naoki Takeuchi[1], Masaya Yamamoto[1], Hiroki Nagai[1], Takuya Hirai[1]
([1]Toyota Motor Corporation)

B32-WPT **Wireless Power Transfer 2**

Room B (14:50-16:10)

Chair: Yukio Yokoi (Takushoku University), Ryosuke Ota (Tokyo Metropolitan University)

20231092 **Educator Oriented Prototype Amplitude Modulation Radio Exploits 40 MHz Capacitive Coupling Wireless Power Transfer**
Yuri Kitagawa[1], Takashi Ohira[1]
([1]Toyohashi University of Technology)

20231093 **Efficient Multiple Input Multiple Output Wireless Power Transfer**
Duong Quang Thang[1], Minoru Okada[1]
([1]Nara Institute of Science and Technology)

20231094 **Theoretical Analysis for Effectiveness of Spread Spectrum for Resonant Type Wireless Transfer System**
Atsuo Hatono[1]
([1]Nippon Institute of Technology)

20231095 **-Electrically Coupled Undersea Wireless Power Transfer System with Shielded Electrodes-**
Ikuo Awai[1], Kazuya Yamaguchi[1], Dai Futagami[1]
([1]Fujiwaves Co., Ltd.)

C32-FC **Hydrogen and Fuel Cell Technology**

Room C (14:50-16:10)

Chair: Makoto Uchida (University of Yamanashi), Shigeki Oyama (Honda R&D Co., Ltd.)

20231101 **Developing Next Generation High Performance Polymer Electrolyte Membrane Fuel Cells Using Metal Foam as Gas Diffusion Layer**
Improved Mass Transport in Gas Diffusion Layer with Embedded Gas Flow Channels
Gaohua Zhu[1], Liang Wang[1], Yuqing Zhou[1], Ercan M. Dede[1], Hongfei Jia[1], Debasish Banerjee[1]
([1]Toyota Research Institute of North America)

20231102 **High Temperature PEMFCs for Heavy Duty Applications**
- Challenges and Opportunities -
Liang Wang[1], Honghong Lin[1], Gaohua Zhu[1], Hongfei Jia[1]
([1]Toyota Research Institute of North America.)

20231103 **A model-based Approach to Set the Future Target of Fuel Cell Performance for Heavy-duty Applications**
Takao Watanabe[1], Masao Shibata[1], Norihiro Fukaya[1], Tomoyuki Nagai[1], Takahisa Suzuki[1]
([1]Toyota Central R&D)

20231104 **Intelligent thermal management simulation of a fuel cell system**
Marius Zubel[1], Marius Walters[1], Jürgen Ogrzewalla[1] Stefan Klopstein[1], Vitali Walter[1], Patrick Schutzeich[2]
([1]FEV Europe GmbH, [2]RWTH Aachen University)

Young Investigator Awards and Closing Ceremony

(16:10-16:30)

Abstract

Day 1 (Monday, May 22)

A11-EP **Technologies for Transportation System and New Service**

Room A (12:50-14:10)

Chair: Osamu Shimizu (The University of Tokyo), Yujin Gotoda (DENSO Corp.)

20231010 **Dynamic Modeling and Control of Motoring-gear for Automated Guided Vehicle Powertrain Application**

Yu-Chin Hsu[1], Mi-Ching Tsai[1], Jia-Sheng Hu[2], Liang-Yi Hsu[1], Chin-Yang Chang[1], Chi-Yang Chang[1], Chinweze U. Ubadigha[1]
([1]National Cheng Kung University, [2]National University of Tainan)

Abstract:
Electric vehicles utilizing passive drivetrains consisting of a single motor, a variable speed gearbox and differentials to provide adjustable performance capabilities are inherently riddled with mechanical complexities, poor efficiency and poor driving performance. This study investigates an alternative power transmission design for electric vehicles which is based on dual motoring-gear with special features of power split through torque and speed coupling capability. The proposed power split drivetrain consists of one main driving motor and two motoring-gear for steering control. The coaxial feature makes the drivetrain structure much simpler, and can be used as model frame for various electric vehicles and automated guided vehicles. The motoring-gear have two air gaps, and thus provide non-contact power transmission as well as torque fuse feature. The drivetrain system can be controlled to achieve both the continuously variable transmission and differential functions, such that operational power range is extended and overall performance improved. A block diagram approach is employed for analyzing the motoring-gear kinematic and dynamic characteristics, the results show that the acclaimed continuously variable transmission and differential capabilities of the proposed drive train were achieved in that steady operation is maintained under varying load conditions.

20231011 **Vehicle to Grid assisted 100% renewable energy supported electric grid system in Japan**

Shemin Sagaria[1], Mart van der Kam[2], Tobias Boström[1]
([1]UiT - The arctic University of Norway, [2]University of Geneva)

Abstract:
Japan emits 1.08 billion Metric Tons of greenhouse gases (GHG) every year, which ranks fifth in the world, with higher emissions per capita than China and India. Through various initiatives, Japan aims to reduce emissions by 46% by 2030 and achieve carbon neutrality by 2050. The phasing out of coal and the production of 100% carbon-free electricity are two of these milestones. This study examines the use of renewable energy (RE) to support 100% of electricity generation in Japan, with EVs as the primary energy storage system. The purpose of this conceptual study is to highlight the significance of vehicle-to-grid (V2G) technology for a nationwide electricity grid system that is supported by RE. We conduct this study in two phases. Phase 1 of the study estimates the amount of RE installation required to meet 100% of electricity generation from RE sources. Considering 17 million EVs with 65 kWh batteries, 100% V2G acceptance, 80% battery availability, and 22 GW of PHS, the model estimates that 454.8 GW of solar PV and 199.3 GW of wind turbines are necessary to meet electricity demands. Exploring V2G in-depth, phase 2 examines the influence of V2G acceptance and battery availability on energy flow. The results show that the system's self-sufficiency reduces when V2G acceptance and battery availability decrease. The hourly reliability of the system drops from 99% to 80%, and the self-sufficiency of the system falls from 99% to 90% when V2G acceptance is reduced to 50% and battery availability to 40%. With 0% V2G acceptance (scenario when the whole vehicle fleet is electrified, but not used for storage), the system's hourly reliability is 66% and self-sufficiency is 80%. Furthermore, the results indicate that at low V2G acceptance rates, the EVs must go through more charging cycles, while at high V2G acceptance rates, they must go through fewer cycles. The study's overall results indicate that V2G technology will be an effective storage solution for Japan in the future.

20231012 **High Power and Power Density Inductive Charging System for Busses and Heavy-Duty Vehicles**

Giuseppe Guidi[1], Jon Are Suul[1,2]
([1]Sintef Energy Research, [2]Norwegian University of Science and Technology (NTNU)

Abstract:
This paper describes the design of the hardware and control systems for a 100 kW wireless power transfer unit intended for high power battery charging. The developed system is suitable for busses, heavy-duty vehicles and small marine vessels, featuring high power density and high efficiency while remaining structurally simple. A power density exceeding 4 kW/kg has been demonstrated for the coil assembly, with a total dc-dc power transfer efficiency of 97% at rated power. Design criteria are given for the resonant coils, including thermal management considerations. The complete power conversion system is also developed, including SiC-based converters and advanced power flow control strategies aimed at maximizing the operating range in terms of coupling and I/O voltages while minimizing the required volt-ampere ratings of the devices and overall system losses. Experimental results are reported, showing that the system is operating according to calculated performances.

20231013 **Bi-level Network Design for UAM Vertiport Allocation Using Activity- Based Transport Simulations**

Sebastian Brulin[1], Markus Olhofer [1]
([1]Honda Research Institute Europe GmbH)

Abstract:
The design or the optimization of transport systems is a difficult task. This is especially true in the case of the introduction of new transport modes in an existing system. The main reason is, that even small additions and changes result in the emergence of new travel patterns, likely resulting in an adaptation of the travel behavior of multiple other agents in the system. Here we consider the optimization of future Urban Air Mobility services under consideration of effects induced by the new mode to an existing system. We tackle this problem through a bi-level network design approach, in which the discrete decisions of the network design planner are optimized based on the evaluated dynamic demand of the user's mode choices. We solve the activity-based network design problem (AB-NDP) using a Genetic Algorithm on a multi-objective optimization problem while evaluating the dynamic demand with the large-scale Multi-Agent Transport Simulation (MATSim) framework. The proposed bi-level approach is compared against the results of a coverage approach using a static demand method. The bi-level study shows better results for expected UAM demand and total travel time savings across the transportation system. Due to its generic character, the demonstrated utilization of a bi-level method is applicable to other mobility service design questions and to other regions.

A12-EP **Technologies of Next Generation Charging System**

Room A (14:30-15:50)

Chair: Osamu Shimizu (The University of Tokyo), Takashi Majima (IHI Inspection & Instrumentation Co.,Ltd.)

20231014 **450-kW Conductive Dynamic Charge System**

Takamitsu Tajima[1], Wataru Noguchi[1], Hiroka Shigi[1]
([1]Honda R&D Co., Ltd.)

Abstract:
The widespread adoption of electric vehicles (EV) is key to reducing CO_2 emissions from vehicles in operation to zero. One example of an initiative furthering the realization of that aim is the introduction of a Dynamic Charging System that recharges EVs in operation directly from the electric road. This paper describes the results of testing Dynamic Charging System for conductive charging from the side applied to heavy-duty trucks.

20231015 **Optimizing the Positions of Battery Swapping Stations - Pilot Studies and Layout Optimization Algorithm -**

Tobias Rodemann[1], Hiroaki Kataoka[2], Thomas Jatschka[3], Günther Raidl[3], Steffen Limmer[1], Hiromu Meguro[2]
([1]Honda Research Institute Europe, [2]Honda R&D, [3]TU Wien)

Abstract:
For electric scooters, battery swapping is a promising alternative to battery charging due to the lower weight and volume of their batteries that allows a manual replacement at battery swapping stations. Mobile batteries are shared between all users and the target of the operator is therefore to maximize the customer satisfaction while minimizing system set-up and operation costs. Here we give an overview of Honda's activities for a Battery as a Service (BaaS) business in Indonesia, Philippines and India, while looking specifically at the optimal placement of battery swapping stations with a given customer demand. Multiple objectives like set-up cost, energy costs, and customer detours are considered. We employ a Large Neighborhood Search (LNS) approach that uses specific destroy and repair operators for each objective and includes a Mixed Integer Linear Programming (MILP) element for repairing solutions. Our results show that the employed LNS outperforms a state-of-the-art pure MILP approach for larger problem sizes with up to 500 potential station locations and 1000 trips. Overall 10-30% better results compared to standard approaches can be obtained.

20231016 **Evaluation of Energy Transfer Efficiency and Path-Tracking Performance for an Autonomous Truck Model with Dynamic Wireless Charging**

Mats Jørgensen[1], Giuseppe Guidi[2], Jon Are Suul[1,2]
([1]Norwegian University of Science and Technology, [2]SINTEF Energy Research)

Abstract:
This paper presents the results from experimental testing of a dynamic wireless charging system for an autonomous truck model in scale 1:14. The truck model is equipped with functionality for autonomous operation by computer-vision-based path tracking and tested on a track that includes a charging section with two coils for dynamic wireless inductive power transfer (DWPT). A path tracking algorithm based on two cameras is shown to provide consistent lateral positioning along the track, which ensures that the truck is approximately centered with respect to the road-side coils when passing the charging section. The road-side coils are automatically activated from the truck when approaching the charging section, and the dc power input to the road-side converters as well as the power output to the on-board battery are logged during the charging cycles. The impact of activating the road-side coils at different positions of the truck is evaluated with respect to the power transfer profile and the overall energy transfer efficiency. It is discussed how the energy transfer efficiency can be increased by transferring power only when the entire vehicle-side coil is above the road-side coil. It is also shown how unnecessary losses will be caused by activating the power transfer before reaching the point when half of the vehicle-side coil is above the road-side coil, corresponding to the point of zero magnetic coupling. However, the total energy transferred to the on-board battery can be maximized by activating the road-side coils close to the point of zero magnetic coupling, and it is demonstrated that this is achieved without causing any significant reduction in the energy transfer efficiency.

20231017 **Activation Timing Control Using On-board Camera for Dynamic Wireless Power Transfer Under Circuit Parameter Variations**

Ryo Matsumoto[1], Hiroshi Fujimoto[1]
([1]The University of Tokyo)

Abstract:
This paper proposes an activation timing control method for dynamic wireless power transfer systems using an on-board depth camera. Conventional timing control methods have used the electrical information of the circuit to detect the approaching vehicle. However, these methods cannot maintain their performance when the parameters of the circuit vary from their designed values. The method proposed in this paper avoids this problem by using the visual information obtained by the depth camera to determine the activation timing. The experimental results demonstrate that the proposed method can maintain a consistent activation timing when the self- inductance of the transmitter and receiver coils vary from their designed values.

A13-EP **Modeling and Evaluation for EV Systems**

Room A (16:10-17:50)

Chair: Hiroshi Nishimura (Vitesco Technologies Japan K.K.), Takashi Majima (IHI Inspection & Instrumentation Co., Ltd)

20231018 **High-Precision Evaluation System of EV Motors in Low-speed Conditions for Improving Motor Control**

Keita Inagawa[1], Takuma Nagashio[1], Yusuke Takeda[1], Koji Sato[1]
([1]ONO SOKKI CO., LTD.)

Abstract:
In recent years, vehicles have become increasingly electrified and individual wheel control has become possible. This has led to an increase in demand for vehicle and powertrain testing using a hub dynamometer as a vehicle test bench. Although a hub dynamometer measures shaft torque and rotational speed and can reproduce various operating conditions, the number of encoder pulses installed for speed measurement, which covers from low to high rotational speed range, is limited. This study achieves improved operational accuracy of a hub dynamometer by obtaining angle and speed information at very low rotational speeds from an encoder with a limited number of teeth by adding detector heads for rotational speed measurement and signal processing, without installing a new high- resolution encoder. As a result, it is now possible to evaluate the start and stop behavior of electric vehicles that can freely generate large torque from a standstill, to evaluate force-regenerative switching at low rotational speeds, to evaluate mechanical brake intervention during deceleration, and to evaluate start and stop behavior on hills with high precision and reproducibility.

20231019 **Distributed Validation and Testing of EV Systems - Results of the European Project XILforEV -**

Valentin Ivanov[1], Viktar Beliautsou[1], Florian Büchner[1]
([1]Technische Universität Ilmenau)

Abstract:
The presented study addresses the methodology for building distributed test platforms that support the design of electric vehicle (EV) systems and the validation of their functionality. The platforms are implemented in the form of an X-in-the-loop (XIL) architecture and may include multiple test setups united in a local or geographically remote network. The communication of the networked test setups is based on the User Datagram Protocol (UDP). The paper presents the realization of the XIL environment suitable for the development of EV control systems such as brake blending, ride blending (RB) and integrated chassis control (ICC). For this purpose, the dynamometric test setup for the in-wheel motor, the hardware-in-the-loop (HIL) brake test bench, the shaker for the suspension actuators, and the driving simulator are integrated into the XIL environment. The results show the validation of the controllers for several complex maneuvers.

20231020 **Application of Thermal CAE Analysis to Electric Drive Module for xEV**

Michinari Fukuoka[1], Yuki Fujita[1], Masahiro Takemoto[1], Yoshiyuki Kimura[1]
([1]DENSO CORPORATION)

Abstract:
This paper presents a method to construct 1D thermal model seamlessly from 3D thermal model to study the thermal performance and the approximate dimensions in the system study stage for the drive motor of xEV. Then, the current setting conditions of power control unit (PCU) for the electro-thermal coupling analysis are arranged with a view to studying the system and thermal establishment on a model basis with the customer.

20231021 **Cooling Performance of Lubricating Oils for Liquid-Cooled Motor and Battery Thermal Management System in EVs**

Keiichi Narita[1], Yasuhito Nakahara[1], Kazushige Matsubara[1], Hiroyuki Tatsumi[1] Daisuke Takekawa[1]
([1]Idemitsu Kosan Co., Ltd.)

Abstract:
This study intends to clarify an impact of lubricating oils on the cooling performance for liquid-cooled motor and battery thermal management system applied to EVs. Test methos for evaluating the heat transfer characteristics between heating elements and test oils were originally designed. Lowering kinematic viscosity of lubricating oils improved the cooling performance at forced convection, and this cooling speed could be greatly influenced by base oil molecular structure. Simulation results using particle method revealed the velocity and temperature distribution near the heating elements, which might play a role in affecting the cooling performance.

20231022 **Investigation of Internal Deformation of Lithium-ion Battery and Simulation Model for Internal Short Circuit**

Shinichi Amano[1], Hiromichi Ohira[1], Nobuhiro Matoba[2], Yasuhito Aoki[2]
([1]JSOL Corporation, [2]Toray Research Center, Inc.)

Abstract:
Fires caused by the thermal runaway of lithium-ion batteries are one of the important issues associated with practical electric vehicles. Thermal runaway and white-smoke generation during impact and/or crushing is often evaluated as part of the safety testing of electric vehicles. Although short circuits are considered to be caused by the contact between positive and negative electrodes, it is difficult to confirm the type of deformation that occurs inside the battery because the battery explodes as a result of short circuits or thermal runaway. This research aims to elucidate the mechanism of internal short circuits by visualizing the internal deformation state when an internal short circuit occurs. First, to investigate the interior of the lithium-ion battery during large deformation, the battery is held and solidified in its deformed state, and the internal deformation is observed using a digital microscope. Observation of a section plane in the deformed state indicates that the aluminum and copper in the current-collector foil are broken in the upper layer. Furthermore, a shear band is confirmed when connecting the points of the broken collector foil. It is presumed that this internal deformation causes contact between the active materials of the positive and negative electrodes and the foil, which causes an internal short circuit. This result is important to explain why battery cells cause internal short circuits when large deformations occur. In addition, to elucidate the mechanism of this shear band, we propose elucidating the internal short-circuit–generation mechanism by constructing a simulation model to reproduce the shear band.

B11-MOT **Performance Improvement of Electric Machines**

Room B (12:50-14:10)

Chair: Hiroya Sugimoto (Tokyo Denki University)

20231023 **Measurement of Vibration and Acoustic Noise Generated by Magnetostriction in Three Stator Cores Made of High Silicon Steel, Amorphous Iron, and Conventional Silicon Steel**

Yifei Cai[1], Akira Chiba[1], Fares S. El-Faouri[1], Naoki Saikawa[1], Yoshizaki Soichiro[2]
([1]Electrical and Electronics Engineering Department of Tokyo Institute of Technology, [2]Steel Research Laboratory of JFE Steel Corporation)

Abstract:
The deformation of stators due to radial electromagnetic forces is considered as the main source of vibration and acoustic noise in electric machines. Similarly, the deformation due to magnetostriction also contributes to the vibration and acoustic noise. In this paper, the magnetostrictive deformation, vibration, and sound pressure level are measured and compared with three stator cores. The three cores are made of high silicon steel, amorphous iron, and conventional silicon steel. These materials are selected for their significantly different magnetostriction properties. The measurement results indicate that magnetostriction can cause significant deformation, vibration, and acoustic noise.

20231024 **Development of a High-Torque Motor with Superior Noise and Vibration Characteristics**

Yoshimasa Kaneda[1], Masashi Matsuda[1], Yuki Mawatari[1], Suzune Mizuno[1]
([1]DENSO CORPORATION)

Abstract:
Recently the diversification of mobility has been started after the advent of IWM (In-Wheel-Motor), then small size and low-noise are requested as a Motor from the Market. (1) In this paper, Toothless Core was adopted as a technology of low- noise and Oriented Magnet was used to increase the Torque. As a result, the measurement of performance with actual sample proved these technologies are effective for coexistence of both market needs.

20231025 **Experimental Consideration on Mode Electricity Consumption of Permanent Magnet Synchronous Motor with Torque Ripple Suppression Control Considering Magnetic Saturation**

Taiki Mikami[1], Keitaro Kawarazaki[1], Nobukazu Hoshi[1]
([1]Tokyo University of Science)

Abstract:
Torque ripple in permanent magnet synchronous motors can be suppressed using various methods, including torque ripple suppression control, which considers magnetic saturation and can suppress torque ripple over a wide operating range. However, the impact of this method on efficiency under variable speed drive has not been thoroughly investigated. Therefore, this paper verified the effect of torque ripple suppression control considering magnetic saturation on efficiency by creating efficiency maps and experimentally deriving losses under variable speed drive in an electric vehicle driving mode. The results show that the increase in loss under driving with torque ripple suppression control was approximately 0.2% compared to without, which had little effect on electricity consumption reduction.

B12-PE **Power Electronics System Technologies**

Room B (14:30-15:50)

Chair: Tomohiro Fukazu (HONDA R&D Co., Ltd.), Satoshi Yasuda (TOYOTA MOTOR CORPORATION)

20231026 **A Study on Auxiliary Circuit for Floating Bidirectional Power Flow Controller based on Partial Power Conversion**

Yohei Sasaki[1], Kenji Natori[1], Yukihiko Sato[1]
([1]Chiba University)

Abstract:
This paper studies an auxiliary circuit for a floating bidirectional power flow controller (F-BPFC) that has been proposed based on partial power conversion (PPC) principle. As the auxiliary circuit, a circuit that enables bidirectional power supplies i.e. powering F-BPFC and regeneration from F-BPFC is required. In this paper, we study a CLLC resonant converter that achieves bidirectional and high-efficiency power supply by accomplishing zero-voltage switching (ZVS) and zero-current switching (ZCS). Effectiveness of the adoption of the CLLC resonant converter as the auxiliary circuit is verified by experimental results.

20231027 **Next generation Electric Drive Units with Multi-level GaN Inverter for Highest HV EV Performance and Efficiency**
- Comparison of 2-level and 3-level inverter topologies -

Philipp Matt[1], Thomas Hackl[1]
([1]hofer powertrain)

Abstract:
This paper discusses the importance of multi-level inverters in electrical drive applications, particularly for the automotive industry. Multi-level inverters offer benefits such as higher voltages, reduced harmonic losses, and improved NVH characteristics and EMC behavior. Gallium-Nitride-based (GaN) components are gaining traction over traditional silicon components due to their superior performance. hofer powertrain has developed a new 3-L GaN inverter, which has shown to improve e-motor efficiency by reducing losses in the WLTP drive cycle by 25%. This improvement translates into less cooling demand, increased performance, and an extended driving range. Additionally, the inverter reduces “Lautheit” by 25% and exhibits similar improvements in EMC behavior, which can be used to meet higher electric drive requirements or to reduce efforts in EMC filtering and NVH damping.

20231028 **A Model-Based Study on a DCDC Converter Reactor Miniaturization using a Variable Bias Magnet Suitable for Vehicle Drive Applications**

Shunya Sakamoto[1], Kensuke Sasaki[1]
([1]Nissan Motor Co., Ltd)

Abstract:
In this paper, a magnetic circuit, which has an opportunity to realize volume reduction of a reactor used in a DCDC converter for vehicle drive applications is proposed. The magnetic circuit is based on a magnetic bias reactor and variable magnets are applied to manipulate its magnetization direction by the external magnetic field induced by the reactor winding. For vehicle drive applications, DCDC converters are demanded to supply wide-output-power-range operations. The proposed reactor changes the magnetization direction of the bias magnets based on operating conditions such as power or regeneration to widen the operable range of reactor cores and realize the downsizing of reactors. In this paper, the design principle of the reactor is discussed, and its effectiveness is evaluated by simulation.

20231029 **Development of the power control unit for the new hybrid system**
- Action of the system loss minimization -

Yoshihiro Shamoto[1], Hiroyuki Oyanagi[1], Ryoji Sato[1], Ryoji Hironaka[1]
([1]TOYOTA MOTOR CORPORATION)

Abstract:
Toyota Motor Corporation has developed a new hybrid electric vehicle (HEV) equipped with a new generation hybrid system. In 5th generation, we put efforts into power control unit (PCU) development which can realize reduced loss, downsized volume, and increased power. Moreover, as for control technique, we developed a new voltage pulse pattern in motor control which can improve fuel efficiency. In this paper, we will explain how to realize it and what the effect is.

B13-PE **Power Electronics Component Technologies**

Room B (16:10-17:50)

Chair: Kenta Emori (Nissan Motor Co., Ltd.), Satoshi Yasuda (TOYOTA MOTOR CORPORATION)

20231030 **Automotive Power Electronics Technology**

Masashi Kosuga[1], Hideyo Suzuki[1]
([1]Hitachi Astemo, Ltd.)

Abstract:
Hitachi Astemo has design technology of high performance and compact size inverter with Generation-4(GEN4) power module which is Hitachi Astemo product of double-cooling power module (PM). Then, Hitachi Astemo has developed new high power, compact size dual inverter for hybrid vehicle (PHEV, HV, REEV) which applying Dedicated Hybrid Transmission (DHT) system.

20231031 **Lowering Carbon Emission with Autonomous Driving Vehicles - Increasing Energy Savings with Advanced Power MOSFETs -**

Martina Giuffrida[1], Giusy Gambino[1], Carmelo Mistretta[1], Giuseppe Longo[1], Filippo Scrimizzi[1]
([1]STMicroelectronics)

Abstract:
Today's industry players are accelerating the speed of automotive technology innovation as they develop new concepts of electric, connected, autonomous, and shared mobility. Major automotive megatrends for electrification and digitalization involve zone architectures, digital control of power devices, battery management systems, power / energy management and power electronics for autonomous driving. The advent of new smart integration strategies in Systems-in-Package (SIP) help improve fully autonomous vehicles' reliability with new high density and compact solutions, which enable increasing energy savings, thus improving the fuel efficiency of the vehicle and decreasing CO_2 emissions.

20231032 **Direct Power Semiconductor Cooling – Potentials, Challenges and Development Approaches**

Benjamin Pessl[1], Gregor Gaßner[1], Hannes Hofstetter[1], Michael Haider-Peterseil[1]
([1]Magna Powertrain / Engineering Center Steyr)

Abstract:
Automotive traction inverters contain power semiconductors with high electrical power capability. Even though the overall efficiency is being improved continuously, the absolute level of waste heat is increasing, due to concurrently rising power levels. This circumstance results in demanding cooling needs and approaches the limits of typical indirectly cooled solutions using thermal interface materials (TIM) or thermal pads. Direct cooling – whereby the coolant is in direct contact with a low-thermal-resistance power-device- mounted heat sink – extends the solution space and enables to effectively address the described limitations. This paper provides a comprehensive overview of challenges to be dealt with during the development of direct cooling solutions for power semiconductors. Detailed insights are presented for thermal and hydraulic optimization, posing the foundation for electrically and energetically performant solutions. It is shown how the utilization of advanced modelling and simulation methods can enhance development speed and helps exploiting technologies to their limits. Complemented by insights into integration-related aspects like geometrical tolerances, corrosion protection and reliability, the paper examines some of the main subjects relevant during development. It concludes with a summary of interactions between the presented influences.

20231033 **Side Gate HiGT That Realizes the High Power Density of IGBT Modules**

Yujiro Takeuchi[1], Masayuki Kamikawa[2], Yukihiro Kumagai[2], Takashi Wada[2], Toshiki Tanimura[2], Takayuki Ouchi[1], Hisayuki Tsuruoka[2], Seiichi Hayakawa[2], Takayuki Kushima[2], Yutaka Kato[2], Masaki Shiraishi[2], Tetsuo Oda[2]
([1]Hitachi, Ltd., [2]Hitachi Power Semiconductor Device, Ltd.)

Abstract:
This paper describes a developed high power density 750 V/800 A 6-in-1 IGBT module suitable for xEV application. The developed module has features of the copper lead structure for reduction of thermal resistance and the epoxy resin encapsulation for improving thermal stress reliability. In order to reduce power loss, side gate HiGTs and U-SFDs were installed to achieve both low switching loss and low noise. Furthermore, side gate HiGTs have a superior feature of a wide RBSOA necessary for the latest high power density IGBT modules. By integrating the above technologies, the developed module can achieve a −29% smaller footprint and a −27% lighter weight while keeping the same output current as our conventional IGBT module. Consequently, the developed module can realize a +70% higher power density than the conventional one.

C12-BAT **Energy Storage Devices & Systems: Systems & Applications**

Room C (14:30-15:50)

Chair: Takaji Umeno (Toyota Central R & D Labs., INC.), Daichi Imamura (Japan Automobile Research Institute)

20231034 **Development of Ultralow-Floor All-Electric Light-Duty Truck**

Akira Hashito[1], Manabu Masuda[1], Hisashi Higashi[1], Yu Yaguchi[1]
([1]Hino Motors, Ltd.)

Abstract:
The growth of e-commerce is making people's lives more and more convenient. However, the logistics industry is facing a deepening shortage of drivers to carry the continually increasing amount of goods that this growth is generating. One cause of this shortage is the physical stress placed on delivery drivers during transportation. At the same time, as all industries accelerate efforts to adopt more environmentally friendly business practices, expectations and demand are rising for domestically manufactured all-electric commercial vehicles. To respond to these environmental changes in the logistics industry, a carbon-free all-electric light-duty truck was developed for last-mile delivery services (i.e., the delivery of goods from the closet logistics depot to the customer) that also alleviates the physical stress placed on the driver. This truck adopts a front-wheel drive layout with a compact drive motor, battery, cooling components, and power distribution units. This layout enables an ultralow-floor walk-through structure in which the driver can move easily from the driver's seat to the cargo space inside the vehicle. The resulting layout makes it much easier to enter and leave the truck and greatly facilitates handling of the cargo. The adoption of an electrified powertrain also eliminates tailpipe emissions, including CO_2. It was confirmed that this truck alleviates driver fatigue during operation under actual conditions, which means it should help to relieve the physical stress placed on the driver during last-mile deliveries. This paper describes the technology adopted to realize an ultralow-floor in an all-electric light-duty truck, how the appropriate battery capacity was determined by analyzing the working conditions of last-mile delivery services, and the results of verification tests.

20231035 **Experimental Verification of Control Method to Increase Motor Power of Rail Vehicle with Onboard Energy Storage System**

Hiroyasu Kobayashi[1], Ryuichi Tsutani[1]
([1]Chiba University)

Abstract:
A control method of hybrid traction system which realizes increase of regenerative brake energy and reduction of consumed energy in the powering by boosting the traction motor voltage has been proposed. The proposed method includes both active HB control and energy management of onboard ESD. In this paper, the experimental verification of the proposed control method of hybrid traction system was performed utilizing 1kW class downscaled experimental setup. The experimental results show that both an accurate DC bus voltage control and energy management of the onboard ESD can be achieved by the proposed control method.

20231036 **Power control strategies Based on Peak and Frequency for Hybrid Type Batteries**

Ryo Kimura[1], Yuki Hiratsuka[1], Keiichiro Kondo[1], Shunya Sakamoto[2], Kensuke Sasaki[2]
([1]WASEDA University, [2]Nissan Motor Co., Ltd.)

Abstract:
Two different power control strategy are examined for the hybrid battery system with the high power density type battery pack and the high energy density type battery pack for electric vehicle. The frequency basis control strategy method 1 is more implicit to design the power controller based on the frequency component of the load power and appropriate to the longer life long of the battery. However, the relation between the design parameters in both control strategies must be revealed in the future work.

20231037 **High heat-resistant Lithium-ion Capacitor Module for HINO TEAM SUGAWARA Dakar HEV**
- Super-durable, excellent output performance and vibration resistance -

Takumi Mio[1], Yukihiro Komatsubara[1], Hisato Kobayashi[1], Naoki Ohmi[1], Hideyuki Hasegawa[1], Akitsugu Yamaguchi[1], Koji Nishi[1]
([1]JTEKT Corporation)

Abstract:
Countries around the world are actively working toward the realization of a carbon-neutral society. In the field of motor sports, the adoption of sustainable fuels and the electrification of competition vehicles are progressing. HINO TEAM SUGAWARA participant of the Dakar Rally, which is well known as the world's toughest motorsports competition, also participated in the competition with a Hybrid Electric Vehicle (HEV) from January 2022. JTEKT supplied a high heat-resistant Lithium-ion capacitor module as the main power supply, contributing to HINO TEAM SUGAWARA finishing in 22nd place overall in the truck division.

C13-BAT **Energy Storage Devices & Systems: Batteries & Capacitors**

Room C (16:10-17:50)

Chair: Manabu Watanabe (Nissan Motor Co., Ltd.), Noriko Yoshizawa (National Institute of Advance Industrial Science and Technology)

20231038 **Material Search of Oxide-Based Lithium Ionic Conductors for Next- Generation All-solid-state Lithium Battery**

Kota Suzuki[1], Ryoji Kanno[1]
([1]Tokyo Institute of Technology)

Abstract:
New material search approaches along the unique two guidelines were conducted to discover the oxide-based lithium ionic conductors for next-generation all-solid-state lithium batteries. A machine learning model was developed, which predicts the ionic conductivity of materials from chemical composition information alone. This model indicated the high ionic conductivity in the Li_2O- SiO_2-MoO_3 system. Systematic synthesis and evaluation revealed the new LISICON phases with the composition of $Li_{4-2x}Mo_xSi_{1-x}O_4$. The material search in the ternary LISICON system (Li-M-M'-M''-O) indicated that the compositional complexity could enhance the ionic conducting properties. In addition to the classical concept (e.g., bottleneck size, polarizability, carrier density), the complexity could be a good indicator for ionic conductor exploration. Finally, in the Li_4GeO_4-Li_3VO_4-Li_5GaO_4 system, the highest ionic conductivity (1.5×10^{-4} S cm^{-1} at 298 K) of the LISICON family was discovered.

20231039 **Exploration of New Materials for All-solid-state Lithium-ion Batteries by Materials Informatics**

Makoto Saito[1], Koki Nakano[1], Hisatsugu Yamasaki[1], Kunihiro Nobuhara[1]
([1]Toyota Motor Corporation)

Abstract:
A key challenge of an all-solid-state lithium (Li)-ion battery (ASSLiB) development is to prevent crack formation in the electrodes during the charge and discharge. Such cracks block the smooth Li-ion transport between negative and positive electrodes and lower the output power. A possible measure is employing a new functional material, which shows higher durability against the crack formation but does not hinder the battery performance. A lot of simulation techniques have been proposed to assist experimental efforts for the new material search. Currently a simulation method consists of three parts has been widely used; candidate generation, synthesizability screening, and performance prediction. However, the ideal materials for ASSLiB have not been reported to the best of our knowledge due to the limitation that a rapid material screening can be done within the conventional material databases. It is known that exploration of unknown materials needs prohibitable computational costs. In this paper, we propose a practical method for unknown material exploration. We combine an unknown crystal structure generation technique using a genetic algorithm, which is known for heavy computational costs, and a machine learning potential to reduce the calculation costs. We demonstrate the performance of the scheme by raising some case studies of new material searches.

20231040 **Effects of Step Length to Failure Mode about Micro Penetration of Traction Batteries**

Zhipeng Sun[1], Hua Ma[2], Fang Wang[1], Xiuling Gao[2], Weijian Hao[1], Shiqiang Liu[1], Yuechao Zhang[2], Yue Xu[1], Weina Wang[1] Tianyi Ma[1]
([1]China Automotive Technology and Research Center Co., Ltd., [2]Tianjin EV Enegies Co., Ltd.)

Abstract:
The internal short circuit of the traction battery is one of the typical failure behaviors that cause the thermal runaway and cause the thermal propagation of battery system. As an effective test method to reproduce the internal short circuit, test conditions need to be studied in depth based on internal short circuit behavior. The penetration step length is one of the important factors affecting the internal short circuit behavior. However, for different battery samples, there is no clear test procedure for how to choose the appropriate penetration step to better reproduce the internal short circuit behavior. In this paper, penetration test with thin nail with different penetration steps was carried out to analyze the evolution of electrical and thermal parameters, which provided data reference for the establishment of universal internal short circuit simulation test.

20231041 **Separation Technologies for the Resource Recycling of Lithium-ion batteries**

Chiharu Tokoro[1,2]
([1]Waseda University, [2]The University of Tokyo)

Abstract:
Demand for lithium-ion batteries is expected to grow rapidly, especially for automotive and mobile applications, due to their high energy density, voltage, and long cycle life. Therefore, the establishment of their resource circulation is also an urgent task. This presentation will provide an overview of the recycling process for lithium-ion batteries, in which energy-saving and highly efficient separation processes have been developed by combining various separation unit operations such as disassembly, heating, reduction, grinding, physical separation, and hydrometallurgy. I will also introduce a novel original separation technology using the electric pulse method for the direct recycling of lithium-ion batteries.

20231042 **Development of Next Generation Battery for Hybrid Electric Vehicle**
- Development Status in Vehicle Energy Japan -

Yasuo Arishima[1], Shuichi Suzuki[1]
([1]Vehicle Energy Japan Inc.)

Abstract:
Vehicle Energy Japan have been promoting the development of lithium-ion secondary batteries for automobiles for about 20 years. In recent years, based on the knowledge gained so far, we have been promoting the digitalization of development with the main purpose of shortening the development period. Although the design and production of batteries is an analog world, by digitizing the characteristics that appear and incorporating the battery control logic developed by our company, we have made it possible to provide battery models that can be evaluated by vehicle OEMs. In this paper, we will introduce our latest battery development status and an example of the above battery model.

Day 2 (Tuesday, May 23)

A21-EP **Technology for In-wheel and Novel Drive Systems**

Room A (12:50-14:10)

Chair: Osamu Shimizu (The University of Tokyo), Shintaro Ohshio (Powertrain and EV Engineering Division)

20231043 **Verification of Centrifugal Pawl Clutch (CePaC) on Two-speed Transmission by Vehicle Test**

Takafumi Hagita[1], Shinji Okada[1], Takaya Yamada[1]
([1]NSK Warner K.K.)

Abstract:
The spread of electric vehicles is required in response to the demand for carbon neutral society. Therefore, it is desired to reduce the cost of electric motors and powertrains. In response to such demands, we verified the possibility of a simple two speed transmission that can bring out driving performance while constructing a powertrain with a down-sizing motor. Centrifugal Pawl Clutch (CePaC) is used for the two speed transmission. This paper describes the principle of shifting mechanism, traction motor torque control method, and the experimental results of the vehicle test.

20231044 **Thermal Evaluation of Direct Cooling Technology for In-wheel Drive System**

Tetsuya Suto[1], Makoto Ito[1], Akeshi Takahashi[1], Ryuichiro Iwano[1], Takafumi Hara[2]
([1]Hitachi, Ltd., [2]Hitachi Astemo, Ltd.)

Abstract:
We are developing a small and lightweight direct-drive system to develop in-wheel electric vehicles (EVs). In conventional oil-cooled motors for driving EVs, it is necessary to minimize the amount of cooling oil that enters between the rotor and stator to suppress fluid friction losses. In this study, we focused on the low-speed rotation of direct drives and developed a direct oil cooling system in which the entire motor magnetic circuit, including the rotor, is immersed in oil. We measured frictional loss and conducted a continuous heat- run test and a short-time rating test on a test bench. The results demonstrated that direct cooling is effective and continuous operation is possible. In this paper, we report on the concept of direct cooling and the results of the measurements.

20231045 **Magnetic Characteristics of High-power-density In-wheel Motor using Halbach Magnet Array**

Makoto Ito[1], Tetsuya Suto[1], Akeshi Takahashi[1], Takafumi Hara[2], Ryuichiro Iwano[1]
([1]Hitachi, Ltd., [2]Hitachi Astemo, Ltd.)

Abstract:
We are developing compact and lightweight in-wheel motors that can increase the cruising range for electric vehicles which are becoming more prevalent in the decarbonized society. This paper proposes a Halbach magnet array to achieve a world-class motor power density of 2.5 kW/kg. Finite element method analysis shows that our Halbach magnet array can obtain a large gap magnetic flux density with a small amount of magnets compared with the conventional Halbach rotor with a surface-permanent-magnet layout.

20231046 **Development of Noise and Vibration Reduction Technology for In-Wheel Motor Vehicles**

Kazumasa Shimode[1], Nobuhide Nishigaki[1], Kenji Yamada[1], Takashi Kawai[1]
([1]TOYOTA MOTOR CORPORATION)

Abstract:
Based on the serious problem of global warming, electric vehicles are focused on because of no greenhouse gas emissions. In-wheel motor (IWM) systems, where the drive motor is installed into wheel, is one of the major electric vehicle drive systems. IWM vehicles have advantage for dynamic performance by four-wheel independent control and flexible interior layout, but they also have several problems for mass-production. The cabin noise is one of the serious issues, because of vibration that occurs due to the unit being directly installed into the suspension. Therefore, reducing the vibration is important for IWM units with consideration of the vehicle's transmission characteristics. This paper describes countermeasures against vibration sources by the motor current control and against the vibration transfer through the trailing arm.

A22-EP **Battery Management and Grid Connectiing Systems**

Room A (14:30-15:50)

Chair: Hiroshi Senoh (National Institute of Advanced Industrial Science and Technology (AIST)), Takeshi Kato (Honda R&D Co.,Ltd.)

20231047 **Development of Predictive SOC Management Control for PHEV in Cooperation with Connected Services**
- Control architecture and benefit -

Yuki Yamada[1], Keisuke Morisaki[1], Vedang Rajyaguru[2]
([1]Toyota Motor Corporation, [2]Toyota Motor Europe)

Abstract:
This report shows the control algorithm and performance of the Predictive EV Drive and its benefit on fuel efficiency in real life. This control switches over the driving modes automatically depending on road load, battery level and traffic conditions. Furthermore, the application of this control for geo-fencing is also shown in this report. In order to achieve these functions, navigation system and plug-in hybrid control has been newly developed.

20231048 **Feasibility Study of Three-Phase Power Supply Using Hybrid / Plug-In Hybrid Electric Vehicles**

Chikara Dodate[1], Masayuki Imoto[1], Naofumi Magarida[1], Mitsuhiro Tabata[1], Takashi Kawasaki[1]
([1]TOYOTA MOTOR CORPORATION)

Abstract:
With because massive natural disasters occurring more frequently, preparation for power outage has become one of the most important issues for local governments and companies. Despite high installation costs, some large-scale evacuation centers are installing the emergency power sources such as generators. In contrast, widely available hybrid (HEVs), plug-in hybrid (PHEVs) and battery electric vehicles (BEVs) that are equipped with a power supply function are good candidates as affordable alternatives. However, this function outputs single-phase 100V, which cannot drive three-phase power equipment. This study examined the feasibility of three-phase power supply using HEVs and PHEVs, to help increase the number of local governments and companies HEVs and PHEVs as an emergency power supply.

20231049 **A Simplified Electric Vehicle Battery Degradation Model Validated with the Nissan LEAF e-plus 62-kWh**

Mattia Marinelli[1], Lisa Calearo[2], Jan Engelhardt[1]
([1]Technical University of Denmark, [2]Ramboll Danmark A/S)

Abstract:
Validated degradation models are needed to ensure optimized operation of battery systems. This paper presents a simplified electric vehicle battery degradation model, which estimates the degradation based on vehicle usage daily values. The model quantifies calendar and cycle degradation based on battery temperature, State-of-Charge and odometer. The model results are compared against two datasets of 2.5 years obtained with a LEAF e-plus: on-board State-of-Health readings retrieved from the battery management system and capacity estimations assessed while monitoring battery full recharges. The results show that, after 2.5 years, the model is well- aligned with the capacity estimations, while the on-board readings estimate the State-of-Health 1.3% lower. The obtained State-of-Health from the model after 2.5 years is equal to 95.6%, with calendar degradation being the major driver for the degradation cumulated so far.

20231050 **DC Charging Infrastructure**
- Towards achieving carbon neutrality -

Osamu Maruta[1], Tomomi Hakomori[1]
([1]CHAdeMO Association)

Abstract:
To achieve carbon neutrality, the vehicle mobility is going to be electrified by the 2030's. In the course of mobility electrification, the energy transforming device, charger and power conditioner can help power grid stabilization by smart charging or feeding energy back from the electric vehicle (V2G). This technology can also enable electric vehicles to supply energy to the shelters in the affected areas in the event of a power outage due to natural disasters. We report on the historical achievements, current tasks, and the future direction of V2G from the viewpoint of in-market experience and technical innovation for more than 10 years.

A23-EP **Autonomous Drive Technologies**

Room A (16:10-17:30)

Chair: Hisashi Imanaga (Japan automobile research institute), Yoshitaka Asakura (KABUSHIKIKAISHA AYE)

20231051 **Roadside Multi-vehicle Tracking under Different Occlusion based on Improved Siamese Network and Trajectory Correlation**

Shuai Wang[1], Yafei Wang[1]
([1]Shanghai Jiaotong University)

Abstract:
Roadside perception requires continuous tracking of vehicles in a fixed perception area. Traffic at city intersections is dense and easy to jam. Traffic lights and traffic jams also significantly lengthen occlusion times, making it harder for roadside sensors to track. In this paper, vehicle tracking model considering dynamic occlusion state transformation and trajectory correlation model based on road occlusion condition are constructed to achieve accurate vehicle tracking in different occlusion state. Firstly, a vehicle dynamic occlusion model was established based on the improved Siam network, and the vehicle dynamic occlusion under the local occlusion condition was analyzed. The tracking accuracy was improved by predicting the vehicle occlusion state. Secondly, a dynamic road occlusion model was established to analyze the possible positions of the occluded vehicles, and the correlation between the new point cloud and the interrupted trajectory in the sensing area was realized based on the point cloud similarity. Finally, the algorithm is verified in the data set DAIR-V2X-I, and it is proved that the algorithm has accurate and continuous tracking effect under the conditions of no occlusion, short-term occlusion and long-term occlusion.

20231052 **Steering Angle Control of Front Wheel Independent Steering System for Cornering Maneuverability Enhancement**

Junnian Wang[1], Ruihao Fan[1], Zidong Zhou[1], Zhenyu Wang[1], Fang Yang[2]
([1]Jilin University, [2]New Energy Development Institute of China FAW Group Co., Ltd.)

Abstract:
At present, steer-by-wire technology has become one of the core members of active chassis technology, due to its benefit for ensuring active safety and handling performance of vehicle, especially for intelligent electric vehicles. In order to improve the maneuverability of the vehicle under extreme condition by steer-by-wire technology, a multi-mode steer-by-wire system is proposed in this paper. The structural composition and dynamic modeling of the proposed steering system is introduced first, then corresponding steering angle decision and following control strategy are described. Simulation results verified the feasibility and steering-angle control effect of the proposed multi-mode steer-by-wire system.

20231053 **Next-Level Enhanced Collaborative Scene Understanding**

Ehsan Moradi-Pari[1], Hossein Nourkhiz Mahjoub[1], Ryoji Igarashi[1]
([1]Honda Research Institute USA, Inc.)

Abstract:
Accurate *"Situational Awareness"* is a key component for reliable decision-making in autonomous driving. Relying on only onboard sensor suites of individual AVs is not sufficient for this purpose, due to its inherent restrictions, like limited detection range and non-line-of-sight limitations. Therefore, to have a safe AV design having a framework that facilitates the collaboration among multiple connected AVs (CAVs) and jointly build up their scene understanding seems to be essential. In this work, we propose a novel framework by utilizing the capabilities of advanced 5G communication and edge-computing technologies. Additionally, our framework is capable of risk assessment and quantification that enables a clear characterization of the collaboration among CAVs and its impact on collision risk reduction and uncertainty. We further investigate the effectiveness of the proposed approach by utilizing real world data and postprocessing analysis.

20231054 **A Noise-Shaped Signaling Method for Vehicle-to-Everything Security based on Channel State Information**

Dongryul Park[1], Seongho Woo[1], Sungryurl Huh[1], Seungyoung Ahn[1]
([1]Korea Advanced Institute of Science and Technology)

Abstract:
This paper presents a method to improve the Vehicle-to-Everything (V2X) security. With recent development of communication technology and traffic applications, V2X is recently commercialized and has been growing as a fundamental system for future applications. Because of the high mobility of the vehicles, V2X requires a low latency and high-reliability. However, previous security methods demand a large computational burden and generate high latency owing to complex operations and long additional data bits for ensuing security. We propose a noise-shaped signaling method that provides high-level security with low latency for reliable V2X communication. The proposed method encrypts original data symbols to noise-like symbols by applying a noise envelope that consists of Chaotic Random Magnitude Sequence (CRMS) and Chaotic Random Phase Sequences (CRPS). The proposed method does not demand additional data bits, generate delay and degrade error rate because the method only uses simple procedure with automatically manipulated sequences for data encryption. We analyze our method in depth using extensive simulations and various viewpoints such as error rate. After these analyses, we confirm that the noise-shaped signaling method is high-level of secure method with a low latency for V2X communication.

B21-WPT **Dynamic Wireless Power Transfer 1**

Room B (12:50-14:10)

Chair: Katsuhiro Hata (The University of Tokyo), Keisuke Kusaka (Nagaoka University of Technology)

20231055 **Report of Burial Technology Applicable to Traffic Zone N6 in Dynamic Wireless Power Transfer**

Takehiro Imura[1], Koki Hanawa[1], Yoichi Hori[1], Hiroyuki Mashito[2], Nagato Abe[2]
([1]Tokyo University of Science, [2]Toa Road Corporation)

Abstract:
For dynamic wireless power transfer, the development of technology for embedding the coils in the road is important. In order to embed coils in the road, both electrical and mechanical properties are required. In this paper, eleven coils were used to verify the optimal burial technique by varying the type of coil and burial method. The electrical characteristics of this coil are evaluated before and after burying them. Moreover, the mechanical strength of the road after burying the coils is evaluated by FWD test. A comprehensive evaluation of the electrical and mechanical properties of the synthetic resin coils when paved was performed. Three coils and their burial methods were experimentally shown to be suitable.

20231056 **Verification of the Effects of Cross-Coupling on Dynamic Wireless Power Transfer for Heavy-Duty Vehicles Using Double-LCC Circuits**

Takahiro Kawakami[1], Takehiro Imura[1], Yoichi Hori[1]
([1]Tokyo University of Science)

Abstract:
Dynamic Wireless Power Transfer (DWPT) is a technology that extends the cruising distance of electric vehicles and contributes to their widespread use. To extend the cruising distance of heavy-duty vehicles with DWPT, increasing the average power received by installing multiple receiver coils is being considered. However, it is known that wireless power transfer using three or more coils causes cross-coupling, which deteriorates the transmission characteristics. In this study, the effects of cross-coupling (CC) are investigated for two types of circuit configurations: Independent Multi-Pad Receiver and Series Multi-Pad Receiver. As a result, it was found that the effect of cross-coupling between the transfer coils is small for the Double-LCC circuit, and that the effect of cross-coupling between the receiver coils is small for the circuit with Series Multi-Pad Receiver. Experiments also showed that the Series Multi-Pad Receiver can obtain 30% more power than the Independent Multi-Pad Receiver.

20231057 **Development of Integrated On-board Converter for Wireless Power Transfer**

Ryosuke Ota[1], Ryohei Okada[2], Nobukazu Hoshi[2]
([1]Tokyo Metropolitan University, [2]Tokyo University of Science)

Abstract:
Integrating converters for wireless power transfer (WPT) and motor drive in electric vehicles (EVs) could improve their power conversion efficiency and cost performance. This paper evaluates a proposed multiport converter that integrates WPT and motor drive systems, through both theoretical analysis and experiments. The proposed WPT system with the multiport converter is modeled to analyze its power loss in the theoretical analysis. The validity of the developed power loss models was confirmed through experiments with a prototype. Moreover, the proposed converter was compared with a conventional converter and found to be more efficient by up to 1.4 percentage points at the maximum output.

B22-WPT **Dynamic Wireless Power Transfer 2**

Room B (14:30-15:50)

Chair: Ryosuke Ota (Tokyo Metropolitan University), Takehiro Imura (Tokyo University of Science)

20231058 **Optimal Location Model of In-motion Wireless Power Transfer System for Trips in Urban-scale Region by Electric Vehicles**

Yudai Honma[1], Daisuke Hasegawa[1], Katsuhiro Hata[1], Takashi Oguchi[1]
([1]The University of Tokyo)

Abstract:
The popularization of electric vehicles (EVs) is limited by their driving range and long charging times. To address this, in- motion wireless power transfer systems (WPTSs) are currently attracting attention as a new power supply system. This study aims to propose a new mixed integer programming (MIP) model to determine the optimal locations of WPTSs in urban-scale area. Specifically, we calculate the amount and locations of WPTS necessary and sufficient to achieve substantially zero consumption of energy in urban areas. We also present an numerical example by real data of a typical medium-sized city in Japan.

20231059 **A Demonstration of Wireless Power Transfer Roadway System based on Electric Field Coupling**

Sonshu Sakihara[1], Tetsuo Endo[1], Takefumi Shindo[1], Masakazu Jomoto[2], Minoru Mizutani[3], Takashi Ohira[3]
([1]Taisei Corporation, [2]Taisei Rotec Corporation, [3]Toyohashi University of Technology)

Abstract:
The objective of our research is to develop a practical technology for a safe and general-purpose wireless power transfer roadway system based on electric field coupling that is highly power transfer efficient and easy to repair and renew. In this paper, we present a structure of our WPT roadway system based on the electric field coupling, results of power transfer efficiency simulations and experiments. The simulation results show that maximum transfer efficiency is 92.6% and average transfer efficiency is 68.4%. Additionally, we constructed a 20m WPT roadway and conducted WPT experiment. As a result, it shows that maximum transfer efficiency is 72.8% and average transfer efficiency is 54%.

20231060 **Interoperability of Wireless Power Transfer**

Juergen Meins[1], Ralf Effenberger[2]
([1]Technical University of Braunschweig, [2]INTIS GmbH)

Abstract:
This paper presents the results of investigations on the magnetic and electric interoperability of wireless power transfer (WPT) based on the magnetic coupling between two coils. A wayside installed coil transmits magnetic flux which is received by a vehi- cle side installed coil. The transferred power can be used to charge vehicle side batteries and/or power the propulsion system. The proof of interoperability is exclusively based on the transmitted and reflected magnetic flux characteristic and is independent of the impedance and the compensation design. Due to the focus on the description of interoperability by the magnetic coupled flux a wide range of the design details as coil geometry, voltage and current levels, electric impedances must not be standardized and can be kept under the responsibility of the individual design.

20231061 **Challenge of Innovative Electric Roadway System Featuring Capacitive Coupling Wireless Power Transfer**

Yukio Yokoi[1], Ryuji Mizouchi[1], Takashi Ohira[2]
([1]Fujiwaves Co., Ltd, [2]Toyohashi University of Technology)

Abstract:
This paper reviews worldwide history and recent trend of Electric Road System(ERS) based on DWPT. History of Patent, FS and Evaluation on test course are reviewed covering Europe, England, United States, Korea, China and Japan. Also review current status of standardization and regulatory such as ISO,IEC,SAE,ITU and CISPR. Report on our ongoing challenge plan using test course for innovative ERS featuring Capacitive Coupling DWPT at Fiji-Yoshida city is introduced . Social implementation of DWPT on Public Road at northern area of Mt. Fuji after evaluating using test course will contribute carbon free smart mobility society in the future. It will also contribute the plan of Fujisan railway which was reported by Fujisan railway study committee at Feb.2021. The draft plan of Fujisan railway with no catenary LRT are overviewed.

B23-WPT **Wireless Power Transfer - EMC**

Room B (16:10-17:30)

Chair: Masahiro Hanazawa (UL Japan), Yukio Yokoi (Takuhsoku Univ)

20231062 **High Efficiency 10kW Class Wireless Power Transmission Using Electric Field Coupling - High Efficiency 10kW Class Wireless Power Transfer by CPT -**

Naoki Tsurutani[1]
([1]Furukawa Electric Co., Ltd.)

Abstract:
Wireless power transmission technology is attracting attention from the viewpoint of improving user convenience during charging. Among wireless power transmission methods, the electric field coupling type has been considered unsuitable for large power transmission compared to the magnetic field coupling type. This time, as a result of repeated studies on the electrode and coil structure of the electric field coupling coupler, we achieved power transmission up to 10.1 kW on the power transmission side and 9.2 kW on the power reception side, and evaluated various characteristics.

20231063 **Evaluation of Human Exposure to EMF in the Wireless Charging Environment for Electric Vehicles**
- Evaluation of the human exposure to EMF according to coil topology and human model position -

Jaewon Rhee[1], Hongseok Kim[2], Seongho Woo[1], Changmin Lee[1], Sanguk Lee[1], Seunghyun Han[3], Seokhyeon Son[3], Seungyoung Ahn[1]
([1]Korea Advanced Institute of Science and Technology, [2]Clear Signal Solutions, Inc., [3]Hyundai Motors Company)

Abstract:
This paper presents the effects of EMF generated during electric vehicle (EV) wireless charging on the human body model through simulation. According to SAE J2954 standard, circular and bipolar coils were selected and the human exposure was evaluated under the worst EMF condition. In addition, the effect of EMF according to the posture and position of the human body model was evaluated, and as a result of the evaluation, it was confirmed that the effect of the position rather than the posture was dominant. Also, as a result of the simulation, the bipolar coil exceeded the human exposure limit of EMF by up to 135%, so the bipolar coil requires stricter design conditions compared to the circular coil.

20231064 **Minimizing Method of Leakage Magnetic Field in Wireless Power Transfer Systems for Electric Vehicles**

Seongho Woo[1], Sungryurl Huh[1], Dongryul Park[1], Jaewon Rhee[1], Seungyoung Ahn[1]
([1]Korea Advanced Institute of Science and Technology)

Abstract:
In this paper, a method for minimizing the leakage magnetic field is proposed from wireless power transfer (WPT) systems that employs the series-series (SS) compensation networks through finding the optimal resonant frequency of RX. Conventional shielding methods need additional materials, power source or shielding coil, but this method can suppress the leakage magnetic field without any additional materials. So, the proposed method is suitable for weight-limited or size-limited WPT systems. Lastly, the proposed method is verified through simulation.

20231065 **Leakage Magnetic Field Suppression Method Using the Next Transmission Coil as a Cancel Coil with Ferrite and Shield in Dynamic Wireless Power Transfer**

Yuto Ito[1], Takehiro Imura[1], Yoichi Hori[1]
([1]Tokyo University of Science)

Abstract:
In recent years, from the perspective of carbon neutrality, the spread of Electric Vehicles (EVs) is progressing worldwide. However, it is not widely used due to its cruising distance and battery weight. Therefore, attention is focused on Wireless Power Transfer (WPT), especially Dynamic Wireless Power Transfer (DWPT), which supplies power to a running EV. The leakage magnetic field is a problem in spreading this technology. If the magnetic field used in WPT using magnetic resonance coupling leaks outside, it may adversely affect the human body and electronic devices. Therefore, in this paper, we consider leakage magnetic field suppression. Although the method of using a canceling coil or changing the coil structure is common, this paper proposes a leakage magnetic field suppression method that does not require additional coils and does not change the coil structure by controlling only the phase of the voltage applied to the cancel coil. Simulations on the proposed method show that it is possible to suppress the leakage magnetic field. It was also confirmed that the magnetic field suppression is effective even when the position of the receiving coil is shifted.

C21-PE **Motor Drive Technologies**

Room C (12:50-14:10)

Chair: Kenta Emori (Nissan Motor Co., Ltd.), Kentaro Hirose (TOYOTA MOTOR CORPORATION)

20231066 **Novel Flux Weakening Control for Improving Current Response and Stability of EV Motor**

Yasumasa Hamabe[1], Yoshiyasu Takase[1], Hengbin Rui[1], Shinya Morimoto[1], Koji Higashikawa[1], Akira Yamazaki[1]
([1]Yaskawa Electric Corporation)

Abstract:
The response and stability of flux weakening control in the high-speed range of IPMSMs is one of the most important factors for EV and industrial applications. Conventional flux weakening control based on the voltage reference feedback method is highly stable against fluctuations motor parameters but has a problem that the current response is low compared to the control in the constant torque region. Therefore, this paper proposes a novel flux weakening controller that combines feedforward and feedback control to improve response and stability of current control in the flux weakening region.

20231067 **Dry Run Detection Method of Sensorless Brushless Motor in Motor Speed Feedback Control System**

Naoki Onosaka[1], Takeru Yamamoto[1]
([1]AISIN Co., Ltd.)

Abstract:
Because of the voltage FF (Feedforward) control specification of conventional electric liquid pumps, when the motor is driven with no liquid at all in the pump chamber, the motor speed will be very high compared to the speed when the pump chamber is filled with liquid. If the pump continues to be driven in this condition, the components of the pump may wear out or, in extreme cases, break. To address this issue, when the motor speed exceeds a certain value, a dry run is detected and a fail operation is per formed to prevent damage to the pump. However, in vehicle systems that require motor speed FB (Feedback) control for the pump, a backlash has been found that prevents detection of dry running in the same way. Therefore, in this study, we established a method to detect dry running of pumps that require FB control without additional hardware such as sensors.

20231068 **PWM Control Method to Improve the Voltage Utilization Rate of the Inverter.**

Takeshi Kuroda[1], Ryota Maeno[1], Takahiro Akahori[1], Akihiro Odaka[1]
([1]Fuji Electric Co., Ltd.)

Abstract:
Inverters that drive in-vehicle motors are required to be driven efficiently and stably in a wide operating range from low- speed large torque to high-speed high-induced voltage. In order to improve the efficiency of the inverter, it is necessary to further reduce the output current for the same torque by improving the voltage utilization rate. In this paper, we propose a PWM control method that improves the voltage utilization rate of the inverter, and confirm its effectiveness by experiments. In addition, the proposed method is compared with other control methods that realize 1-pulse, and points to be further improved in the proposed method are considered.

20231069 **Flying-start Strategy for Permanent-Magnet-Synchronous-Motor Under Position Sensorless Control with Initial Speed Estimation**

Rongjiao Hao[1], Shinji Doki[1], Kazuki Asahina[2], Akira Ide[2]
([1]Nagoya University, [2]Toyota Industries Corporation)

Abstract:
In this paper, a flying-start strategy for position-sensorless-controlled permanent-magnet-synchronous-motor (PMSM) with the initial speed estimation is proposed. For the motors with lower rated speed, initial position estimation based on Extended Electromotive Force(EEMF) is fast enough for flying-start, but proper current control cannot be guaranteed if it comes to higher speed, unless both the speed and position are fully estimated. In the proposed method, the initial speed of the motor is estimated in a short time to improve the position estimation and decrease the decoupling voltage error during the flying-start at middle or high speed.

C22-MOT **Permanent Magnet Machines in Transportation Applications**

Room C (14:30-15:50)

Chair: Junichi Asama (Shizuoka University), Kohei Aiso (Shibaura Institute of Technology)

20231070 **High Power Density Technologies for the Driving Motors in Electric Vehicles**

Takeshi Kitayama[1], Hiroyuki Hattori[1], Keiji Takizawa[1]
([1]TOYOTA MOTOR CORPORATION)

Abstract:
In recent years, CO_2 emission regulations have been tightened, and vehicles with excellent environmental performance have become popular worldwide. The hybrid system installed in HEVs, which is a representative example of this, requires a high power density package to enable itself to be installed in any vehicle. For the driving motor in electric vehicles, which is the main unit of the system, developing high power density technologies is expected. This paper describes high-power and downsizing technologies for motors.

20231071 **On-line Torque Estimation Using Flux Approximation Surfaces for Torque Feedback MTPA Control**

Sota Kawashima[1], Keiichiro Kondo[1], Kazuhiko Matsunami[2], Shinji Nakazono[2]
([1]WASEDA University, [2]Suzuki Motor Corporation)

Abstract:
IPMSM deviates from the optimal operating point for vector control due to magnetic saturation of inductance and magnet flux variation with magnet temperature change. Therefore, torque feedback MTPA control, one of the control methods of IPMSM that is resistant to parameter fluctuations, is used. The accuracy of torque estimation, which is a problem in this process, is improved by an approximation method that calculates the estimated torque from the values of current and magnet flux during drive.

20231072 **HREE-free Hot-deformed Nd-Fe-B Magnets for xEV**
- Highly controlled techniques of shape and orientation-direction -

Takanori Kajiwara[1], Naoto Murase[1], Takashi Oikawa[1], Hiroshi Miyawaki[1]
([1]Daido Steel Co., Ltd.)

Abstract:
Nd-Fe-B magnets are required the addition of heavy rare earth elements (HREE) to secure enough coercivities in order not to deteriorate their remanence magnetizations due to the demagnetization field when they are applied to various uses. However, the procurement risk of the HREE is regarded as a particular concern. Daido Steel Co., Ltd. (DS) and Daido Electronics Co., Ltd. (DEC) developed HREE-free hot-deformed magnets composed of ultra-fine crystal grains which shows high coercivities without the HREE addition six years ago. Honda Motor Co., Ltd. (Honda) recently proposed an improved performance motor design for xEV utilizing the shape and orientation controlled magnet which has the ideal magnetic circuit. In order to realize this new design, DS and DEC have developed technology for controlling the shape and orientation of the HREE-free hot-deformed magnets through the net-shape molding process. The newly developed magnet has been begun the preparations for mass production.

20231073 **Magnetic Form which applies C Shaped Magnet for Hybrid Electric Vehicle**

Shingo Soma[1], Daiki Atsuda[1]
([1]Honda R&D Co, Ltd.)

Abstract:
Currently, electrification for vehicles such as battery electric vehicles (BEVs), plug in -hybrid electric vehicles (PHEVs), fuel cell electric vehicles (FCEVs) and hybrid electric vehicles (HEVs) are attracting a great deal of attention, due to the urgent need to reduce CO_2 emissions created from transportation and energy dependency on crude oil. Honda has set a target achieving two -thirds of total global sales as electrified by 2030. A traction motor is one of the essential components for electrified vehicles. Generally, Interior Permanent Magnet Synchronous Motors (IPMSM) are used as traction motors due to their high torque and power density, high effi ciency and ease of use. The design of rotors, which consist of magnets and electrical steel sheets, is important for IPMSM since not only average torque, efficiency and quietness depend on it, but also cost. We have developed a novel rotor, which allows for a degree of f reedom in the shape of the magnets.

C23-MOT **Future Trend and Challenges in Electric Machines**

Room C (16:10-17:30)

Chair: Hideaki Arita (Mitsubishi Electric Corporation), Kyohei Kiyota (Tokyo Institute of Technology)

20231074 **Modeling of Direct Cooling Method with Forced Convection Boiling Phenomena considering Liquid Phase Behavior of Liquid Gas Two-Phase Refrigerant for Vehicle Traction Application PMSM**

Tatsuya Morimoto[1], Kensuke Sasaki[1], Takashi Kato[1]
([1]Nissan Motor Co., Ltd.)

Abstract:
A direct cooling with boiling phenomena for motor stator winding is expected to be one of output capability improvement methods of-Electric Vehicle (EV) traction applications due to its high heat dissipation capability. However, the behavior of refrigerant
under boiling phenomena in such narrow space like stator slot is not studied very well. So, a model to obtain heat transfer coefficient of the method is proposed. The model includes capillary force effect to fill the gap in the stator winding with refrigerant liquid under convection boiling by pump system. A case of winding temperature under the phenomena is calculated using a stator slot model, and the calculated result reasonably agree with the experimental result. The result shows non-linear sensitivity to slot fill factor and winding temperature, and it suggests importance of slot fill factor for maximizing cooling performance of the method.

20231075 **Effects of Conductor Materials for Reducing Winding Loss in Permanent Magnet Synchronous Machines**

Hiroya Sugimoto[1], Yuto Yamada[1]
([1]Tokyo Denki University)

Abstract:
This paper presents a design of high slot fill aluminum winding in permanent magnet machines for reducing winding losses. Generally, there is a trade-off between the winding weight and the winding losses. The winding DC loss is reduced with an increase of cross-sectional areas of conductors. In general, the aluminum winding is effective for reducing the winding weight, on the other hand, the winding loss is high because the electrical conductivity is low. In this paper, the conductor material is changed in each turn because the winding loss is concentrated in the closest conductor from the stator tooth tip. An aluminum alloy that has relatively low electrical conductivity is assigned to the first layer. In 2D-FEM analysis, it significantly contributes for reducing winding AC losses compared to that of previous aluminum winding machine. In addition, shapes of the stator tooth tip and the first layer of conductors are improved. This manuscript presents that these improvements are significantly effective for reducing winding losses.

20231076 **Downsized 48V Motor Winding Structure for an EV Powertrain - Compact, High-output Motor Built with Double-layer, Short-pitch, Distributed Windings -**

Daiki Tanaka[1], Akira Suwabayashi[1], Junichi Asama[2]
([1]JATCO Ltd, [2]Shizuoka University)

20231077 **Development of A Novel In-Wheel Motor System Integrated of Magnetic Gear and Multiple High-Speed Motors**

Kohei Aiso[1], Kan Akatsu[2], Yasuaki Aoyama[3]
([1]Shibaura Institute of Technology, [2]Yokohama National University, [3]Hitachi, Ltd.)

Abstract:
A technical innovation for the downsizing of motor system is necessary to realize the saving energy, and roomy and comfortable car interior space in electric vehicles. In this research, a novel in-wheel motor system of multiple high speed motors and Magnetic Multiple Spur Gear (MMSG) for the electric vehicle is proposed. The MMSG can achieve the high mechanical strength and high transmitted efficiency by the structure separating several input rotors even in the speed region of 50000 min^{-1}. Moreover, the MMSG system realizes the drastic downsizing and the high efficiency by transforming the input of multiple high speed motors. In this presentation, the performances of proposed drive system with MMSG are clarified by the experiment.

Day 3 (Wednesday, May 24)

A31-EP **Control for Drive Systems**

Room A (12:50-14:30)

Chair: Daisuke Gunji (NSK Ltd.), Giuseppe Guidi (SINTEF Energi AS)

20231078 **Flux-based Cascade Vector Control for xEV Applications - Reduction of Calibration Time for Torque Response -**

Shun Taniguchi[1], Kentaro Matsuo[2], Kazuaki Tobari[1], Toshiyuki Ajima[1], Kenichi Yoshida[2], Eigo Kishimoto[2]
([1]Hitachi, Ltd., [2]Hitachi Astemo, Ltd.)

Abstract:
Flux-based cascade vector control is proposed, which uses flux instead of current for torque control. The proposed method does not require any step-response test but instead employs a steady-state test for torque-response calibration. The method is verified by conducting an experiment using an EV motor. A reduction in calibration time is realized with precise torque control response.

20231079 **Enhancement of xEV Motor Driving Force Control**

Haibo Liu[1], Kazuya Enokizono[1], Masaru Kubota[1], Sadahiro Akama[1], Keisuke Kawai[1]
([1]DENSO CORPORATION)

Abstract:
To realize a carbon-neutral society, it is necessary to develop technologies to promote the electrification. The expansion of regenerative range of cooperative regenerative braking system is a promising technology. Here, two issues arisen in expansion of regenerative range (motor enhanced regenerative braking) are handled and solutions have been established, which are specified as (1) keeping regenerative braking until stop (2) continuation of regenerative braking in ABS actuation scenes. Regarding issue (1), a feed forward control is proposed which is independent from using wheel speed to ensure the vehicle stopping. At the same time, G omission and deterioration of drivability due to vibration caused by driveshaft twisting and gear-rattling is suppressed to an acceptable level. Dealing with issue (2), a PID control in piecewise function is suggested which is divided by differential of tire slip ratio. In small differential of slip ratio area, a linear PID control is deployed to control the motor force precisely to keep tire gripping. In the area where differential of slip ratio is large, an ID control is dominated to limit the change of slip ratio. The solutions of (1) and (2) were implemented in a rapid- prototype environment, and braking tests on dry road and μ-jump road (a sudden change in the road surface μ) had been conducted to confirm the validity of those control. It is proved that both the improvement of energy efficiency and keeping stopping distance equivalent to conventional ABS system are realized. In the future, further verification of the robustness will be carried out on xEVs.

20231080 **Regenerative Brake Controller based on Vehicle Behavior prediction**

Viktar Beliautsou[1], Ilnaz Giliazov[1], Aleksandra Beliautsou[1], Valentin Ivanov[1]
([1]Technische Universität Ilmenau.)

Abstract:
The braking function of an electric vehicle can be implemented with both friction brakes and electric motors, which require a suitable control strategy for their coordinated operation. Many previous studies on this topic have focused on conventional serial or parallel brake control strategies. In this paper, we present a different approach to brake torque blending control based on a motor efficiency map and an improved single pedal control strategy based on vehicle behavior prediction. In this strategy, the regenerative braking is prepared for activation when the controller predicts a deceleration mode. The motor efficiency map of the test model was analyzed and optimized in this way. An artificial neural network was selected to implement an advanced braking strategy. Standardized driving cycles with three different driver profiles were used to train and evaluate the neural network. The results show that this approach significantly improves the vehicle's efficiency. For the WLTP cycle, the proposed strategy can reduce the average energy consumption by 4%, at which the energy recovered has been increased by 9%. For the HWFET cycle, the recovered energy could be increased up to 24%.

20231081 **Effective Modeling and Controller Design for Two-Input-Two-Output Torque Difference Amplification Motor Drive System**

Hiroyuki Fuse[1], Guangzhi Yu[1], Hiroshi Fujimoto[1], Kaoru Sawase[2], Naoki Takahashi[2], Ryota Takahashi[2], Yutaro Okamura[2], Ryosuke Koga[2]
([1]The University of Tokyo, [2]MITSUBISHI MOTORS CORPORATION)

Abstract:
For electrified vehicles, a torque vectoring differential (TVD) with a two-motor-torque difference amplification mechanism (TDA-TVD) has been proposed and it generates a greater torque difference. However, due to the complex driving force transmission system including planetary gears and driveshafts, TDA-TVD has problems with the vibration of both the driveshaft torque and the yaw rate while differential torque is generated. To deal with this issue, this study analyzes TDA-TVD in frequency domain and also propose a novel modeling method to construct vibration suppression controllers that deal with both longitudinal motion and yaw motion simultaneously. First, this paper shows a theoretical frequency do- main analysis using matrices and obtain resonance frequencies of TDA-TVD. Second, TDA-TVD is modeled based on a summation-differential mode transformation. Third, simulations and experimental evaluations of vibration suppression using a real vehicle with the TDA-TVD are demonstrated.

20231082 **Investigations on the Energy Saving Potential of X-by-wire Chassis Systems and Advanced Integrated Control Strategies**

Marius Heydrich[1], Christopher Hamatschek[1], Markus Gundlfinger[2], Christian Eichhammer[2], Claus Lechner[3], Christoph Fachbach[3], Florian Büchner[1], Valentin Ivanov[1], Sebastian Gramstat[2], Eric Armengaud[3,4]
([1]University of Technology Ilmenau, [2]AUDI AG, [3]AVL List GmbH, [4]Armengaud Innovate GmbH)

Abstract:
This paper describes real-world driving tests with a battery-electric sport utility vehicle equipped with innovative chassis actuators such as high-torque in-wheel machines and a hybrid brake-by-wire (BBW) system tailored specifically for electric vehicles. In addition, the vehicle incorporates a new E/E architecture and communication bus systems to integrate the new components into the global bus network. Integrated control functions are used to investigate the potential of the new by-wire actuators to improve energy efficiency. To this end, the vehicle is tested in comparison with a series vehicle. The focus of the presented experiments is on the energy saving potential through integrated control of the subsystems for different functions such as regenerative wheel slip control or torque blending. At the end, a comparison is made between the baseline vehicle with standard centralized powertrain and friction braking system and the demonstrator with the adapted actuators to show the advantages in terms of overall efficiency and energy consumption.

A32-EP **Eaxle and Powertrain System**

Room A (14:50-16:10)

Chair: Takashi Hirose (SUBARU Corporation), Takeshi Kato (Honda R&D Co.,Ltd.)

20231083 **Challenges of the Development of an Axle Drive Platform in a Disruptive Environment - SCALABLE PLATFORM FOR AN EFFICIENT 400-VOLT AXLE DRIVE -**

Hirofumi Yudahira[1], Takahiro Kato[1], Hiroshi Nishimura[1]
([1]Vitesco Technologies, Japan K.K.)

Abstract:
As a global Tier1 supplier Vitesco Technologies is facing a broad scale of OEM requirements and interests in general. In particular when talking about electric Axle Drive Systems another dimension of complexity is present. This requires a generic platform development with the highest possible level of scalability and flexibility as well as a strong cost competitiveness which is a typical contradiction. Beside significant development efforts an inevitable circumstance is the need for multiple and sometimes long-lasting development cycles to balance the contradictions and to optimize the outcomes. Additional challenges occur when disruptive factors apply like a significant change of market environment or unexpected technology drifts. Vitesco Technologies will present the current fourth generation Axle Drive (Electronics Motor and Reducer: EMR4) platform and explains how to deal with disruptive changes in the recent years based on specific examples:

20231084 **Series Concept of an Externally Excited Synchronous Machine as a Magnet- Free Option in the integrated E-Axle Platform EMR4**

Gunter Muehlberg[1], Nico Daun[1], Hilko Hakvoort[1], Takahiro Kato[2], Hiroshi Nishimura[2]
([1]Vitesco Technologies Germany GmbH, [2]Vitesco Technologies, Japan K.K.)

Abstract:
Electromobility is now firmly set to become the mainstream of future mobility. The growing range of Battery Electric Vehicles (BEVs) adds more frequent long-distance highway trips at higher speeds to the powertrain requirement list. This, together with geopolitical tensions, out-of-sync supply chains, a significantly increased rare-earth cost level and the growing importance of a BEV's Global Warming Potential (GWP) has initiated a comeback of Externally Excited Synchronous Machines (EESM) for BEV powertrains. They offer a rare earth-free alternative to the Permanent Magnet Synchronous Machines (PSMs), which have become the mainstream over the past decade. Considering the growing importance of high-speed driving, EESMs offer a better efficiency at >110 km/h than PSM, and they have a lower overall GWP. Up until recently, EESMs were often seen critically as they can add manufacturing complexity and production cost. Vitesco Technologies has ten years of field-experience with EESM in series use since 2011 and has utilized this expertise to develop a new 400 V/800 V EESM series concept complete with excitation stage that combines the advantages of EESM technology with a significantly simplified and cost-optimized design for manufacturing. The magnet-free EESM rotor is readied as a new option within the modular and scalable EMR4 platform that is compact enough to address even the D-segment, but can be scaled upwards to include all passenger cars segments above.

20231085 **Development of e-AWD Parallel Hybrid System**

Shoichi Kuwayama[1], Kensuke Kamichi[1], Manabu Ishimoto[1]
([1]Toyota Motor Corporation)

Abstract:
This paper describes the development of a new e-AWD parallel hybrid system. This hybrid powertrain system consists of a high-torque 2.4-liter turbocharged engine and a front unit that contains a 6-speed automatic transmission, an electric motor, and an inverter. It also includes a rear eAxle unit that contains a water-cooled high-power motor, an inverter, and a reduction gear, as well as a bipolar nickel-metal hydride battery. By combining a turbocharged engine that can output high torque across a wide range of engine speeds using two electric motors (front and rear), this system achieves both smooth acceleration with a torquey driving feel and rapid response when the accelerator pedal is pressed. In addition, a new AWD control using the water-cooled rear motor realizes more stable cornering performance than the previous e-AWD system. In this way, developing a hybrid system with appealing new driving characteristics increases the variety of electric powertrains available to customers as part of measures to help achieve carbon neutrality.

20231086 **Technology of BEV Powertrain for Mid-Size SUV**

Naoki Takeuchi[1], Masaya Yamamoto[1], Hiroki Nagai[1], Takuya Hirai[1]
([1]Toyota Motor Corporation)

Abstract:
Toyota Motor Corporation has launched a new battery electric vehicle (BEV) that incorporates the newest evolutions in BEV powertrain systems and vehicle platform innovations. This new BEV uses newly developed large-format battery cells. In addition to achieving the key performance targets, these cells also incorporate new technologies to increase battery energy density and reduce battery deterioration. The BEV battery cooling system features a chamber structure that separates the cooling plate and battery cells. The battery pack also incorporates a newly developed high-resistance coolant with low conductivity. BEV system efficiency is improved by leveraging technologies that were originally developed for HEVs and the development of new systems. For example, radiant heating and a newly developed heat pump system were adopted that extend the EV driving range in cold conditions. Newly developed SiC semiconductors were also adopted that greatly improve power consumption. This paper discusses the technology of the new BEV system.

B31-WPT **Wireless Power Transfer 1**

Room B (12:50-14:30)

Chair: Keisuke Kusaka (Nagaoka University of Technology), Katsuhiro Hata (The University of Tokyo)

20231087 **Wireless Charging is Now**
- Bringing automated wireless charging to accelerate EV adoption -

Tom Okada[1]
([1]WiTricity)

Abstract:
For many years, people talked about wireless power transfer (WPT). Since Nikola Tesla's time in the late 1800s, wireless power transfer (WPT) has been used in applicationssuch as telemetry, satellite communications, and radio frequency identification (RFID) tags. Most of these applications transfer low amounts of power, in the range of microwatts to milliwatts, for data transfer. For higher- power applications, from a few watts to several kilowatts – over moderate distances – WPT has become the focus of industrial developments and electric vehicles. But, until recently, wireless charging of electric vehicles has only been a dream. Now, it's reality.

20231088 **Evaluation of a Communication-less and Load-independent Resonance Mismatch Compensation Method for Wireless Power Transfer at Close Coil-to-Coil Distances Using LCC-S Circuits**

Yuki Ouchi[1], Takehiro Imura[1], Yoichi Hori[1]
([1]Tokyo University of Science)

Abstract:
Wireless power transfer (WPT) for electric vehicles (EV) uses compensation capacitors to adjust the resonant frequency. However, due to the influence of ferrites and aluminum plates, the resonance is shifted when the distance between the coils changes. Resonance mismatch is a cause of deteriorated transmission characteristics. This paper proposes a resonance mismatch compensation method for LCC-S circuit, focusing on the output voltage and independent of load variations. The proposed method does not require any control on the transmitter (Tx) side, and the resonance mismatch compensation is carried out using information only on the receiver (Rx) side, without using communication. To validate the theory, transmission characteristics were evaluated by numerical analysis and experiments. Comparison of the results shows that load-independent resonance mismatch compensation is possible by focusing on the output voltage.

20231089 **Sheet Coil and Ultra-thinner VA Unit Used in EV-WPT**

Akane Arakawa[1], Masato Okabe[1], Junya Otsuki[1], Kenichi Miyazaki[1], Hiroyuki Hase[1]
([1]Dai Nippon Printing Co., ltd.)

Abstract:
With the spread of EVs, there are increasing expectations for wireless power transfer (WPT) systems that can be easily recharged. The authors have developed a sheet coil for this system that is thinner and lightweight compared to conventional coil using Litz wire. Using this coil, we have demonstrated that power transmission is possible at 11.1 kW, which is the standard for power specified in SAE J-2954[(1)(2)]. In addition, by reducing the distance of ferrite plate and aluminum shield, the entire coil unit can be made thinner, further succeeding in developing a VA coil unit with high performance by suppressing the coil loss due to the reducing distance between both.

20231090 **Coupling Coefficient Extraction between Transmitter Coils and Receiver Coil in Wireless Power Transfer System for Automatic guided vehicles**

Sungryurl Huh[1], Seongho Woo[1], Dongryul Park[1], Seungyoung Ahn[1]
([1]Korea Advanced Institute of Science and Technology)

Abstract:
This paper proposes a method for extracting the coupling coefficients of a receiver coil and each transmitter coil in a wireless power transfer system composed of multiple transmitter coils for automatic guided vehicles (AGVs). The coupling coefficient is essential information because the operation state of several transmitter coils is determined depending on the coupling coefficient with the receiver coil. In addition, in case of movement of the receiver coil or a change in load, the information of the receiver coil should be monitored even in the deactivated transmitter coils. The proposed coupling coefficient extraction method is designed to extract the coupling coefficient even when the transmitter coil is deactivated. The proposed method was verified by targeting a 300 W class AGV, and the results of the proposed method had a small error of 2.5% compared to the results measured using dedicated equipment.

20231091 **Applicability of HD-PLC / PaWalet Link Technology to WPT system**

Naohiro Kawabata[1], Hisao Koga[1], Toshiyuki Wakisaka[1]
([1]Panasonic Holdings Corporation)

Abstract:
In a wireless power transfer (WPT) system in which multiple vehicles such as EVs and E-Bikes are placed close to each other, wireless communication is used for charging control and collecting various data (images, sensors, etc.). In those systems, radio wave interference causes false detection of vehicles and security issues. We propose PaWalet Link (*1) technology, which applies HD- PLC (*2) (High-Definition Power Line Communication), a kind of high-speed power line communication technology, to near-field wireless communication as a method that achieves both high-speed communication and avoidance of radio wave interference. By superimposing the HD-PLC signal on the loop antenna, we showed that PaWalet Link technology enables high-speed communication within a limited range of several tens of centimeters and avoidance of radio wave interference using channels with different frequency bands.

B32-WPT **Wireless Power Transfer 2**

Room B (14:50-16:10)

Chair: Yukio Yokoi (Takushoku University), Ryosuke Ota (Tokyo Metropolitan University)

20231092 **Educator Oriented Prototype Amplitude Modulation Radio Exploits 40 MHz Capacitive Coupling Wireless Power Transfer**

Yuri Kitagawa[1], Takashi Ohira[1]
([1]Toyohashi University of Technology)

Abstract:
This paper stimulates university students to put RF circuit theory into practical electronics involving wireless power transfer. A Hartley oscillator using a low noise MOSFET 2SK241 generates 40 MHz sinusoidal waves, which is linked by a double series resonant toroidal LC coupler to a power booster stage using twin bipolar transistors SS8050 in parallel. Two pairs of metallized plastic plates work as a capacitive coupling wireless power transfer system. A toroidal inductor compensates in series for the coupling capacitance to enhance the power transfer efficiency. A double current rectifier using twin point contact diodes 1N60 converts the RF power back into DC. A medium wave signal broadcasted from NHK Nagoya radio station is received at Toyohashi located 80 km apart with a ferrite bar antenna 2V59M followed by an RF folded cascode amplifier using complementary bipolar transistors 2SC1815 and 2SA1015. A point contact diode 1N60 is again used for AM detection. A constant current diode E-102 enhances the voltage gain in the audio amplification stage. A double emitter follower diamond buffer using two pairs of complementary transistors finally drive an 8 Ω sound speaker. Prospective wireless engineers should be able to learn much of analog RF circuitry from this educator oriented handmade masterpiece.

20231093 **Efficient Multiple Input Multiple Output Wireless Power Transfer**

Duong Quang Thang[1], Minoru Okada[1]
([1]Nara Institute of Science and Technology)

Abstract:
This paper introduced a multiple-input multiple-output (MIMO) based wireless power transfer (WPT) system for supplying the power to moving vehicles. The conventional single-input single-output (SISO) WPT system has a problem in its flexibility and power transfer efficiency. The proposed MIMO-WPT system makes efficient use the multiple transmitters and receivers to optimize the power transfer efficiency. We can maximize the efficiency by controlling the input and output currents at the multiple coupler nodes, The numerical analysis shows that the proposed MIMO-WPT can drastically improve the power transfer efficiency. Furthermore, we extend the MIMO-WPT for moving vehicle application. The extended MIMO-WPT cancels the backward waves on the transmission line by making use of the RF generators implemented on the receiver side.

20231094 **Theoretical Analysis for Effectiveness of Spread Spectrum for Resonant Type Wireless Transfer System**

Atsuo Hatono[1]
([1]Nippon Institute of Technology)

Abstract:
For the resonant type wireless power transfer systems (WPT system) (1), this paper clarifies theoretically for tolerance of Q factor and the effectiveness of the spread spectrum (3) for noise suppression. The resonant type enables the high efficient power transmission even in small coupling coefficient k on high Q value resonant circuits. For practical uses, it requires high stability of the Q factor and suppression of high-intensity radio noise. The high efficient mechanism of the resonant type revealed theoretically by the energy loop theory (5). This theory showed that the power is transmitted during Q-time frequency period with the storage of un-transmitted energy in one period on the neighboring magnetic field (5). Based upon the energy loop theory, this paper analyze theoretically the effectiveness of spread spectrum. It becomes clear that noise suppressions can be achieved by the spread spectrum without significant loss of efficiency since transmission efficiency is tolerant for fluctuation of oscillation when the transmitter is in the ideal resonance.

20231095 **-Electrically Coupled Undersea Wireless Power Transfer System with Shielded Electrodes-**

Ikuo Awai[1], Kazuya Yamaguchi[1], Dai Futagami[1]
([1]Fujiwaves Co., Ltd.)

Abstract:
The power transfer underwater requires the coverage of electrodes unconditionally to avoid the corrosion induced by the electrochemical effect. The shielding and high permittivity of water collaborate to induce special effects to the wireless power transfer undersea, such as unexpected low transmission loss. The high density of NaCl in the seawater sometimes help reduce the propagation loss, contrary to the expectation. The present paper starts from the general expression of the WPT system based on the admittance matrix, moves to the real 4 electrode model, and then to the effect of electrode shielding. But the discovery of the insufficiency in the study platform of WPT system undersea, and strong resolution for its reconstruction are the conclusion.

C31-FC **Hydrogen and Fuel Cell Technology**

Room C (12:50-14:30)

Chair: Kiyoshi Yamaura (Mitsubishi Motors Corporation), Seiji Sano (TOYOTA MOTOR CORPORATION)

20231096 **CAE Application Method for Determining Basic Structure to Improve Performance of Electrochemical Hydrogen Compression Stacks**

Toru Honda[1], Koki Tamura[1], Yohei Kataoka[1], Daimon Hayato[1], Hiroto Yoshimura[1], Eiji Haryu[1], Shinichi Takahashi[1]
([1]Honda R&D Co., Ltd.)

Abstract:
In order to expand the use of hydrogen, a convenient hydrogen compression technology is needed. As one of the means to achieve this, we are developing an Electrochemical Hydrogen Compression (hereinafter referred to as EHC) technology to compress hydrogen electrochemically. In EHC cells, water management around the electrocatalyst is important. Therefore, we are developing design that would improve performance efficiently by extracting structural elements using requirements analysis, and by utilizing CAE technology and quality engineering. To equalize the flow velocity of hydrogen in the reaction area, quality engineering was used to identify a sensitive factor of the hydrogen flow path structure, and so we could reduce the range of flow velocity to 4%. For the porous structure, which are important parts of EHC cells, we used simulation and optimization software to find the optimal specification. Through these efforts, the current density at the same voltage was increased by a factor of 4 from the initial specification.

20231097 **Optimal Energy Management Strategy for a Light-Duty Fuel Cell Hybrid Electric Vehicle**

Tianhong Wang[1], Qi Li[1], Weirong Chen[1], Alexandre Ravey[2], Elena Breaz[3], Fei Gao[2]
([1]Southwest Jiaotong University, [2]FEMTO-ST Institute FCLAB, Univ., UTBM, CNRS, [3]Technical University of Cluj-Napoca)

Abstract:
High operating cost and low durability of stack are two main factors that limit the widespread commercial usage of fuel cell technology. Besides, most of the existing strategies focus only on ameliorating system operating efficiency or fuel consumption, but do not fully consider the impact of other factors such as power sources performance degradation. Based on above background, this study presents an optimal energy management strategy for a light duty fuel cell hybrid electric vehicle considering power sources durability and system operating cost. To achieve this purpose, this paper formulates a cost function that considers multiple factors such as the system total hydrogen consumption, power sources performance degradation degree and battery state of charge variation. In addition, sequential quadratic programming algorithm is used to solve the optimal reference power of the fuel cell. Furthermore, a global optimization-based dynamic programming algorithm will be used as the test benchmark in this study to evaluate the effect of the proposed strategy.

20231098 **New regulatory framework for type approval and certification of hydrogen- powered vehicles and their components in the European Union after repeal of regulation (EC) 79/2009**

Martin Sekura[1], Thomas Frohn[2]
([1]TÜV SÜD Product Service GmbH, [2]TÜV SÜD Auto Service GmbH)

Abstract:
Increasingly stringent regulations to reduce pollutant and CO_2 emissions from road vehicles have raised enthusiasm for registration and development of hydrogen-powered vehicles in the European Union. With this trend, questions arise how the market entry of hydrogen- powered vehicles is regulated. Until 2022, the current legislative framework in the EU referenced three regulations which could be applied: Reg. (EC) 79/2009, Reg. (EU) 2021/535 and UN Regulation No 134, whereby Reg. (EC) 79/2009 was repealed in July 2022. This led to regulatory gaps, since the scope of these regulations is not completely congruent. This paper discusses the status and possible solutions for this issue. As first step, the European Union issued regulation (EU) 2021/535, which also takes material compatibility of the hydrogen system or liquified hydrogen into account. Another solution might be to implement relevant requirements from Reg. (EC) 79/2009 to other remaining regulations. It is also in the interest of manufacturers to address product liability issues not only by fulfilling type approval requirements, but also qualifying their products according to relevant industry norms and standards. This becomes especially relevant if no regulation for type approval is in place.

20231099 **A Study on the Performance Stability and the Water management of PEFC with Interdigitated Gas Flow Channels formed on a Gas Diffusion Layer - Improvement of Performance Stability under high & low humidification conditions and clarification of the mechanisms by experimental and numerical analysis -**

Tatsuya Inoue[1,2], Daiki Sakai[1], Kazuyuki Hirota[1], Koichi Sano[1], Naoki Hirayama[3], Mitsunori Nasu[3], Takahiro Suzuki[4], Shohji Tsushima[4], Junji Inukai[2], Masahiro Watanabe[2], Akihiro Iiyama[2], Makoto Uchida[2]
([1]Suzuki Motor Corporation, [2]University of Yamanashi, [3]Enomoto Co., Ltd., [4]Osaka University)

Abstract:
A new design concept for polymer electrolyte fuel cells that included a flat-metal separator and a gas diffusion layer (GDL) with interdigitated gas flow channels (FCs), was developed in our previous research. This new design cell of the interdigitated flow channel on the GDL with porous ribs has a clear advantage over the conventional design of interdigitated flow channel on the separator with solid ribs in being able to maintain higher performance under conditions of both water excess and water shortage. We suggested that these advantages are caused by the porous ribs which contribute to proper water management in the cell, as well to increase temperature around the GDL/MEA interface to avoid water accumulation. In this study, to validate the mechanism of the newly designed cell, the temperature distribution is analyzed by numerical simulation and the water distribution is analyzed by visualization technique by neutron radiography imaging. From these results, porous ribs in the new design cell are found to play important roles in conditions of excess water: The porous ribs contribute to alleviate water accumulation in the GDL by reserving excess water and increasing the temperature of the GDL especially up on the outlet-side channel.

20231100 **X-ray Imaging and Numerical Simulation for Optimization of PEFCs with Advanced Materials**

Takahiro Suzuki[1], Kanae Kinose[1], Mitsunori Nasu[2], Naoki Hirayama[2], Masahiro Watanabe[3], Katsuyoshi Kakinuma[3], Makoto Uchida[3], Akihiro Iiyama[3], Shohji Tsushima[1]
([1]Osaka University, [2]Enomoto Co., Ltd., [3]University of Yamanashi)

Abstract:
Materials used for polymer electrolyte fuel cells (PEFCs) can affect transport phenomena in the PEFCs and resultant cell performance. The objective of this study is to clarify the relationship between advanced materials and transport phenomena. In this study, X-ray radiography of a PEFC under operating conditions was performed using the advanced materials used for a catalyst layer and a gas diffusion layer, respectively. Furthermore, a novel PEFC model considering electrochemical reaction and transport phenomena, which can reflect the effects of materials, was developed and a numerical simulation was performed for the optimization of PEFC design and performance. Parameter optimization based on the developed model was demonstrated.

C32-FC **Hydrogen and Fuel Cell Technology**

Room C (14:50-16:10)

Chair: Makoto Uchida (University of Yamanashi), Shigeki Oyama (Honda R&D Co., Ltd.)

20231101 **Developing Next Generation High Performance Polymer Electrolyte Membrane Fuel Cells Using Metal Foam as Gas Diffusion Layer**
Improved Mass Transport in Gas Diffusion Layer with Embedded Gas Flow Channels

Gaohua Zhu[1], Liang Wang[1], Yuqing Zhou[1], Ercan M. Dede[1], Hongfei Jia[1], Debasish Banerjee[1]
([1]Toyota Research Institute of North America)

Abstract:
In recent years, low-temperature polymer electrolyte membrane fuel cells (PEMFCs) have played an increasingly important role in zero emission strategy to halt climate change. The performance improvement is a particular focus of fuel cell research and development, with water management being one of the major areas of interest. Here we report the development of a novel Titanium (Ti) foam gas diffusion layer (GDL) material with embedded gas flow channels. Owing to the porous nature of the gas channel walls, the membrane electrode assembly (MEA) performance is significantly improved because of enhanced mass transport. When Ti GDL is characterized using 2nd Gen catalyst and membrane materials, high power density of 2.09 W/cm^2 was observed at 90% relative humidity (RH), which are respectively 12% improvement over state-of-the-art 2nd Gen Mirai performance. Furthermore, we demonstrated that with our metal foam GDLs can be used with flat bipolar plates, which may lead to potential manufacturing cost reduction of the fuel cell components. The work provides new pathway to achieve both high performance and low cost for fuel cells, water electrolyzers and other related technologies.

20231102 **High Temperature PEMFCs for Heavy Duty Applications**
- Challenges and Opportunities -

Liang Wang[1], Honghong Lin[1], Gaohua Zhu[1], Hongfei Jia[1]
([1]Toyota Research Institute of North America.)

Abstract:
Recently, high-temperature proton exchange membrane fuel cells (HT-PEMFCs) for heavy duty applications has attracted lots of attention. Instead of traditional phosphoric acid doped polybenzimidazole-based membrane (PA/PBI) which is only stable when operating between 140°C to 160°C and low current density, an ion-pair type of membrane was developed. The ion-pair membrane is based on quaternary ammonium-biphosphate ion-pair coordination. The ion-pair MEA has a much wider operating temperature (80°C-200°C) and stable for dynamic operation of fuel cells. This leads to the potential application of HT-PEMFC for heavy duty applications due to its better heat rejection, simpler water management and high fuel impurities tolerance. We review the state-of-the-art ion pair MEAs for performance and durability. Moreover, phosphoric acid (PA) effect to oxygen reduction reaction (ORR) was studied. Pt alloy catalysts were evaluated on both low temperature and high temperature rotating disk electrode to understand the PA poisoning and possible countermeasures. A few strategies were explored to improve ORR catalyst activity. Based on what we have learned for the evaluation results, we will share our perspectives on further improve the MEA performance in HT-PEMFCs.

20231103 **A model-based Approach to Set the Future Target of Fuel Cell Performance for Heavy-duty Applications**

Takao Watanabe[1], Masao Shibata[1], Norihiro Fukaya[1], Tomoyuki Nagai[1], Takahisa Suzuki[1]
([1]Toyota Central R&D)

Abstract:
This paper proposes a modeling and optimization method that enables a fuel cell performance target to be derived from the system requirements of various fuel cell applications, such as heavy-duty trucks (HDTs), buses, and industrial machinery. We developed a comprehensive model of the fuel cell system, comprising a fuel cell performance model, catalyst degradation model, and power management control model of the hybrid system containing a fuel cell and a battery. The model predicts the end-of-life fuel cell performance based on the initial performance of the fuel cell and how the fuel cell system is operated, allowing the simultaneous optimization of the hardware and software. By conducting the optimization calculation assuming various fuel cell performances, the model derives the required fuel cell performance with the optimal system components that satisfy durability and performance requirements.

20231104 **Intelligent thermal management simulation of a fuel cell system**

Marius Zubel[1], Marius Walters[1], Jürgen Ogrzewalla[1] Stefan Klopstein[1], Vitali Walter[1], Patrick Schutzeich[2]
([1]FEV Europe GmbH, [2]RWTH Aachen University)

Abstract:
Electric vehicles that use fuel cells to generate on-board electricity are considered the cornerstone of zero-carbon, zero-emission long-haul heavy-duty transportation. Besides the main energy source, the fuel cell, a fuel cell system is complemented by a thermal management system. A key function of the thermal management system is to ensure a safe and efficient operation. Insufficient thermal management at high fuel cell power levels requires a derating of the performance and thus to a drop in power output to avoid damages to the fuel cell stack. With fuel cells, the required cooling capacity is significantly higher than with combustion engine powertrains of the same power. This leads to a higher required cooling air flow and to higher pressure losses in the cooling module and engine compartment.
With this in mind, the paper uses a modular fuel cell electric vehicle model to couple the physical thermal models of the components such as radiators and fans to optimize the complete cooling system. Due to their specific performance characteristics, axial fans will possibly not be able to provide sufficient air flow and pressure rise. Hence, different fan designs (axial, combined axial/radial, etc.) will be compared and evaluated regarding their impact on energy consumption and fuel cell performance. A thermal management strategy is then developed to minimize performance degradation as well as energy and fuel consumption. The overall system performance is analyzed for an exemplary driving cycle.

Authors' Index

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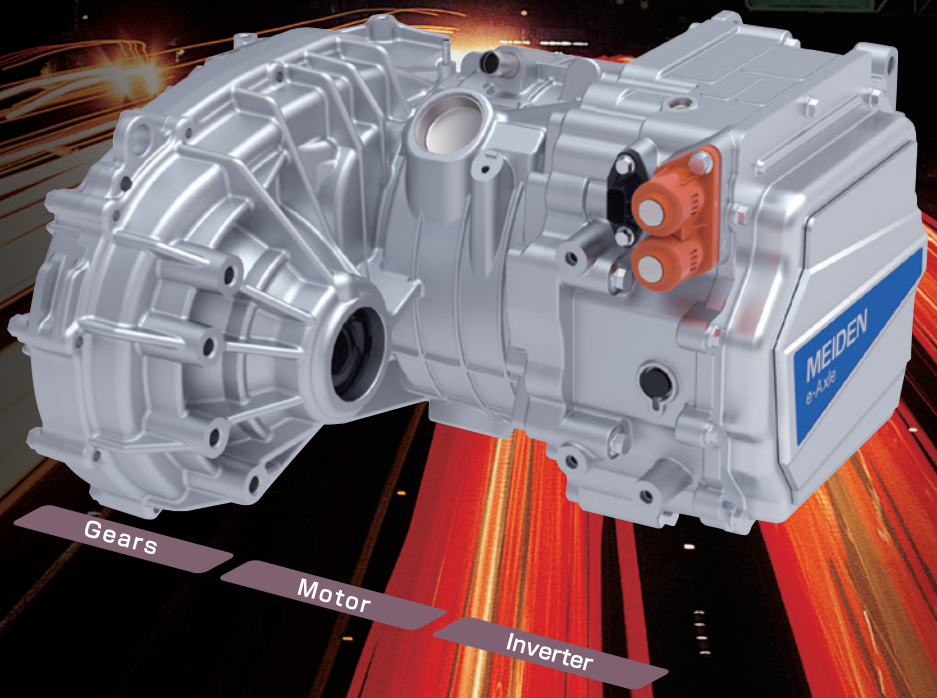

TECHNOLOGY

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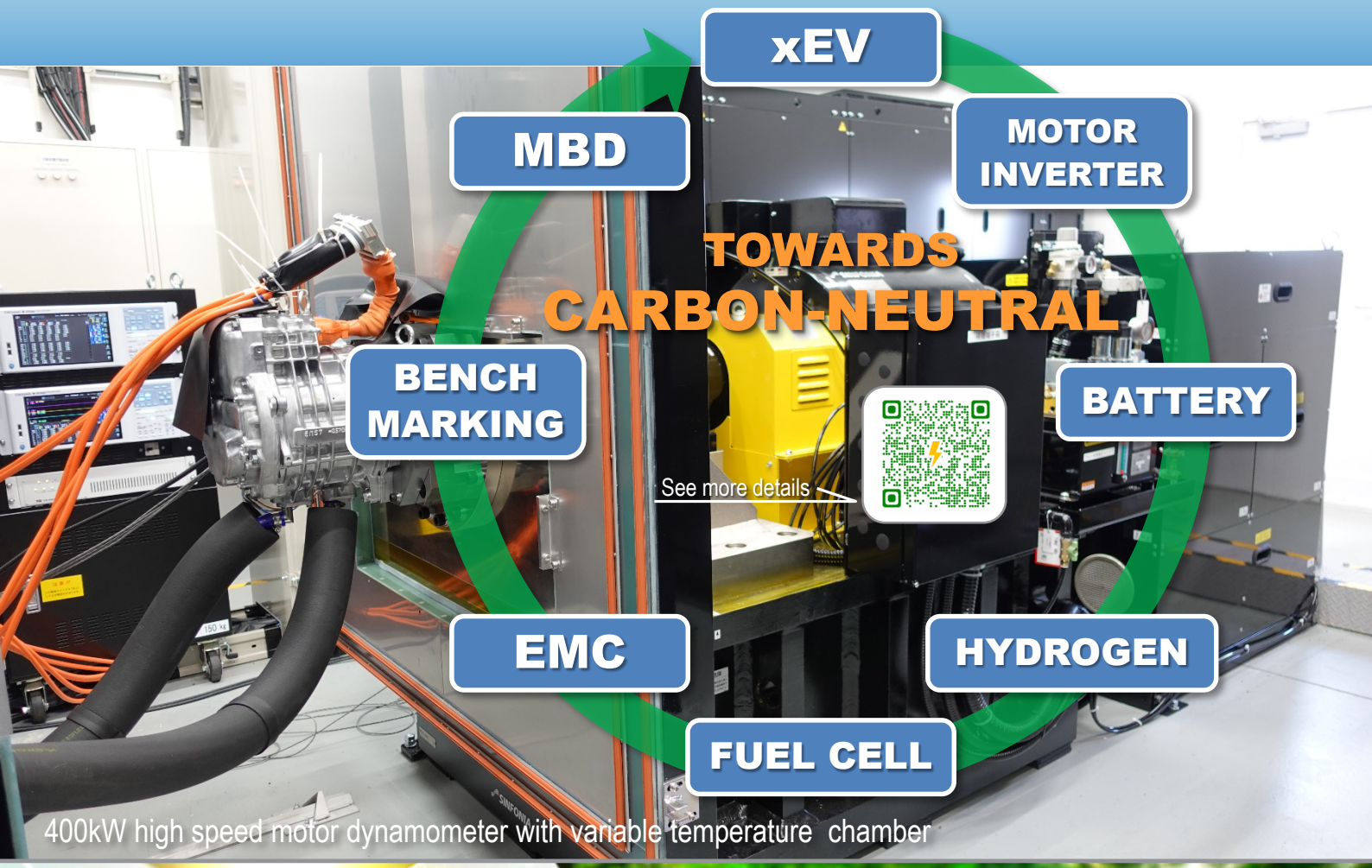
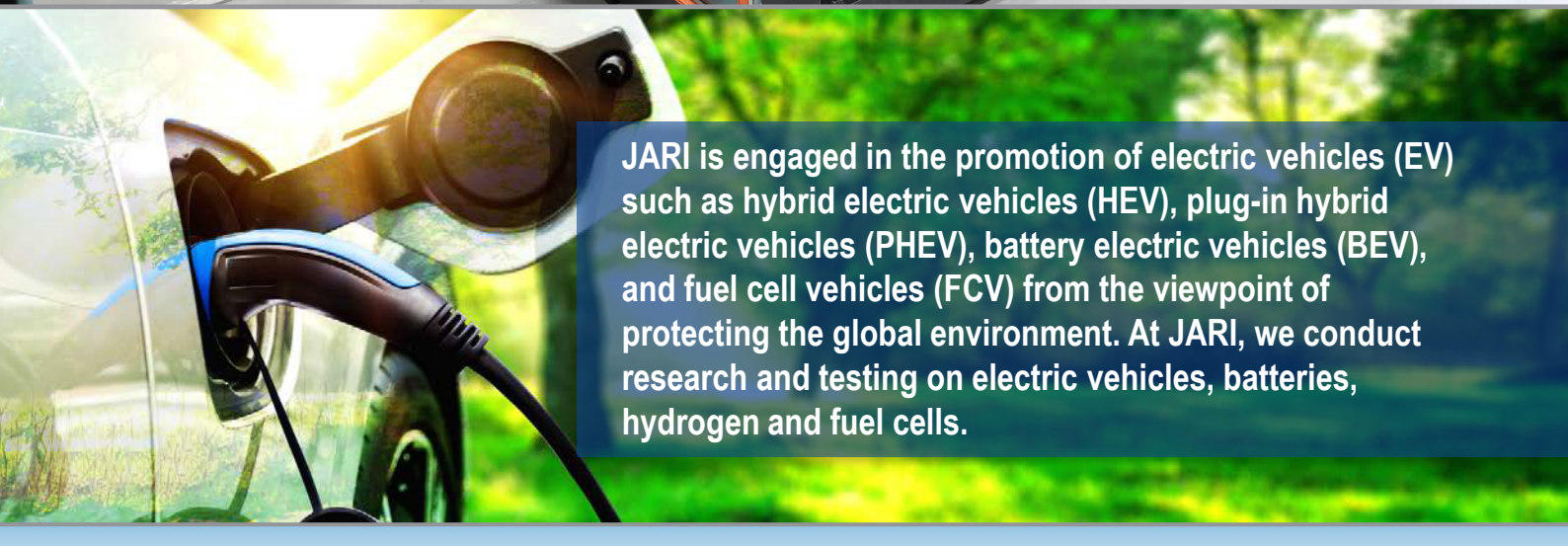


400kW high speed motor dynamometer with variable temperature chamber



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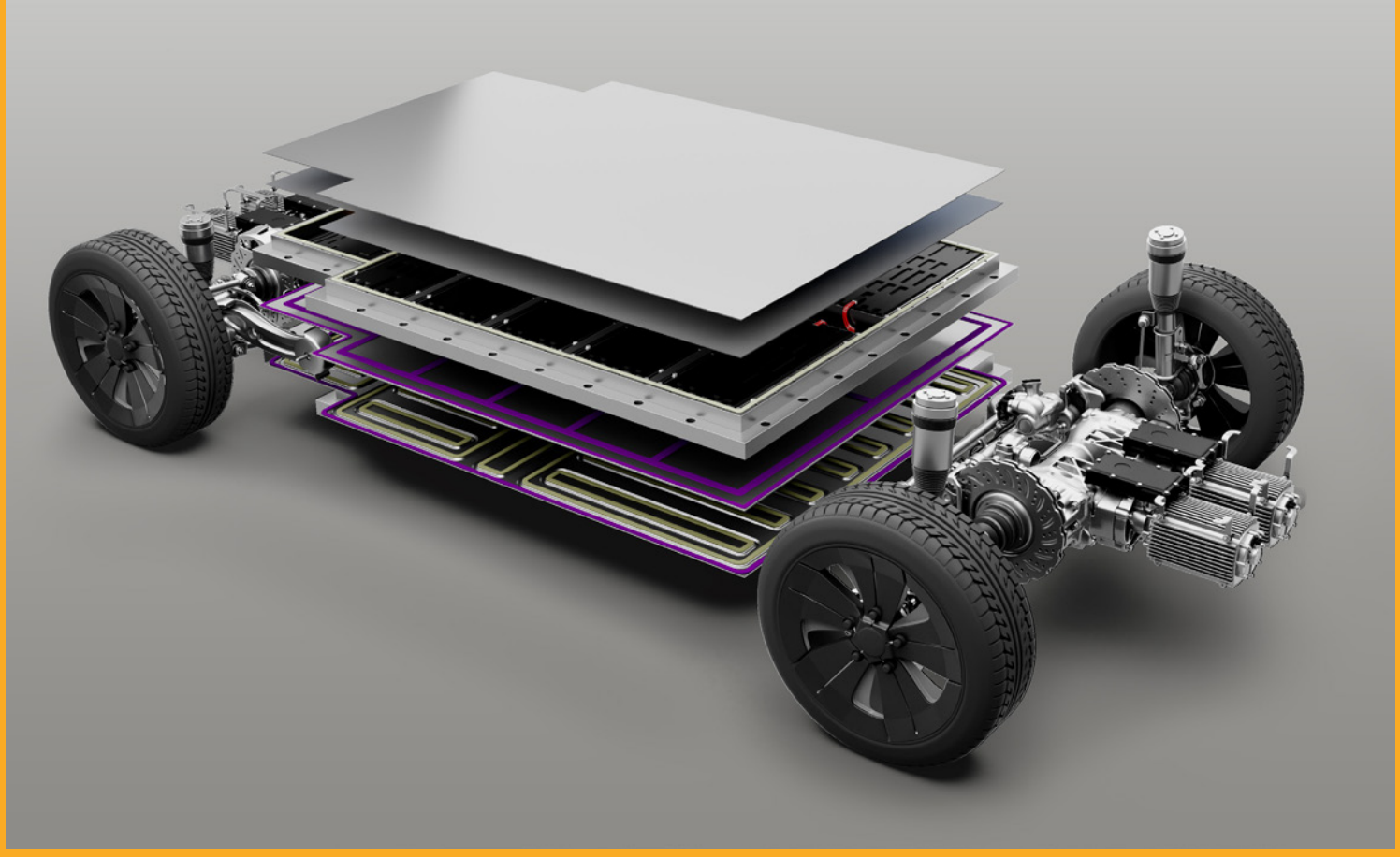

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Timetable

	DAY 1 May 22 MONDAY				DAY 2 May 23 TUESDAY				DAY 3 May 24 WEDNESDAY				
	Plenary Room	Room A	Room B	Room C	Plenary Room	Room A	Room B	Room C	Plenary Room	Room A	Room B	Room C	
	G301+G302	G314+G315	G316-G317	G318-G319	G301+G302	G314+G315	G316-G317	G318-G319	G301+G302	G314+G315	G316-G317	G318-G319	
9:20	Opening Ceremony												9:20
9:30	**Plenary Session 1** Toshihiro Hirai Nissan Motor Co., Ltd.				**Plenary Session 4** Mitsumasa Yamagata TOYOTA MOTOR CORPORATION				**Plenary Session 7** Philip Mawby University of Warwick				9:30
10:10	**Plenary Session 2** Toru H. Okabe Institute of Industrial Science, The University of Tokyo				**Plenary Session5** Akira Yoshino Asahi Kasei Corp.				**Plenary Session 8** Yasuhiro Daisho Research Organization for Next Generation Vehicles, Waseda University				10:10
10:50	**Plenary Session 3** Tongzhu Zhang China Automotive Technology & Research Center Co., LTD.				**Plenary Session 6** Jan Pettersson Swedish Transport Administration				**Plenary Session 9** Keiji Ohtsu Honda R&D Co., Ltd.				10:50
11:30	**Lunch by own** **11:30-12:50**												11:30
12:50		**A11-EP** Technologies for Transpotation System and New Service	**B11-MOT** Performance Improvement of Electric Machines	None		**A21-EP** Technology for In-wheel and Novel Drive Systems	**B21-WPT** Dynamic Wireless Power Transfer 1	**C21-PE** Motor Drive Technologies		**A31-EP** Control for Drive Systems	**B31-WPT** Wireless Power Transfer 1	**C31-FC** Hydrogen and Fuel Cell Technology	12:50
14:10		Break (20min)				Break (20min)							14:10
14:30		**A12-EP** Technologies of Next Generation Charging System	**B12-PE** Power Electronics System Technologies	**C12-BAT** Energy Storage Devices & Systems: Systems & Applications		**A22-EP** Battery Management and Grid Connectiing Systems	**B22-WPT** Dynamic Wireless Power Transfer 2	**C22-MOT** Permanent Magnet Machines in Transportation Applications		Break (20min)			14:30
										A32-EP Eaxle and Powertrain System	**B32-WPT** Wireless Power Transfer 2	**C32-FC** Hydrogen and Fuel Cell Technology	14:30
15:50		Break (20min)				Break (20min)							15:50
16:10		**A13-EP** Modeling and Evaluation for EV Systems	**B13-PE** Power Electronics Component Technologies	**C13-BAT** Energy Storage Devices & Systems: Batteries & Capacitors		**A23-EP** Autonomous Drive Technologies	**B23-WPT** Wireless Power Transfer - EMC	**C23-MOT** Future Trend and Challenges in Electric Machines				Award, Closing Ceremony	16:10
16:30													16:30
17:30						Move to the party venue							
17:50													
18:00					**18:00-20:00** **Reception Party** **at RISTORANTE ATTIMO** **(pre-registered Only)**								18:00