

1. Session Title

Advanced Cooling Systems for Electric Machines and Power Electronic Converters (PART 1)

2. Abstract

Increasing the power density of the electric motors and power electronic converters is becoming important in several emerging applications such as electric vehicles, electric airplanes, and mining, which demand high functionality of the components within a small footprint and with the smallest mass. Thermal management and advanced cooling can directly help increase the power density of components by enabling more power and current handling capabilities while keeping the operational temperatures within limits, or reduced footprint and weight of components for the same power-handling capabilities. In addition to power electronics and electric machines, thermal management is important for enabling integrated electric (traction) drives with improved metrics.

The goal of this special session is to share the advancements in thermal management of electric machines, power electronics, and integrated electric drives. This includes phase-change materials, additive manufacturing, air-, liquid-, and two-phase cooling advancements, new materials, as well as simulation and optimization techniques. Advanced thermal management can help in reducing cost, and improve the performance, reliability, and efficiency of components. One important aspect of this session is that advances in thermal management will be presented within the context of power electronics and electric machines that have been demonstrated improved metrics through lab-scale, as well as demonstration/implementation within real-world operational environments.

3. Session Organizers

Organizer 1: Dr. Bulent Sarlioglu, Jean van Bladel Associate Professor, University of Wisconsin-Madison; Associate Director, Wisconsin Electric Machines and Power Electronics Consortium



Dr. Bulent Sarlioglu is a Jean van Bladel Associate Professor with the University of Wisconsin-Madison and the Associate Director of the Wisconsin Electric Machines and Power Electronics Consortium. From 2000 to 2011, he was with Honeywell International Inc.'s Aerospace Division, Torrance, CA, USA, most recently as a Staff Systems Engineer.

His expertise includes electrical machines, drives, and power electronics, and he is the inventor or co-inventor of 20 U.S. patents and many international patents. In addition, he has more than 200 technical papers that are published in conference proceedings and journals. Dr. Sarlioglu was the recipient of the Honeywell's Outstanding Engineer Award in 2011, the NSF CAREER Award in 2016, and the 4th Grand Nagamori Award from Nagamori Foundation, Japan, in 2018.

Dr. Sarlioglu is currently IAS VTS distinguished lecturer. He serves as the Chair of PES Motor Subcommittee, one of the co-editors of the IEEE Electrification Magazine. Dr. Sarlioglu was the general Chair of ITEC 2018 and Technical Program Co-Chair for ECCE 2019, and special session chair in ECCE 2020. Dr. Sarlioglu is the recipient of the IEEE PES Cyril Veinott Electromechanical Energy Award in 2021. Dr. Sarlioglu is a Fellow of IEEE and the National Academy of Inventors.

Organizer 2: Dr. Jin Wang, Professor, Ohio State University



Jin Wang (IEEE Fellow) received his Ph.D. degree from the Michigan State University in 2005. He worked at Ford for two years before joined the Ohio State University (OSU) in 2007 as an Assistant Professor. He became a Full Professor at OSU in 2017. His current research interests include wide bandgap power device based high-voltage and high-power converters, renewable energy integration, and transportation electrification. Dr. Wang has over 200 journal and conference papers and 9 patents.

Dr. Wang received the PELS Richard M. Bass Young Engineer Award in 2011, the National Science Foundation's CAREER Award in 2011, and the Nagamori Award in 2020.

Dr. Wang currently serves as the Chair for the Technical Committee on Aerospace Power (TC11). Before that, he had served as Chair for the Technical Committee on Emerging Technologies (2018~2020). Dr. Wang initiated the IEEE Workshop on Wide Bandgap Power Devices and Applications (WiPDA) and served as the General Chair for the inaugural workshop in 2013 and the Steering Committee chair in 2014.

Organizer 3: Sreekant Narumanchi, Group Manager of the Advanced Power Electronics and Electric Machines Group, Center of Integrated Mobility Sciences at the National Renewable Energy Laboratory



Sreekant Narumanchi is the Group Manager of the Advanced Power Electronics and Electric Machines Group within the Center of Integrated Mobility Sciences at the National Renewable Energy Laboratory, where he is currently in his 18th year. He leads a Group of 12 researchers focused on electro-thermal, thermal-fluids, thermo-mechanical and reliability aspects of power electronics and electric machines.

Sreekant is an ASME Fellow, an IEEE Senior Member, and has published over 80 peer-reviewed journal and conference papers and book chapters. Professionally, he is active as an Associate Editor for the ASME Journal of Electronic Packaging (JEP), as an organizer for ASME InterPACK and IEEE ITherm conferences, and as Guest Editor of the IEEE Components, Packaging, and Manufacturing Technologies Journal. Sreekant is part of numerous working groups and external/scientific advisory boards. He is also part of the Executive Committee of the ASME Electronic and Photonic Packaging Division.

Some of the external awards Sreekant has received include the 2021 THERMI Award, the 2020-21 Associate Editor of the Year Award from the ASME JEP, the 2018 ASME EPPD-K16 Clock Award, a 2016 R&D 100 Award, the Best Paper Award from the ASME JEP (2003), and the ASME 2013 InterPACK Conference Outstanding Paper Award.

4. Session Panelists/Speakers

Panelist 1: Brij Singh, Technical Fellow - Power Electronics Engineering, John Deere

Title: Off-Road Vehicle's SiC Inverter Enabled by Advanced Packaging and Cooling

Panelist 2: Jeffrey Ewanchuk, Principal Engineer in Power Electronics at Raytheon Technologies Research Center

Title: Approach to the Thermal Management and Experimental Validation of a >99.5% Solid State Circuit Breaker for Electrified Aircraft Applications

Panelist 3: Alan Mantooh, University of Arkansas

Title: Embedded Microcooling in Advanced Power Electronic Modules

Panelist 4: Jin Wang, Ohio State University

Title: Integrated liquid metal based cooling, the ultimate cooling strategy for power electronics