Guest Editorial: Special Issue on Electrical Discharges in Vacuum

THE 30th International Symposium on Discharges and Electrical Insulation in Vacuum (ISDEIV), held in Okinawa, Japan from 25 to 30 June, brought together the global scientific community dedicated to advancing the fields of vacuum discharges and insulation. With 204 delegates from 17 countries, representing almost every continent, the symposium provided a valuable platform for exchanging ideas, addressing challenges, and presenting cutting-edge research. The theme of the symposium, "Vacuum Insulation and Discharge Technology for Environment-Friendly Electric Power Systems," highlighted the critical role that vacuum technologies play in the global transition to sustainable energy. As a nonprofit organization, ISDEIV has a long history of fostering interdisciplinary collaboration. Since 1964, the symposia have provided a forum for researchers to exchange scientific knowledge and explore both fundamental and applied aspects of vacuum discharge physics. Under the guidance of the Permanent International Scientific Committee (PISC), currently chaired by Prof. Shenli Jia of Xi'an Jiaotong University, ISDEIV continues to drive progress in the field.

The 2023 Symposium featured a diverse range of presentations, with nine invited talks and 145 oral and poster presentations. Four-page papers for these presentations were published in a proceedings volume. In this Special Issue, selected papers present extended versions of these papers, focusing on vacuum arc physics, vacuum breakdown mechanisms, and the latest developments in vacuum interrupter applications. These papers capture both the theoretical and experimental advances that are shaping the future of high-voltage electrical systems and vacuum discharge technologies. Key topics to be explored during the symposium include: 1) vacuum breakdown and flashover mechanisms—covering phenomena such as vacuum breakdown initiation, pre-breakdown activity, and surface discharge dynamics; 2) vacuum arc behavior—interactions between vacuum arcs and magnetic fields, as well as innovations in vacuum arc physics and modeling techniques; and 3) applications of vacuum technology—advances in vacuum interrupters, surface modification technologies, vacuum microelectronics, and applications in fusion reactors and particle beam technologies.

The ISDEIV2023 scientific program was initiated by Dr. rer. nat. Edgar Dullni, who received the prestigious Walter P. Dyke Award, donated by Toshiba Corporation, for his outstanding contributions to the field. His plenary lecture, "High Current Interruption of Vacuum Interrupters and Voltage Breakdown during Recovery," provided valuable insights into the critical factors influencing vacuum arc dynamics during current interruption and set the tone for the high-level discussions that followed.

This symposium also celebrated excellence in research with several notable awards.

1. The ISDEIV Best Paper Award-Japan Prize was awarded to Chen Guan and colleagues for their paper "A Relationship Between Vacuum Arc Characteristics and Short-Circuit Current Interrupting Capability at Minimum Arcing Times," which was presented at ISDEIV 2022 and later published in IEEE TRANSACTIONS ON PLASMA SCIENCE. Chen Guan presented the key findings of this award-winning research during ISDEIV 2023.

2. The Paul A. Chatterton Young Investigator Award was presented to Yimeng Li of Xi'an Jiaotong University for her work on "Effect of Cathode Radius on the Pre-breakdown Characteristics in Vacuum Nanogaps." Her research highlights the influence of geometric factors on pre-breakdown phenomena, paving the way for innovations in nanogap technologies.

3. The 2023 Best Film Award went to Bo Cao and collaborators from Xi'an Jiaotong University for their outstanding 3D reconstruction of vacuum arcs under a transverse magnetic field. This visualization breakthrough has provided the community with new perspectives on the behavior of vacuum arcs under the influence of external magnetic fields.

This Special Issue features a broad range of research contributions, including diagnostic methods for switching vacuum arcs using high-speed cameras, thermal conductivity measurements of fuzzy tungsten using thermoreflectance methods, and the development of X-ray collimators to identify radiation sources in devices insulated by large vacuum gaps. Additional papers explore the influence of chromium oxide coatings on partial discharge, numerical simulations of retrograde motion of cathode spots, studies on the relaxation of electric fields using vanadate glass, and cutting-edge simulations of multicomponent vacuum arcs, as well as practical applications such as high-voltage vacuum interrupters and their arcing characteristics during short-circuit current interruption. These papers not only advance theoretical knowledge but also suggest new directions for real-world applications, particularly in the development of reliable, environmentally sustainable power systems.

The Guest Editors would like to express their sincere gratitude to all the authors who submitted their valuable and insightful contributions for this Special Issue. Special thanks are also due to the reviewers whose expertise and efforts have ensured the high quality of these papers. The Guest Editors

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would like to express their sincere gratitude to the Senior Editor, Dr. Kenneth Struve, for his indispensable support and guidance throughout this process. We hope that the research presented in this Special Issue will inspire further advances in vacuum discharge physics and technology, and we look forward to welcoming new and returning participants to the next ISDEIV Symposium in Chengdu, China in 2025.

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