Special Session I

Special Session Basic Information:

专栏题目 **Session Title**	中文：电子元器件可靠性与质量一致性评估与优化 英文：Assessment and Optimization of Reliability and Quality Consistency for Electronic Components

专栏介绍和征稿主题
Introduction and topics

中文：

随着“多电化、全电化”等概念在航空航天、新能源汽车、工业控制、5G 通信等关键领域逐步推广，电子元器件的长期可靠性低与质量一致性差的问题已成为影响所在系统功能和寿命的核心瓶颈。传统的可靠性评估方法（如基于手册、基于加速寿命试验统计）和质量一致性控制手段（如基于经验的过程管控、事后筛选）往往面临准确度低、周期长、成本高、破坏性强、难以覆盖复杂失效机理与全参数空间等挑战，难以满足现代电子元器件高可靠、低成本、短周期的严苛需求。

近年来，多物理场建模仿真技术、数据驱动、大数据分析、人工智能（AI）、先进实验表征等方法的飞速发展，为解决上述挑战提供了新路径。在虚拟环境中构建高保真的电子元器件数字模型，融合材料特性、工艺波动、环境载荷等多源信息，实现对潜在失效模式、全寿命周期可靠性以及批次质量波动的高效、精准预测与溯源。进一步结合智能优化算法，系统性地识别影响可靠性与一致性的关键设计与工艺参数，并对其进行多目标协同优化与稳健性设计，从而在设计和制造源头显著提升电子元器件的可靠性水平与批次稳定性。

本专题旨在汇聚学术界与工业界的最新研究成果和实践经验，聚焦利用先进仿真、数据驱动和智能优化技术解决电子元器件可靠性与质量一致性评估及优化中的关键科学问题与工程难题，推动相关前沿技术的创新发展和工程应用转化。征稿主题包括但不限于电子元器件多物理场建模仿真与验证、可靠性评估与寿命预测新方法、质量一致性评估与控制技术、可靠性与质量一致性优化设计、先进实验表征与测试验证、人工智能与大数据在可靠性与质量一致性中的应用。

英文：

With the deep integration of electronic systems into critical fields such as aerospace, new energy vehicles, industrial control, and 5G communication, coupled with increasingly demanding performance requirements, the long-term reliability and batch-to-batch quality consistency of electronic components have become critical bottlenecks affecting system functionality and lifespan. Traditional reliability assessment methods (e.g., accelerated life testing, statistical sampling) and quality consistency control measures (e.g., experience-based process control, post-production screening) often face challenges such as being time-consuming, costly, destructive in nature, struggling to cover complex failure mechanisms, and failing to fully consider the entire parameter space. These limitations make them ill-suited to meet the stringent demands of modern electronic systems for high reliability, low cost, and short development cycles.

In recent years, the rapid advancement of multiphysics modeling and simulation, big data analytics, artificial intelligence (AI), and advanced experimental characterization methods has provided new pathways to address the aforementioned challenges. Constructing high-fidelity digital models of electronic components in a virtual environment and integrating multi-source information such as material properties, process variations, and environmental loads enables efficient and accurate prediction and root cause identification of potential failure modes, lifetime distributions, and batch quality variations. Furthermore, by incorporating intelligent optimization algorithms, it becomes possible to systematically identify the key design and process parameters that affect reliability and consistency, and to perform multi-objective collaborative optimization and robust design on them. This significantly enhances the reliability level and batch stability of electronic components at the source during both the design and manufacturing stages.

This Special Session aims to bring together the latest research achievements and practical experiences from both academia and industry, focusing on leveraging advanced simulation, data-driven, and intelligent optimization technologies to address

critical scientific challenges and engineering bottlenecks in the assessment and optimization of electronic component reliability and quality consistency. It seeks to propel the innovation and development of these cutting-edge technologies and facilitate their translation into engineering applications. Topics of interest include, but are not limited to Multiphysics Modeling and Simulation for Electronic Components, Novel Methods for Reliability Assessment and Lifetime Prediction, Quality Consistency Evaluation and Control Techniques, Reliability and Quality Consistency Optimization Design, Advanced Experimental Characterization and Test Validation, Applications of AI and Big Data in Reliability and Quality.

Special Session Chair(s):

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Organizer's Brief Biography

中文：

陈昊，2022 年在哈尔滨工业大学获得电机与电器专业博士学位，现为哈尔滨工业大学电气工程及自动化学院助理研究员。2021 年 1 月至 2021 年 10 月在新加坡国立大学工业工程与系统管理系联合培养，合作导师为董润祯教授。主要研究方向为机电组件全寿命周期质量一致性设计，在质量一致性设计和稳健性设计领域主流期刊发表了 15 篇论文。

英文：

Hao Chen is currently an assistant research fellow with the School of Electrical Engineering and Automation, Harbin Institute of Technology. He received his doctoral degree in electric machine & electric apparatus in 2022 from Harbin Institute of Technology, China. He was a visiting scholar with the Department of Industrial Systems Engineering and Management, National University of Singapore from Jan. 2021 to Oct. 2022, supervised by Prof. TANG Loon Ching. His research interests include life-cycle quality consistency design for electromechanical components. He is currently the author of more than 15 journal papers in the field of quality consistency design and robust design.

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Organizer's Brief Biography

中文：

郑博恺，2023 年在哈尔滨工业大学获得电气工程专业博士学位，现为福州大学电气工程与自动化学院讲师，曾于 2019-2020 年在米兰理工大学能源系访学。主要研究方向为电子系统的可靠性建模和剩余寿命预测，已在质量与可靠性领域主流期刊发表 10 余篇论文。

英文：

Bokai Zheng is currently a lecturer at the College of Electrical Engineering and Automation, Fuzhou University. He received his doctoral degree in electrical engineering in 2023 from Harbin Institute of Technology, China. He was a visiting scholar with the Energy Department, Politecnico di Milano, from Jan. 2019 to Jan. 2020. His research interests include reliability modeling and remaining useful life prediction for electronic systems. He has published more than 10 peer-reviewed journal papers.

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Organizer's Brief Biography

中文：

刘兰香，2023 年在哈尔滨工业大学获得电气工程专业博士学位，2024 年在米兰理工大学获得能源与核科学技术专业博士学位，现为哈尔滨工业大学电气工程及自动化学院助理研究员。主要研究方向为电器结构动力学与弹跳控制、质量优化设计与一致性控制，目前已在动力学与质量控制主流期刊、会议发表论文 20 余篇。

英文：

Lanxiang Liu is currently an assistant research fellow with the School of Electrical Engineering and Automation, Harbin Institute of Technology. She received her doctoral degree in Electrical Engineering in 2023 from Harbin Institute of Technology. She then obtained PhD degree in Energy and Nuclear Science and Technology from Politecnico di Milano in 2024. Her main research interests focus on the structural dynamics and bounce control of electrical appliances, as well as quality optimization design and consistency control. She has published more than 20 peer-reviewed journal and conference papers in the field of dynamics and quality control.