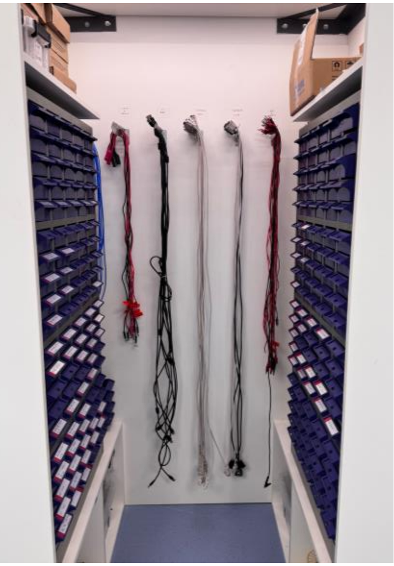
重庆大学
CHONGQING UNIVERSITY

实验室科研画像

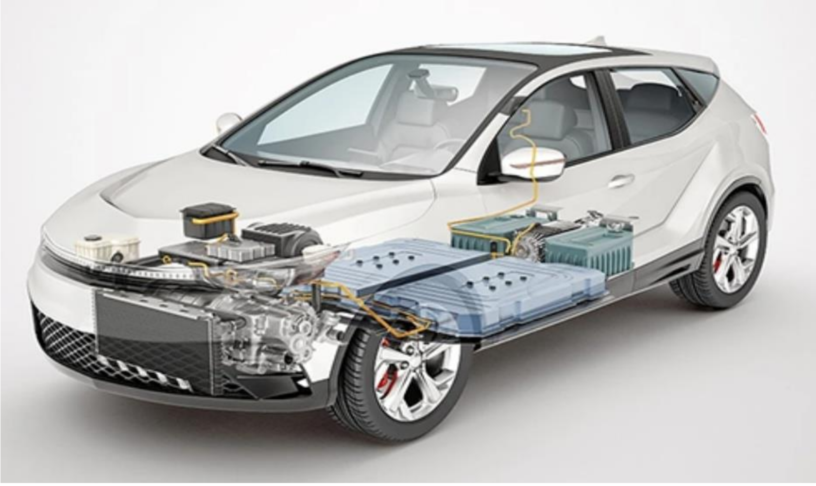
——碳化硅电力电子实验室

实验室科研环境长什么样



核心应用场景

重庆大學 CHONGQING UNIVERSITY



电动汽车主电驱

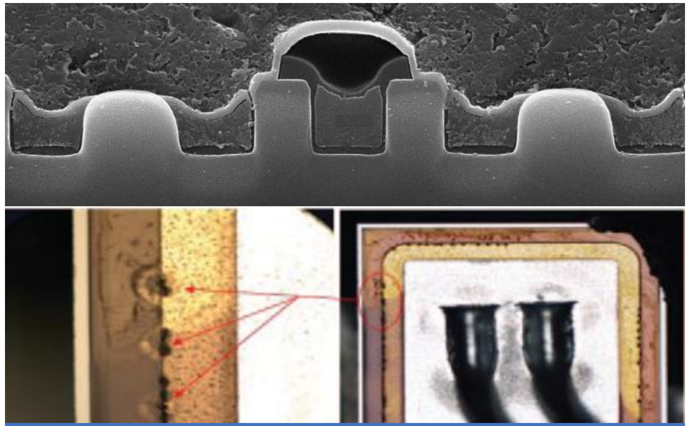
柔直换流阀

固态变压器SST

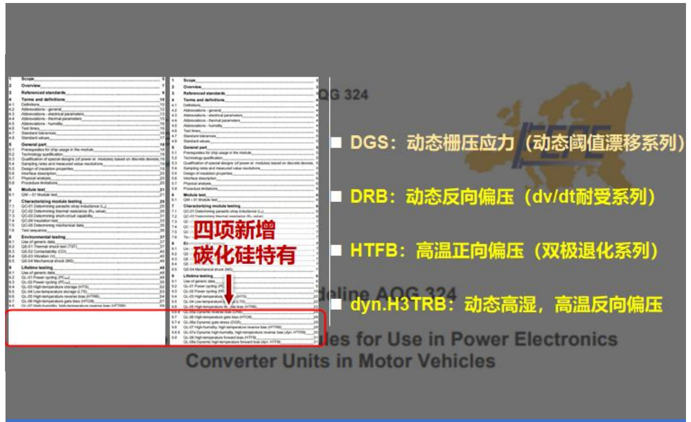
我们到底在研究什么

重庆大学
CHONGQING UNIVERSITY

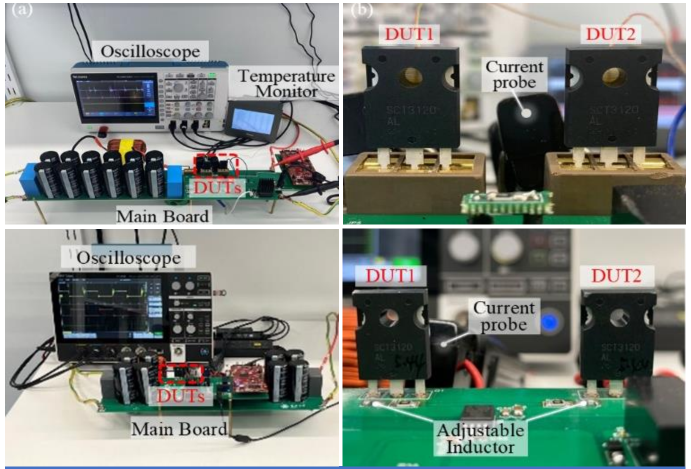
应用场景



器件问题



可靠性问题



测试评价

系统/平台

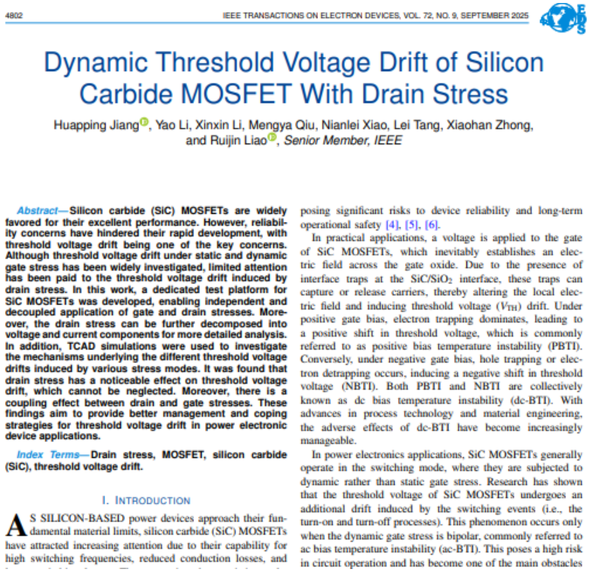
系统/平台（标准版）

研究方向

重庆大学 CHONGQING UNIVERSITY

碳化硅器件物理与可靠性机理	▪ 研究器件在电、热、场等应力条件下的物理机制和失效演化 ▪ 聚焦阈值漂移、参数离散、耐受能力变化等关键机理 ▪ 学生参与后可掌握机理分析、实验设计及独立科研能力
碳化硅器件可靠性测评技术	▪ 开发动态阈值漂移、dv/dt耐受、抗辐照能力等可靠性测试方法 ▪ 构建可量化的评价指标体系，确保实验数据可靠性与可重复性 ▪ 学生可在实验中获得系统测评能力
碳化硅器件与测评系统研发	▪ 设计器件、测试平台和测评系统 ▪ 平台和系统涵盖驱动电路、控制程序、实验系统结构 ▪ 学生可参与系统实现与调试，形成完整项目能力

进组后主要做什么


4802 IEEE TRANSACTIONS ON ELECTRON DEVICES, VOL. 72, NO. 9, SEPTEMBER 2025

Dynamic Threshold Voltage Drift of Silicon Carbide MOSFET With Drain Stress

Huapping Jiang, Yao Li, Xinxin Li, Mengya Qiu, Nianlei Xiao, Lei Tang, Xiaohan Zhong, and Ruijin Liao, *Senior Member, IEEE*

***Abstract*—Silicon carbide (SiC) MOSFETs are widely favored for their excellent performance. However, reliability concerns have hindered their rapid development, with threshold voltage drift being one of the key concerns. Although threshold voltage drift under static and dynamic gate stress has been widely investigated, limited attention has been paid to the threshold voltage drift induced by drain stress. In this work, a dedicated test platform for SiC MOSFETs was developed, enabling independent and decoupled application of gate and drain stresses. Moreover, the drain stress can be further decomposed into voltage and current components for more detailed analysis. In addition, TCAD simulations were used to investigate the mechanisms underlying the different threshold voltage drifts induced by various stress modes. It was found that drain stress has a noticeable effect on threshold voltage drift, which cannot be neglected. Moreover, there is a coupling effect between drain and gate stresses. These findings aim to provide better management and coping strategies for threshold voltage drift in power electronic device applications.**

***Index Terms*—Drain stress, MOSFET, silicon carbide (SiC), threshold voltage drift.**

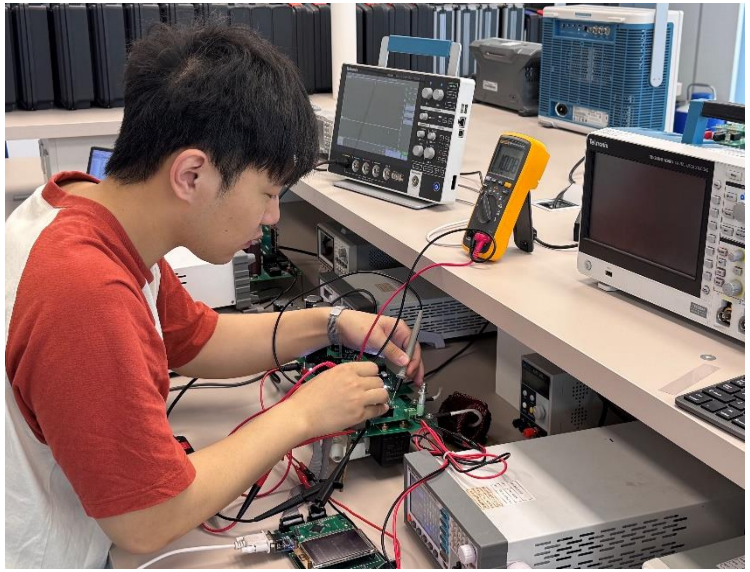
I. INTRODUCTION

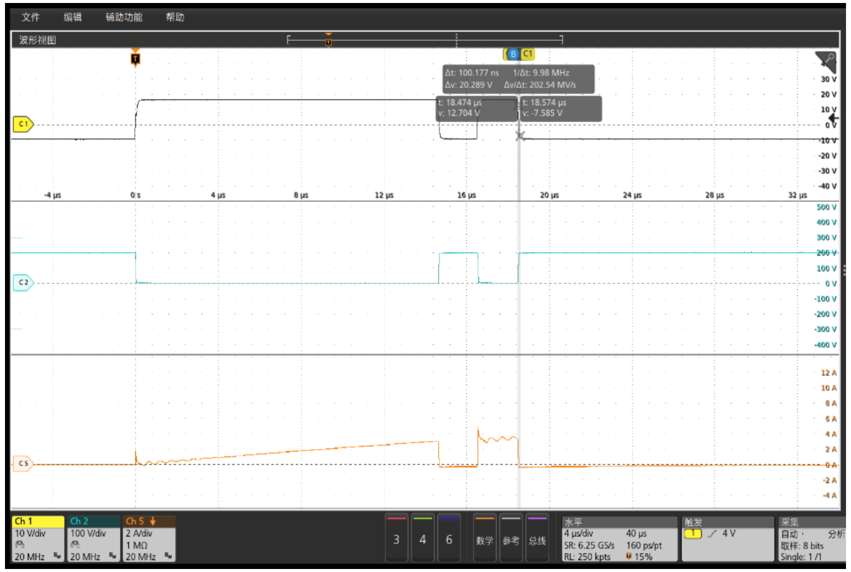
AS SILICON-BASED power devices approach their fundamental material limits, silicon carbide (SiC) MOSFETs have attracted increasing attention due to their capability for high switching frequencies, reduced conduction losses, and

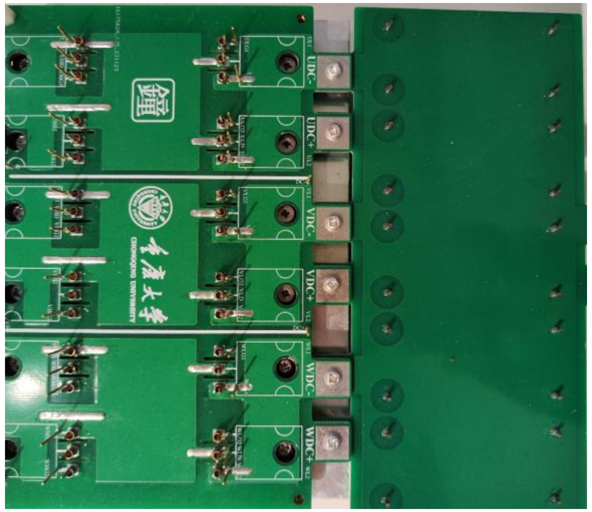
posing significant risks to device reliability and long-term operational safety [4], [5], [6].

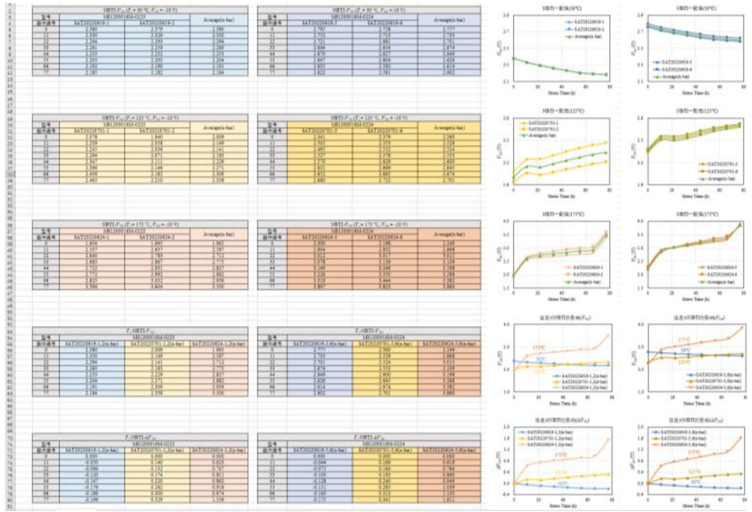
In practical applications, a voltage is applied to the gate of SiC MOSFETs, which inevitably establishes an electric field across the gate oxide. Due to the presence of interface traps at the SiC/SiO_2 interface, these traps can capture or release carriers, thereby altering the local electric field and inducing threshold voltage (V_{TH}) drift. Under positive gate bias, electron trapping dominates, leading to a positive shift in threshold voltage, which is commonly referred to as positive bias temperature instability (PBTI). Conversely, under negative gate bias, hole trapping or electron detrapping occurs, inducing a negative shift in threshold voltage (NBTI). Both PBTI and NBTI are collectively known as dc bias temperature instability (dc-BTI). With advances in process technology and material engineering, the adverse effects of dc-BTI have become increasingly manageable.

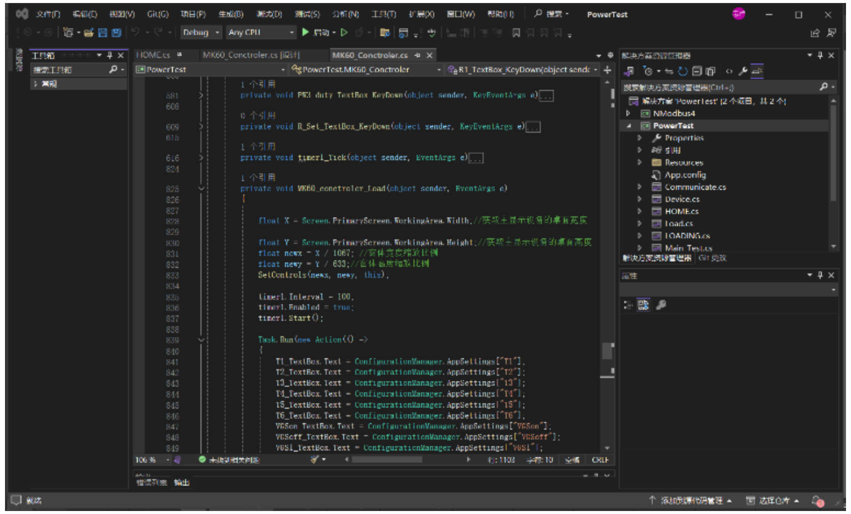
In power electronics applications, SiC MOSFETs generally operate in the switching mode, where they are subjected to dynamic rather than static gate stress. Research has shown that the threshold voltage of SiC MOSFETs undergoes an additional drift induced by the switching events (i.e., the turn-on and turn-off processes). This phenomenon occurs only when the dynamic gate stress is bipolar, commonly referred to ac bias temperature instability (ac-BTI). This poses a high risk in circuit operation and has become one of the main obstacles



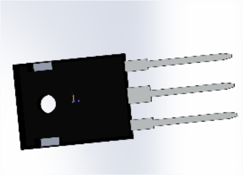
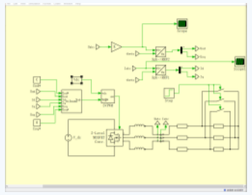
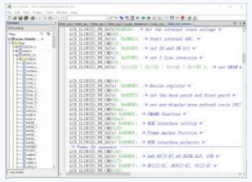








获得怎样的知识体系和能力框架

培养方向	掌握的知识	获得的能力	图
器件	SiC功率器件物理、制造工艺、可靠性机理	功率芯片和封装的仿真与设计能力、器件可靠性分析能力	
电路	电力电子电路与控制、功率半导体驱动电路、采样与控制电路	电路设计、焊接、组装和调试能力	
程序	上位机/下位机程序、数据采集与处理方法	程序设计与调试能力、数据分析与处理能力	
结构	测评系统、平台与装置结构、散热与温控系统	结构设计、整机组装与调试能力、独立完成平台/系统开发的能力	

什么样的学生适合我们

重庆大学 CHONGQING UNIVERSITY

态度为首	▪ 对科研任务耐心且专注 ▪ 遵循实验规范、严格记录数据 ▪ 面对复杂问题，能够实事求是、循序渐进地分析与解决
性格稳重	▪ 不浮躁、不急功近利 ▪ 尊重事实和数据
求知欲强	▪ 对器件物理、 电力电子系统、可靠性测评充满兴趣 ▪ 乐于钻研新技术、新方法,主动学习理论与实践知识
团队意识与沟通能力	▪ 能够与导师、 同学和技术支持人员协作 ▪ 思路清晰，精准回答问题

团队氛围

- 定期团建、节日关怀、助研津贴
- 一般确认录取后入组
- （特殊情况可与导师沟通）
- 科研需持续投入时间和精力

实发（元）
3200
5050
5545
5450
6350
4970
4170
4995
4800
1330
340
46200

毕业去向

長沙理工大學

HUAWEI

国家电网 STATE GRID

汇川技术 Inovance

禾望电气 Hopewind

长安汽车 CHANGAN AUTO

欢迎加入！

Huaping.Jiang@cqu.edu.cn