碳化硅电力电子实验室招生介绍

——专注于碳化硅功率半导体芯片可靠性及其测评技术

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目 录

1. 实验室简介

碳化硅电力电子实验室专注于碳化硅（SiC）功率半导体芯片的可靠性及其测评技术研究，面向电力电子核心应用场景：电动汽车主电驱、固态变压器（SST）和柔直换流阀。实验室围绕器件物理、可靠性机理、测试评价方法和测评系统研发开展工作，致力于将基础研究与工程实践相结合。

学生将参与从器件到机理，再到测评和系统开发的完整科研链条，在实践中获得系统知识与综合能力。

2. 实验室定位

实验室通过碳化硅功率半导体器件可靠性及其测评技术研究培养学生，定位于：

- 理解电动汽车主电驱、固态变压器（SST）和柔直换流阀等典型电力电子应用场景对器件的需求
- 学习和理解器件物理原理及可靠性机理
- 掌握可靠性测评方法，并能够参与技术开发
- 参与器件测评系统和实验平台搭建，获得动手经验
- 培养兼具科研能力和工程实践能力的学生

实验室与以电路、拓扑或控制为主的团队不同，更加聚焦器件本体和测试评价问题，强调科学问题与工程实现的紧密结合，为学生提供可直接参与科研和平台研发的机会。

3. 研究方向

实验室总体研究方向为碳化硅功率半导体与电力电子技术，涵盖机理分析、可靠性测评及系统研发。

研究方向一：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

研究方向二：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

研究方向三：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

进入课题组培养体系后，学生将根据研究方向逐步参与机理分析、测试评价和平台研发等具体任务，在科研项目中逐步独立承担工作，形成从基础实验到系统研发的完整科研流程。

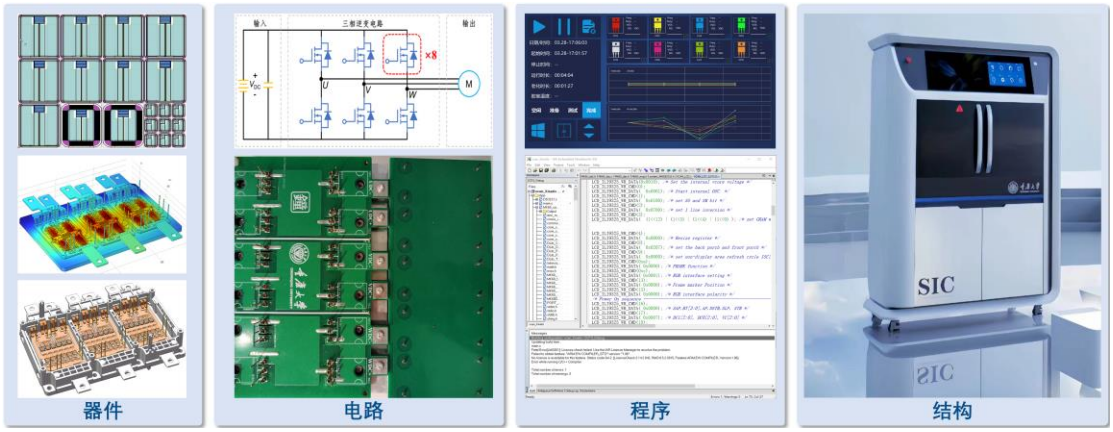
4. 学生培养

本实验室注重系统化、项目化和工程化培养，目标是帮助学生形成贯通“器件—电路—程序—结构”的完整知识体系和能力框架。学生不仅学习功率半导体器件物理、可靠性机理和测试方法，也将逐步参与真实实验平台、测评系统和科研项目，在真实问题中训练科研能力、工程能力和组织协同能力。

实验室重视过程训练和长期积累，强调主动性、执行力、沟通闭环和团队协作。学生与课题组完成双向确认后，将进入入学前培养阶段；正式入学后，将根据个人基础、研究方向和课题组安排，逐步进入系统科研训练。

培养方向	掌握的知识	获得的能力
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

正式入学后，学生将从文献学习、基础实验和平台熟悉入手，逐步参与器件物理测试、可靠性评价实验、测评系统开发与调试等科研任务。通过阶段性训练，学生将形成贯通“器件-电路-程序-结构”的完整知识体系和能力框架，逐步具备从问题分析到系统解决方案设计与实现的综合能力。



5. 入学前培养

学生与课题组完成双向确认后，将进入入学前培养阶段。入学前培养一般从推免确认、拟录取或录取确认后开始，至研究生正式入学前结束，目的是帮助学生提前了解研究方向、熟悉课题组运行方式、建立基本科研习惯，并为正式入学后的科研训练做好准备。

入学前培养分为跟组培养和入组培养两种形式。对于本科尚未毕业，且本科学校仍有课程、毕业设计、答辩、实习或离校手续等安排的学生，以本科学校安排为准，可通过跟组培养方式线上参与课题组学习、组会交流和阶段性反馈。

对于本科毕业相关安排已基本结束，或已取得本科学位的学生，如无身体健康、家庭特殊情况等原因，原则上应到实验室开展入组培养。入组培养期间，学生参加组会、学习交流和阶段性训练，并可根据实际情况参与科研项目和实验室岗位。课题组按实验室现行规定提供生活补贴；学生如参与科研项目或承担实验室岗位，可根据实际工作内容和贡献获得相应助研津贴。

6. 适合的学生类型与特质

本实验室更适合愿意较早进入科研训练、重视过程积累、希望在研究生阶段形成科研与工程综合能力的学生。

（1）态度认真

- 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。

（2）性格稳重

- 不浮躁，不急功近利；
- 尊重事实和数据，能够接受长期训练和阶段性积累；
- 遇到问题能够及时沟通，而不是回避或拖延。

（3）求知欲强

- 对功率半导体器件、电力电子系统、可靠性测评或测评系统开发有真实兴趣；
- 乐于钻研新技术、新方法，愿意主动补充器件、电路、程序和结构等相关知识。

（4）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；
- 能够清晰表达问题、准确反馈进展，并按节点完成阶段性任务；
- 愿意参与团队协作、公共平台建设和项目实践。

如学生更希望研究生阶段以课程学习为主，暂不愿较早进入科研训练，或不能接受组会交流、线下参与、项目实践和团队协作，建议在充分了解实验室培养方式后慎重选择。

在本实验室，态度与性格是科研成长的首要因素，能力与技能可通过系统训练逐步获得。具备认真、稳重、求真务实和持续学习意愿的学生，将更适合本实验室的培养方式。

7. 研究特色

- 聚焦核心应用：紧密围绕电动汽车主电驱、SST 和柔直换流阀
- 以可靠性为主线，兼顾机理研究、测评技术和系统研发
- 学术研究与工程实现结合，贯通器件—测评—系统
- 核心建设者兼具产业与学术背景，曾在中国中车和海外科研机构工作
- 学生在科研项目中可快速形成实践能力和知识框架

8. 研究条件

实验室场地约 108 平方米，配备器件测试平台、实验设备和测评系统。学生

将在实验室中亲自操作实验、开发测试系统并分析数据，获得实操经验和系统研究能力。

9. 技术积累

实验室针对电动汽车主电驱、固态变压器（SST）和柔直换流阀三大典型电力电子应用场景，已建立下述完整技术基础体系，支撑三个研究方向，学生通过实践将掌握贯通知识与能力体系，形成独立解决科研问题的能力。

- 芯片设计与仿真
- 电路设计与仿真
- 程序开发与调试
- 平台/系统结构设计、组装与调试

10. 代表性成果

实验室针对电动汽车主电驱、固态变压器（SST）和柔直换流阀三大典型电力电子应用场景，在碳化硅功率半导体及可靠性研究方向取得了显著成果：

- 学术论文 70 余篇，其中期刊 40 余篇、会议 30 余篇
- 中国发明专利 30 余项（已授权 26 项）、英国专利 2 项

- 参与标准制定：第三代半导体联盟团体标准 1 项、JEDEC 标准 1 项
- 成果覆盖器件、可靠性机理、测评技术及测试平台开发

10.1. 代表性学术论文

[1] L. Tang, H. Jiang*, R. Liao, Y. Huang, X. Zhong, X. Qi, L. Liu and Q. Zhang, "Impact of the Threshold Dispersity Evolution on the Current Sharing of Parallel SiC MOSFETS," in IEEE Transactions on Power Electronics, vol. 39, no. 5, pp. 6312-6326, May 2024.

该工作主要针对并联 SiC MOSFET 在阈值离散性演化条件下的电流均流问题开展研究，揭示了阈值分散变化对器件并联一致性的影响规律。该成果属于“碳化硅器件物理与可靠性机理”方向，体现了实验室将器件参数演化机理与实际应用问题相结合的研究特色。

[2] H. Jiang*, X. Qi, G. Qiu, X. Zhong, L. Tang, H. Mao, Z. Wu, H. Chen and L. Ran, "A Physical Explanation of Threshold Voltage Drift of SiC MOSFET Induced by Gate Switching," in IEEE Transactions on Power Electronics, vol. 37, no. 8, pp. 8830-8834, Aug. 2022.

该工作主要针对 SiC MOSFET 在栅极开关过程中出现的阈值电压漂移现象，从器件物理角度给出了相应解释。该成果属于“碳化硅器件物理与可靠性机理”方向，体现了实验室围绕动态阈值漂移问题开展机理研究的特色。

[3] H. Mao, H. Jiang*, L. Ran, J. Hu, G. Qiu, J. Wei, H. Chen, X. Zhong, N. Xiao, L. Wang and M. Yang, "An Asymmetrical Power Module Design for Modular Multilevel Converter With Unidirectional Power Flow," in IEEE Transactions on Power Electronics, vol. 38, no. 1, pp. 1092-1103, Jan. 2023.

该工作主要针对单向功率流模块化多电平换流器中的功率模块设计问题，提出了相应的非对称功率模块结构方案。该成果体现了实验室在功率器件相关设计与工程实现方面的研究基础，也反映出实验室能够将器件研究与电力电子应用需求相联系。

10.2. 代表性发明专利

[1] 蒋华平,廖瑞金,钟笑寒,谢宇庭,汤磊,赵柯,肖念磊. 多工作模式电路的控制装置及其控制方法: CN116743138A [P],2023.（授权）

该专利主要面向多工作模式测试或实验电路中的控制实现问题，旨在提升测试过程中的功能切换与控制灵活性。该成果体现了实验室在测试平台控制装置与相关系统开发方面的能力。

[2] 蒋华平,廖瑞金,戚晓伟,钟笑寒,汤磊,赵柯,肖念磊. 绝缘栅型半导体器件的阈值电压恢复方法及相关产品: CN116743134A [P],2023.（授权）

该专利主要面向绝缘栅型半导体器件阈值电压测试与恢复过程中的关键问题，服务于相关可靠性评价和测试流程实现。该成果体现了实验室围绕阈值电压相关测评问题开展方

法和装置研发的能力。

[3] 蒋华平,廖瑞金,赵柯. MOS 型半导体器件的栅极驱动电路和电力变换装置:CN 116436450A [P],2023.（授权）

该专利主要面向 MOS 型半导体器件相关实验与应用中的栅极驱动问题，为器件测试与应用验证提供支撑。该成果体现了实验室在驱动电路设计及相关平台装置开发方面的技术基础。

10.3. 代表性器件与设备

[1] 车规级 1200V20mΩ碳化硅 MOSFET 芯片

该芯片体现了实验室在碳化硅功率半导体芯片方向上的研究基础，可为器件特性、可靠性及相关应用研究提供对象支撑。该成果反映了实验室不仅关注测试评价，也重视器件本体相关研究。

[2] 动态阈值漂移（DGS）测试设备（多功能版）

该设备面向碳化硅 MOSFET 动态阈值漂移问题开展测试与评价，可支持多种工作模式和更丰富的实验需求。该成果体现了实验室在可靠性测评技术与测试系统研发方面的系统实现能力。

[3] 动态阈值漂移（DGS）测试设备（标准版）

该设备面向动态阈值漂移测试的标准化、规范化需求，适合开展针对性较强的测试与评价工作。该成果体现了实验室在测试平台工程化和测评技术落地方面的能力。

[1]碳化硅MOSFET芯片

[2]多功能版设备

[3]标准版设备

11. 团队情况

- 教师 2 名，行政助理 1 名，技术员 1 名
- 博士和硕士研究生十余名
- 兼具产业与学术背景，为学生提供理论与实践结合的指导

- 团队高效，学生将获得充分指导和实践机会

12. 毕业去向

本实验室毕业生主要面向高校、科研院所、国家电网、华为、汇川技术、禾望电气、长安汽车等单位发展，岗位多集中在功率半导体器件、电力电子系统、可靠性测试、技术研发和工程应用等方向。

【博士毕业生】

- 高校及科研机构从事科研和教学工作；
- 华为、国家电网等单位从事核心技术研发工作。

【硕士毕业生】

- 华为、汇川技术、禾望电气、长安汽车等新能源和电力电子领域重点企业；
- 就业岗位多为研发、测试、应用、系统设计或技术支持类岗位；
- 近年毕业生就业待遇整体较好，部分学生入职后在年度考核中获得优秀评价，体现出较好的岗位适应能力和发展潜力。

实验室希望通过系统科研训练和真实项目实践，帮助学生在毕业时具备较扎实的器件理解能力、测试分析能力、平台开发能力和工程协作能力，为后续学术发展或产业研发岗位奠定基础。

13. 申请与联系

欢迎有意申请硕士、博士或推免研究生的同学联系本实验室。申请前，建议先阅读本招生介绍、教师主页和《实验室科研画像》，了解实验室研究方向、培养方式、入学前培养安排和基本要求。

研究生招生一般包括材料初筛、线上一面、线下二面、双向确认、入学前培养和正式入学等环节。线上一面主要考察专业基础、方向理解和初步匹配度；线下二面主要考察综合素质、真实意愿、科研强度接受度和与实验室培养方式的匹配情况。

学生与课题组完成双向确认后，将进入入学前培养阶段。入学前培养包括跟组培养和入组培养两种形式，具体安排根据学生类别、本科学校安排和个人实际情况确定。

有意申请的学生可通过邮件联系，并提交个人简历、成绩单及其他能够体现专业基础、科研训练、竞赛经历或项目经历的材料。邮件中建议简要说明本人专

业背景、研究兴趣、已了解的实验室方向，以及希望申请硕士、博士或推免的具体情况。

联系邮箱：Huaping.Jiang@cqu.edu.cn。

14. 附录

14.1. 期刊论文

[1] H. Jiang*, Y. Li, X. Li, M. Qiu, N. Xiao, L. Tang, X. Zhong and R. Liao, "Dynamic Threshold Voltage Drift of Silicon Carbide MOSFET With Drain Stress," in *IEEE Transactions on Electron Devices*, vol. 72, no. 9, pp. 4802-4809, Sept. 2025.**（二区）**

[2] L. Tang, H. Jiang*, X. Zhong, Y. Huang, N. Xiao, K. Zhao and R. Liao, "Influence of Mismatched Gate Loop Inductance on Threshold Dispersity Evolution and Current Sharing of Parallel SiC MOSFETs," in *IEEE Transactions on Power Electronics*, vol. 40, no. 5, pp. 6921-6932, 2025.**（一区）**

[3] H. Jiang*, K. Zhao, R. Liao, X. Zhong and L. Tang, "Gate Drive Method for Reducing Threshold Voltage Drift of Silicon Carbide MOSFET, "*in IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol.12, no. 6, pp. 5864-5873, December 2024. **（二区）**

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