

**Physics, operation and reliability of wide
bandgap semiconductor devices**

讲座专家: Professor Layi Alatise

时间: 12月12日 19:00-21:40

12月13日 19:00-21:40

12月14日 19:00-21:40

12月15日 19:00-21:40

地点: 文昌校区逸夫楼合2室

Professor Layi Alatise

University of Warwick (华威大学)

Royal Society Industry Fellow

Senior Member of IEEE

Research Interests

- Advanced power semiconductor materials and devices for improved energy conversion
- Power electronic converters and systems
- Energy conversion in electrical and power systems



Four Lectures will be presented by Professor Layi

Layi 教授将针对电力电子半导体器件及可靠性做4场讲座



Brief introduction for the lecture series:

Physics, operation and reliability of wide bandgap semiconductor devices

- **WBG devices** like SiC MOSFETs and GaN eHEMTs are gaining popularity due to their improved performance
- The physics of these devices differ from silicon devices due to **advanced material properties** like high critical electric field.
- It is important to understand these **WBG device characteristics** to better exploit their performance.
- **Device reliability** also needs to be understood and well characterised. For example, device performance under surge events like short circuits and unclamped inductive switching should be characterised.
- **Device packaging** is also a very important component as it determines thermo-mechanical reliability under power cycling, temperature cycling and thermal shock

Physics, operation and reliability of wide bandgap semiconductor devices: **Part I**

标题	Fundamentals of Power Semiconductor Physics
时间地点	文昌校区逸夫楼合2教室 12月12日 19:00至21:40
涵盖内容	Lecture 1: Introduction to Band-structures and Bandgaps Lecture 2: Introduction to Carrier Transport Mechanisms Lecture 3: Wafer Production Process Lecture 4: Introduction to PN Junctions
内容简介	<p>In this lecture, we shall cover the fundamental device physics behind Power Semiconductor devices. The topics will include concepts like carrier transport mechanisms, drift-diffusion equations, continuity equations, carrier generation and recombination. We shall also look at the PN junction and how the doping impacts the built in potential, the drift and diffusion currents balance out under thermal equilibrium and how the Fermi level varies across the junction under thermal equilibrium and non-equilibrium. Semiconductor band diagrams are critical to understanding the physics of power devices, so we shall look into these as well. These topics are important towards understanding the operation of power semiconductor devices like MOSFETs, IGBTs, Thyristors etc. They are also important towards understanding what it means to be a wide bandgap semiconductor.</p>

Physics, operation and reliability of wide bandgap semiconductor devices: **Part II**

标题

Power MOSFETs and IGBTs

时间地点

文昌校区逸夫楼合2教室 12月13日 19:00至21:40

涵盖内容

Lecture 1: Introduction to Power MOSFETs
Lecture 2: Introduction to IGBTs

内容简介

This lecture introduces fundamentals of the power MOSFET and the IGBT. These are the 2 most important devices in power electronics as majority of the power converters are implemented using these technologies. We shall start by looking at the physics of the MOS interface and exploring concepts like accumulation, depletion and inversion. We shall also look into the process flow, the equipment used in the process flow (diffusion, implantation, etching, lithography, sputtering), the principles of operation and the characteristics of these devices. We shall conclude by looking at the applications of these devices and how the physics of operation determines the relevant applications for each technology.

标题

SiC and GaN Power Devices

时间地点

文昌校区逸夫楼合2教室 12月14日 19:00至21:40

涵盖内容

Lecture 1: SiC Power MOSFETs
Lecture 2: GaN Power Devices

内容简介

This lecture introduces the two major wide bandgap devices currently on the market. These are the SiC MOSFET and Schottky diodes and the GaN enhancement mode high electron mobility transistor. These devices are currently revolutionizing power electronics by improving power density through high speed operation at reduced losses. In this lecture we shall explore how high critical electric fields are exploited to enable reduced conduction and switching losses of the power devices.

Physics, operation and reliability of wide bandgap semiconductor devices: **Part IV**

标题

Packaging and Reliability

时间地点

文昌校区逸夫楼合2教室 12月15日 19:00至21:40

涵盖内容

Lecture 1: WBG Device Electrothermal Characteristics and Reliability
Lecture 2: Packaging and Thermo-mechanical Reliability

内容简介

In this lecture, we shall explore the electrothermal and thermo-mechanical reliability of WBG power devices. These include operation under surge conditions like short circuits and unclamped inductive switching. We shall also explore the reliability and qualification process of power devices including JEDEC standards that contain test metrics, procedures and analysis. We shall look at high temperature gate bias, high temperature reverse bias, power cycling temperature cycling and thermal shock. Other topics covered in this lecture will include the different packaging types including discrete packaging, integrated module packaging and pressure packaging.

联系人及承办单位

承办单位： 中国矿业大学电气工程学院
中国矿业大学电气化低碳技术研究中心
电气化低碳技术中欧联合实验室

联系人： 原熙博 教授
郭 祥 副教授

欢迎各位老师、同学踊跃参加！