Motivation

- Semiconductors
- Measuring and standardizing electronic properties
- Enhancing capabilities of instruments
Methods of Sample Characterization

Photoemission Electron Microscopy

Credit: Niefind Falk

Electrical Measurements

Probe Tips

Micropositioner

Camera
The Instruments

Yokogawa 7651
DC Power Source – Outputs voltage or current

Keithley 6514
System Electrometer – Measures current, voltage and resistance

Agilent E4980
Precision LCR Meter – Sweeps through voltage/frequency while measuring impedance

Source Measurement Unit
The work done

Adding instruments to Pymeasure
The instrument API is controlled using SCPI commands.

Adding functionality
The existing libraries were modified to add necessary functionality and controls to each instrument.

Adding a user interface
Python code was used to control instruments and add a graphical user interface.

Testing!
The instruments were connected and tested with various devices to ensure reliability.
Source Measurement Unit Calibration

Commercial Resistors

MOS Device

GaN Diode

- Aluminum
- Silica (9.7 nm)
- Semiconductor (p-type)
- Top contact
  - 400 nm Mg:GaN (Na ~ 4E17)
  - 8 μm GaN (n ~ 1.7E16 cm⁻³)
  - n-GaN substrate
  - Back contact (whole substrate)

- Current (mA)
- Voltage (V)
- Current Density (A/m²)
- Voltage (V)
- Current (μA)
C-V Characteristics

- Performing CV measurements
- Expected depletion behavior
- Testing and Results
Methods of Sample Characterization

**Electrical Measurements**
- Micropositioner
- Probe Tips
- Camera

**Photoemission Electron Microscopy**
- PEEM
- Electrons
- Sample

Credit: Niefind Falk
PEEM – Sample Holder

- AutoCad
- 6 Separate Components
- PEEM Shuttle and Electrical Contact
- Operando Electrical Measurements
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Sample Holder
Electrical Contacts

PEEM Shuttle designs provided by manufacturer
Printed Circuit Board for Sample Holder

- Purpose
- Symmetrical
- Ultra High Vacuum compatible materials
- Designed for sample holder

Roussel et al., 2009
Summary

• Got 3 instruments working with the probe station
• Added documentation to code to make it easier to use and modify as needed
• Modelled and modified PEEM sample holder
• Modelled and designed PCB for sample holder

Future Work

• Adding more functionality to instruments
• Using similar code to add support for more instruments
• Manufacturing the sample holder and PCB
• Testing the PEEM and the electrical contacts
Citations


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Feel free to ask questions!