I. Physikalisches Institut (IA) Physik neuer Materialien

RWTH AACHEN UNIVERSITY

I. Physikalisches Institut (IA)
Phase-Change Materials
Prof. Dr. rer. nat. Matthias Wuttig

Topic for a Master Thesis

„Interfacial transport behaviors between MVB and non-MVB materials “

Phase change random access memory (PCRAM), one of the non-volatile memory technologies, is highly wanted to fulfill the requirements of long-term memory and analog-based calculation. Phase change materials (PCMs) possess a transition between amorphous and crystalline states which can be achieved rapidly and reversibly, allowing the large contrast of electrical and optical properties for these two states to serve as the “0” and “1” logical state in circuits or laser readers. Even more promising, there are intermediate states between “0” and “1” in PCM, which can be used as analog values or weights in neuromorphic to reduce the complexity of circuit.

A common concern for PCM devices is the interfacial transport behavior, i.e. the electrical contact and the thermal boundary resistance, between PCM and different electrode materials. For PCM, we have established chemical bonding indicators to facilitate the exploration of novel PCMs. With the indicators, we have found some materials are bonded with a special chemical bonding, namely metavalent bonding (MVB), which originated from the competition between electron localization and delocalization. We have also found some interesting interfacial behaviors between MVB and non-MVB materials in nanoscale, a special interfacial transport behavior can be expected between them. For electrode, not only metals, but also materials like Carbon, TiO2, even PCM itself are employed as the nanoscale heaters. So, we would like to have a comprehensive understanding for interfacial transport behaviors between these different materials.

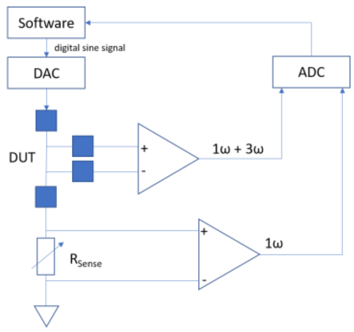

Figure 1 Schematic of 3ω measurement setup

In this project, we will employ 3-omega measurement to explore thermal transport and transmission line measurement to explore electrical contact resistance. The probe station for electrical measurement is already established. We will build up a measurement system for 3-omega measurement based on our probe station. A PCB board with Digital-analog converter and operational amplifier will be used to generator a sine-wave force current, and an Analog-digital converter will be used to collect the detected Voltage data. The system need to be well-calibrated for more accurate measurement later. For the device under test, we will employ sputtering to deposit films. The test structures can be patterned with both shadow mask and optical lithography with lift-off method.

Task:

1. Built up and calibrate the 3-omega system (PCB design will be assisted by our electronic technician)
2. Explore interfacial transport behavior between MVB and non-MVB materials

Profile:

Master student from physics or materials science who is interested in devices and circuit

(knowledge of Python recommended)

Yiming Zhou
✉ ymzhou@physik.rwth-aachen.de
28 A 511 0241 / 80 20335