ETH zürich

# Master / Semester Thesis

## Unipolar Resistive Switching in Valence Change Memory Cells

**Short Description**
The goal of the project is to simulate and gain a deeper understanding of unipolar resistive switching in oxide-based memristors by combining different methods, such as Density Functional Theory (DFT), Kinetic Monte Carlo, and quantum transport simulations. The student will use an already established simulation protocol (**Fig. 1a**) to calculate necessary parameters for systems that exhibit unipolar switching. The main tasks of the projects will be to simulate unipolar I-V characteristics, to explain the physical process that led to it, and to provide some guidelines for enhancing the performances of such devices.

**The Big Picture**
Valence-change memory (VCM) cells based on oxides have attracted significant interest in recent years due to their potential applications in non-volatile memory devices and neuromorphic computing. Most VCMs exhibit bipolar switching governed by the formation and the rupture of a conductive filament made of oxygen vacancies. Some devices are known to exhibit unipolar switching (**Fig. 1b**), which is believed to be induced by Joule heating. However, a detailed atomistic picture of the underlying mechanisms remains incomplete.

**Type of Work**
The project will consist of:
- A literature review on oxide-based memristors, DFT calculations, KMC simulations, and quantum transport calculations (10 %),
- Performing DFT, KMC, and quantum transport calculations (60 %)
- Coding, data post-processing and analyzing, and report writing (30 %)

**Prerequisites**
We are seeking a candidate with a strong interest in nanoeletronics and materials science, with experience with Python and C++, and familiarity with Linux-based operating systems.

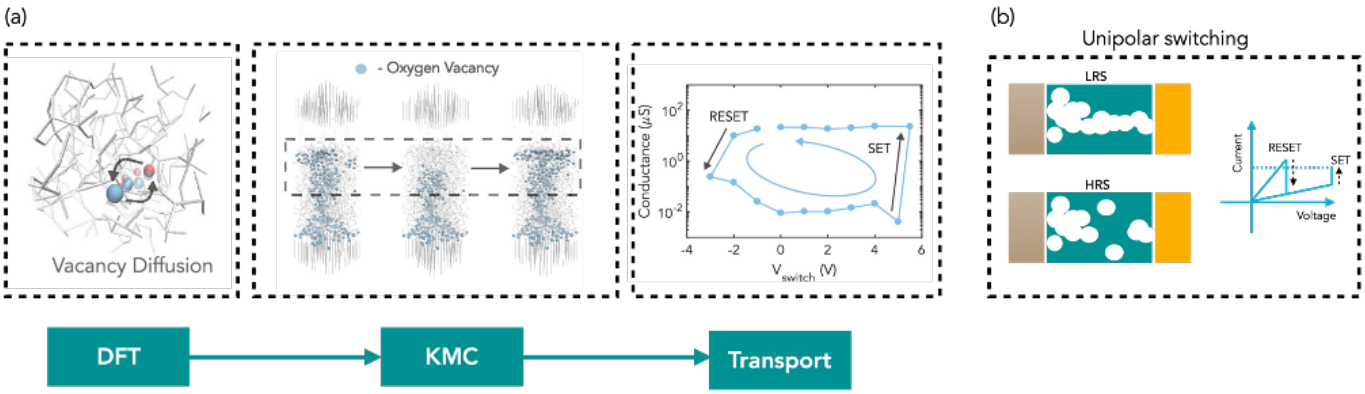


**Fig. 1** (a) The simulation protocol consisting of DFT, KMC, and quantum transport calculations. The images are adapted from [1]. (b) The schematic description of unipolar resistive switching.

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**References**

[1] Manasa Kaniselvan, Mathieu Luisier, and Marko Mladenović *ACS Nano* 2023 **17** (9), 8281-8292

**Status: Available**

Looking for 1 Semester/ Master student

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