Position as a

Studentische Hilfskraft (SHK)

Modeling of fabricated metal-insulator-metal devices using the principles of memristive systems

The Chair of Fundamentals of Electrical Engineering is actively involved in the modeling and system-theoretic analysis of novel memristive nanodevices [1], suitable for modern energy-efficient Edge Computing systems. Taking advantage of the physical phenomena governing these novel metal-insulator-metal (MIM) nanodevices, non-volatile information storage is realized in an unprecedented low-power and high-density manner by utilizing memristive crossbar arrays. Moreover, analog computing is revitalized through the ability of such structures to perform processing-in-memory, driving modern computing systems beyond the limitations imposed by the conventional von Neumann architecture. Aiming at the accurate and computationally efficient simulation of large-scale memristive systems that are necessary for the solution of real-life problems, e.g. time-critical pattern recognition tasks, the modeling of MIM devices needs to be addressed in a circuit design compatible approach, providing both accuracy in the description of the device's behavior and low computational complexity.

In the context of this research-related project, the development of a mathematical model that captures both the static and dynamic behavior of fabricated memristive devices is to be performed. The modeling approach will utilize the principles of memristors and memristive systems and will involve the necessary physical mechanisms for the electron and ion mobility within certain MIM structures to describe the operation of fabricated Hafnium oxide memristive devices [2]. The experimental measurement data that is necessary for the validation of the developed model is to be provided by the corresponding external partner of the Chair.

The SHK position should include, but not be limited to, the following:
- Literature research on the existing memristor models
- Modeling of single memristive devices
- Implementation of a simulation environment for memristive crossbar arrays

For this SHK position, a very good knowledge of the basics of electrical engineering, circuit simulation as well as programming (Python and/or MATLAB) is required. In-depth knowledge of memristive device modeling and the design of memristive crossbar arrays can be acquired in the course of this scientific work. Depending on the student's background and expectations, experience with commercially used circuit design tools may also be acquired.

References:
[1] Tetzlaff, Ronald. *Memristors and Memristive Systems*. Springer, 2013
[2] Quesada, E. P. B., et al., "Memristive-based in-memory computing: from device to large-scale CMOS integration". *Neuromorphic Computing and Engineering*, 1(2), 024006, 2021

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