Topic for a

Project Work / Studienarbeit

Read/write schemes for 3D memristive crossbar arrays

At the Chair of Fundamentals of Electrical Engineering various applications with memristive memory elements are investigated to enable non-conventional and low-power analog computing systems [1]. Memristive devices have internal memory functions like a RAM and can be used in crossbar structures for highly parallel computations, especially for matrix multiplications, as they are massively used in Artificial Neural Networks (ANN) [2]. In a current project, 2D memristive crossbar arrays are analyzed for efficient read and write schemes but also 3D integrated structures are considered using SPICE-compatible memristor models. In this context, the fundamental investigation of efficient read and write schemes for manufacturable 3D structures is an open research question. Within the scope of a scientific work, 3D memristive crossbar arrays are to be implemented in a Python-based circuit simulation framework with NgSpice-backend and suitable read/write schemes should investigated towards accuracy, speed and energy efficiency.

The student research project should include, but not be limited to, the following:

- Literature research on 3D integrated 1R/1S1R crossbar structures
- Implementation of efficient read and write schemes in a Python-based circuit simulation framework with NgSpice-backend
- Analysis of accuracy, speed and energy efficiency of various read and write schemes based on simulation results for 3D memristive crossbar arrays
- Optional: Suggestions of optimal connections and wiring options as well as further implementation of parasitic resistors and capacitors might strengthen the impact of the work
- Documentation of the results

For this work, a good knowledge of the basics of electrical engineering is required and basic knowledge in SPICE simulations is required. In-depth knowledge of memristor models and 3D structures can be acquired in the course of the student research project.

References:

[1] Tetzlaff, Ronald. *Memristors and Memristive Systems*. Springer, 2014
[2] R. Schroedter, A.S. Demirkol, A. Ascoli, R. Tetzlaff, E. Mgeladze, M. Herzig, S. Slesazeck, T. Mikolajick, “SPICE Compact Model for an Analog Switching Niobium Oxide Memristor”, IEEE International Conference on Modern Circuits and Systems Technologies (MOCAST), pp. 1–4, 2022

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