

The memristor is one of the four basic two-terminal circuit elements (apart from the resistor, inductor, and capacitor). Memristor is characterized by a nonlinear relation between charge and flux. Its resistance depends on the history of current flowing through the element or the voltage across the element. Memristors were theoretically introduced in 1971 by prof. L.O. Chua. Memristive behaviour was recognized in a nano-scale double-layer of titanium dioxide film by researchers at Hewlett-Packard Labs in 2008. After this achievement, memristors have received significant attention due to a number of possible applications including large capacity non-volatile memories and neuromorphic systems.

One of the most important properties of memristors is that when the power is switched off at any time the memristor can assume a continuous range of distinct equilibrium states. It follows that memristors can serve as a non-volatile analog memory. When two sufficiently different values of internal states are selected to code binary states one can use memristors as non-volatile binary memory. Existence of memristive behaviour in nano-scale opens a large spectrum of opportunities in the realization of low-power, high-density memory technology, which could replace existing technologies (flash memories and dynamic random-access memories). Since memristors can handle analog values, and moreover the memristor is capable to simulate synaptic connections between neurons, some future devices based on memristors could be possibly designed to mimic biological functions and be used in constructing brain-like computers.

Research will be carried out in the following phases:

- comparison of existing memristor models in terms of accuracy and effectiveness, and development of new models for simulations of new types of memristor implementations,
- development of effective methods for analysis and design of electronic systems containing memristors,
- analysis of simple electronic systems with a single memristor and design of such systems including selection of parameters forcing a desired operating point,
- analysis of multimemristor systems including networks of locally connected multistable or oscillatory memristor-based units and selection of parameters to realize a desired functionality,
- verification of models and analysis methods in laboratory experiments.

Realization of the project will lead to development of methods for analysis and design of electronic systems containing memristors. In a further perspective analysis of memristive systems will make it possible to use memristors for the construction of specialized electronic systems for e.g. large capacity nonvolatile memories and neuromorphic systems. A software toolbox will be developed for the analysis, evaluation and design of electronic systems with memristors. Contacts of our research group with research centers with technological capabilities to implement memristor systems will make it possible to carry out practical verification of developed methods.