

Memristors are unique electronic elements that are passive (they can dissipate energy and are not power sources) and have a state memory. In functional terms, they are similar to synapses present in animal nervous systems. These features mean that memristors are considered as the main building blocks of future computers. Their existence was theoretically predicted in the 1970s, which initiated very intensive research work.

As part of this project, it is planned to develop a synthesis of new semiconductor materials that exhibit simultaneously the characteristics of ferroelectrics - materials that show ordering the internal structure under the influence of an external electric field.

Materials that exhibit such characteristics include lead halide perovskites, photovoltaic materials successfully tested also in memristive applications. The main limitation of their widespread use is high sensitivity to moisture and their toxicity.

In this project, it is planned to design and test two classes of chemical compounds, which on the one hand will combine semiconductor and ferroelectric features, and on the other hand be free from drawbacks of lead perovskites (higher durability and lower toxicity). In addition, it is anticipated that new materials will enable fine tuning of electrical properties to obtain memristors with the desired properties.

These materials will be accurately characterized in terms of structure and electrical properties. It is planned to make a series of thin film memristors, the operation of which will be based on modulation of the energy barrier at the metal-semiconductor junction (the so-called Schottky barrier). This configuration should provide much better parameters of the memristor, in particular greater durability and lower energy consumption in the switching process.

It is anticipated that the combination of semiconductor and ferroelectric features in one material can bring many benefits from the point of view of the operation of the memristors: faster switching, longer state retention time, multi-state switching.

Functional features of memristors, and in particular their synaptic features will be determined in specially designed model systems for neuromimetic studies.