DESCRIPTION FOR THE GENERAL PUBLIC

The subject and the main goal of the proposal are the fundamental research studies and the complex analysis of the electrical charge transport mechanisms in a new type of thin film gradient structures based on the transparent transition metals, in which the memristive effects are observed. The word "memristor" is a concatenation of the word „memory" and the word „resistor", which indicates that such element is characterized by the ability to remember its resistance state depending on the value and the direction of the current flows. First mentions of the resistive switching mechanisms were published in 1962. The resistive switching was then observed in the metal-oxide-metal Al/Al_2O_3/Al type of structures, in which the change of the resistance was achieved by the pulse voltage stimulation resulting in the specific hysteresis loop in the I-V curve plane. In 1971, Leon Chua during his analysis of the three basic passive electronic elements (resistor, capacitor and inductor) noticed, that there is a missing link between the magnetic flux and the electrical charge. Then, Chua proposed the existence of the fourth passive electronic element called memristor, which is showing the hysteresis loop characteristic for memories with the ferromagnetic core. Following this idea, the memrsitor behaves as nonlinear resistor with the ability to remember its resistance states. The conclusion is that, the memristor is a nonliner resistor with the feature allowing to change its resistance in the time domain, based on the amount of the current flowing through the structure.

First report on the practical realization of the memirstor was published in 2008, in the paper written by the scientists from the HP LABS in which they described memristive effect observed in the nanoarray memory system based on the thin layer of titanium dioxide. The experimental confirmation of the missing fourth electronic element has opened the wide range of possible applications of such structure in many fields, starting from the chaotic systems and ending with the commercial nanodevices. Potential applications of the memristor is really enormous. It is anticipated that such structures finds their usage in the fields of nonvolatile RAM, dynamic RAM and in the flash memories. For this reason, in the recent years, the fabrication and the research of the memristive structures has gained in popularity, mainly due to the intensive develoment of micro- and nanotechnology, especially semiconducting nanomaterials and nanodevices. Also in the field of transparent electronics the demand for transparent diodes and transistor is increasing, which is the reason for seeking the materials based on the oxides exhibiting resistive switching, including such transition metals as Cu_2O, CoO or TiO_2.

In practice, the memristor structures have been implemented so far as the multilayer systems consisting of alternating thin layers of insulating and semiconducting oxides. The novelty proposed in this application is the research and the analysis of the resistive switching mechanisms in the gradient structures, i.e. those in which the concentration of individual components (mixture of insulating and semiconducting oxides) varies with the thickness of such structure. According to the applicants, such elements may constitute interesting alternative for existing multilayer structures and in particular may be an interesting addition to the transparent elements for the transparent electronics.

However, the practical realization of such structures requires a series of fundamental research to be carried out and founding the answers to many questions regarding issues related to, among others, the resistive switching mechanisms. The models existing in the literature are still not complete, therefore the aim of this project is to deepen the knowledge about transport properties in the memristive structures, especially in the thin film gradient structures based on the transition metal oxides.