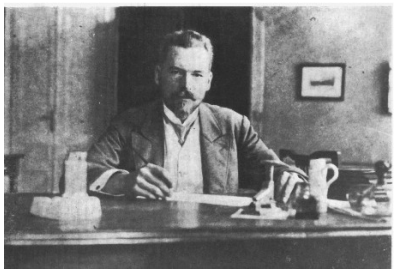

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Problems in creating adequate stochastic model of memristors

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Currently, the investigations of resistive switching have attracted much attention. Electronic devices, the functioning of which is based on the resistive switching, are called memristors. The memristor as a new fundamental element of the electrical circuit that dissipates energy and has memory was theoretically predicted by Chua in 1971, but found its hardware implementation only in 2008. It represents a thin (from several nanometers to several tens nanometers in thickness) dielectric film sandwiched between two conductive electrodes. The switching of a memristor from the low resistance state (LRS) to the high resistance state (HRS) is achieved by the rapture of the filament by a voltage pulse (so-called RESET process). The filament can be restored by a voltage pulse of the opposite polarity that results in the switching from the HRS back to LRS (so-called SET process). As a result, its current-voltage characteristic is nonlinear and takes the form of hysteresis. At present, memristors have found application in diverse areas of science and technology ranging from information processing to biologically inspired systems. In particular, they are considered to be promising for application in the next generation non-volatile computer memory (Resistive Random Access Memory, ReRAM), in the neuromorphic computer systems, etc.
All previous theoretical and experimental studies have neglected the important effect of noise on the memory properties of these elements. As a result, an adequate stochastic model of memristor, taking into account many different factors as well as internal and external noises, is still far from being constructed. Difficulties in creating an adequate model associated with complex physico-chemical reactions occurring inside the film under the action of an applied electric field, the structure of the conducting filament, setting the right conditions at the boundaries with contacts, various memristor materials, etc. It has already become clear that to create a real model of the device, the ideal memristor models proposed by Chua are not enough and it is necessary to consider the system as multistable in terms of statistical physics approach.
In this report after a brief overview of previous achievements in this area the new results both theoretical and experimental studies of memristors performed in the “Laboratory of stochastic multistable systems” of National Research Lobachevsky State University of Nizhni Novgorod would be presented. Among them, experimental investigations of the resistive switching in a memristor based on a thin film ZrO2(Y)/Ta2O5 stack under a random noise voltage in the form of white Gaussian noise signal with certain parameters, measurements of the activation energies of oxygen ion diffusion in yttria stabilized zirconia by flicker-noise spectroscopy, probabilistic analysis of the voltage-controlled and the current-controlled ideal memristor under the action of the external voltage in the form of Gaussian noise, non-stationary distributions and relaxation times in a stochastic model of memristor.

Summary

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