Electrical circuit model for neuron firing device by negative differential resistance junctions components

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In information engineering field, pulse generation devices are called neuron firing devices (NFD) performing calculation in brain like computer. To realize the NFD, we can model the electrical circuit not only with the various combination of resistors, capacitors and inductors but also with noise or nonlinear junctions such as negative differential resistance (NDR). If such an information processing device that utilizes noise could be realized, it would be very helpful in extracting the basic designing of artificial information processing system including the realization of robots with artificial intelligence. In our group, we have experimentally succeeded to fabricate controllable noise devices or pulse generation ones using polyoxometalate (POM) nanoparticles junction network. However, it is not well-known how POM nanoparticles work in the system to generate pulses. The purpose of present work is to determine how POM particles work in network structure on the basic of electrical and chemical process which generates the noise although maintaining their robustness. After checking many kinds of models, it is concluded that a model shown in Fig.1(a) is the most adequate noise generation system with the combination of resistors, capacitors and the NDRs reproducing the experimental result. The circuit behavior has been verified with the NG-SPICE simulations by analyzing the simplified analytic model, and then confirmed through the experiment results. As shown in Fig.1(b) that the simulated noise in current amplitude increases with the applied bias which is similar to the experimental data in Fig.1(c). It is considered the phenomenon is caused by NDR devices and can be used in brain-like computing in near future.

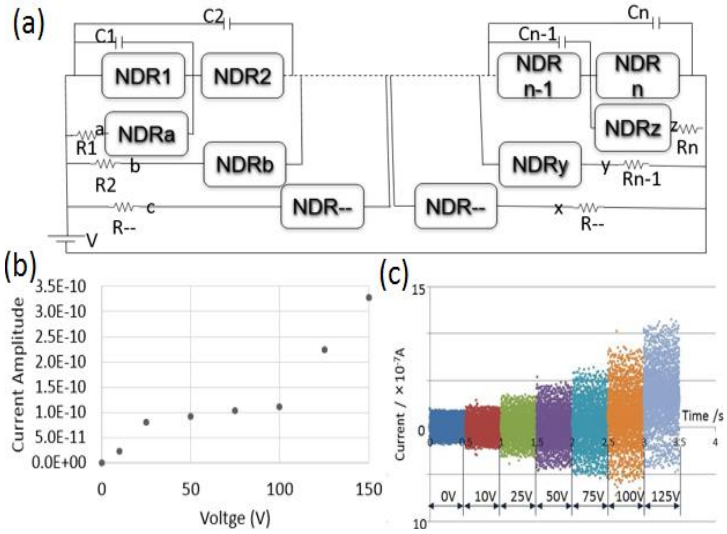

Fig.1 (a) Schematic model for the generation of neuron like pulse. (b) Simulated data showing the amplitude of noise in current increases with the applied bias. (c) Experimental result obtained from the fabricated device with the network of CNT complexed with POM.