Memristor Nanomemory Passive Power Device

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ABSTRACT

The memristor memory has several advantages of over conventional transistor-based memories. One is its strikingly small size. Though memristor is still at its early development stage, its size is at most one tenth of its Random access memory (RAM) counterparts. If the fabrication technology for the memristor is improved, the size advantage could be even more significant. Another feature of the memristor is its incomparable potential to store analog information, which enables the memristor to keep multiple bits of information in a memory cell. Besides these features, the memristor is also an ideal device for implementing synaptic weights in artificial neural networks.

Keywords: memristor, carbon nanotubes, artificial intelligence, ram, nano

1 INTRODUCTION

A memristor (a.k.a., a memory resistor) is a non-linear passive two-terminal electrical component relating electric charge and magnetic flux linkage [1, 2]. It was envisioned, and its name coined, in 1971 by circuit theorist Leon Chua[3]. According to the characterizing mathematical relations, the memristor would operate in the following way: the memristor's electrical resistance is not constant but depends on the history of current previously flowing through the device (i.e., its present resistance depends on how much electric charge has flowed in what direction through it in the past; the device remembers its history — the so-called non-volatility property). When the electric power supply is turned off, the memristor remembers its most recent resistance until it is turned on again. In this paper , a non-volatile memory circuit in embodiments of the present work have the following features: (a) a logic source, and (b) a semi-conductive device being electrically coupled to the logic source, having a first terminal, a second terminal and a nano-grease with significantly reduced amount of carbon nanotube loading located between the first and second terminal, wherein the nano-grease exhibits non-volatile memory characteristics.

2 EXPERIMENTAL

The base oil was heated at a temperature between about 70 °C and about 180 °C. The carbon particles and/or boron nanomaterials were added sequentially in smaller portions. the carbon particles and/or boron nanomaterials were sonicated in the fluid to form a conductive grease composition. Then the the conductive grease was passed hrough a roller mill for several times to produce the homogenos conductive grease.

3 RESULT AND DISCUSSION

As shown in Table 1, some greases are better than the common commercial grease in terms of electrical resistances. Some samples show 4-5 times conductivity enhancement. Closer study of the measured resistance values leads to an unexpected observation, is, the combination of a carbon nanotubes and base oil have functional groups for forming the hydrogen boding between them leads to a high conductivity grease. In other words, hydrogen bonding between a carbon nanotube and base oil is the reason to have extra high conductivity.

Table 1. The ingredients and measured resistance of some exemplary greases [4, 5].

Base Oil	Carbon Material	Carbon wt. %	Resistance (ohm.cm)
Petro-Canada NH650HT	MWNT-OH (Industrial)	7.5	22.4
ROYCO 500	MWNT-OH (Industrial)	7.5	80
PAO Durasyn 166	MWNT-OH (Industrial)	7.5	4.5k
Petro-Canada NH650HT	Nano C SWNT	2	2.3k
Krytox XHT750	Helix MWNT	15	40
Krytox XHT750	MWNT-OH (Industrial)	1.8	18.6
Ethylene Glycol	MWNT-OH (Industrial)	4.46	96

Figure. 1a-d shows Simulink Model plots of a Simulink Model representation of a memcapacitor circuit and plot for the nano-grease materials electrical response in accordance with an embodiment of the present work is shown. From the charts on figures 1a-d it can be seen the charge on the memcapacitive cell plots almost on top of the Simulink Model. Thus, the inventors have discovered the nano-grease material can be placed in a cell and the materials have capacitive properties having a non-volatile memory property. Also, from the plots, it can be shown these properties held up over a period. From plot A where the tests were run for 10 seconds, to plot B where the tests were run for 1 minute 40 seconds, to plot C where the tests were run for 16 minutes 40 seconds and finally to plot D where the tests were run for 2 hours 46 minutes and 28 seconds it can be shown the nano-grease material holds its non-volatile memory capacity over time as well.

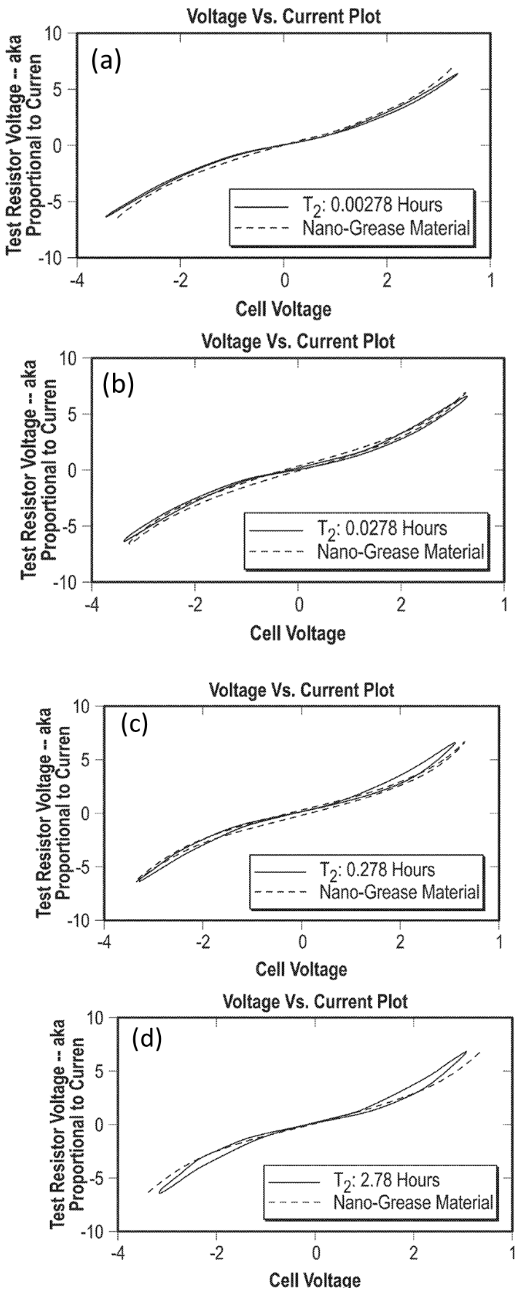

Figure 1: Simulink Model plots of a Simulink Model representation of a memcapacitor circuit and plot for the electrical response of the nano-grease materials

Figure 2 shows a pictorial representation of a nano-grease memcapacitor circuit in accordance with an embodiment of the present work is shown. Memcapacitive gel cell circuit 1100 may have an AC voltage source 1102, a resistor 1104, a memcapacitive gel cell 1108 and a voltage sensor 1106 in a most simplified and basic sense. Memcapacitive gel cell circuit 1100 is a general and simplified depiction of a non-volatile memory circuit in accordance with an embodiment of the present figure. As can be seen, AC voltage source 1102 is only shown connected to one memcapacitor gel cell 1108, however, it is fully contemplated AC voltage source 1102 could be the input for several memcapacitive gel cells 1108 up to tens of trillions of memcapacitive gel cells 1108. AC voltage source 1102 could be most any varying voltage, current or magnetic flux input to a nano non-volatile memory circuit without departing from the spirit of the work.

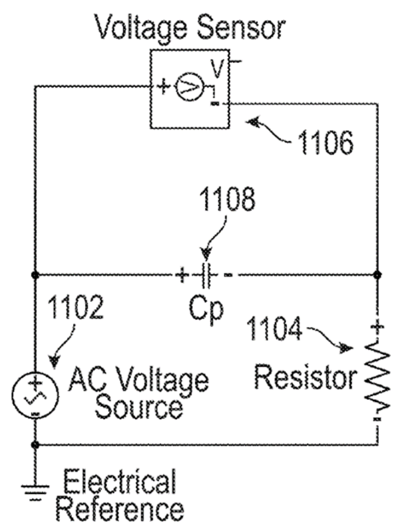

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Figure 2: pictorial representation of a nano-grease memcapacitor circuit in accordance with an embodiment of the present work.

The memresistor , memcapacitor and meminductor of the present invention exhibit what is called a type two pinched hysteresis curve which is unique for memdevices. Standard memdevices are type one meaning they follow a figure eight crossing pattern through the origin , while the memdevices of embodiments of the current invention would be classified as a type two . Further, the memdevice of the embodiments of the current invention exhibit a charging style and dis - charging style curve as shown in figure 3a. Further, 3c shows a modeled charging curve reproducing the memdevice's voltage - current curves shown in figure 3a.

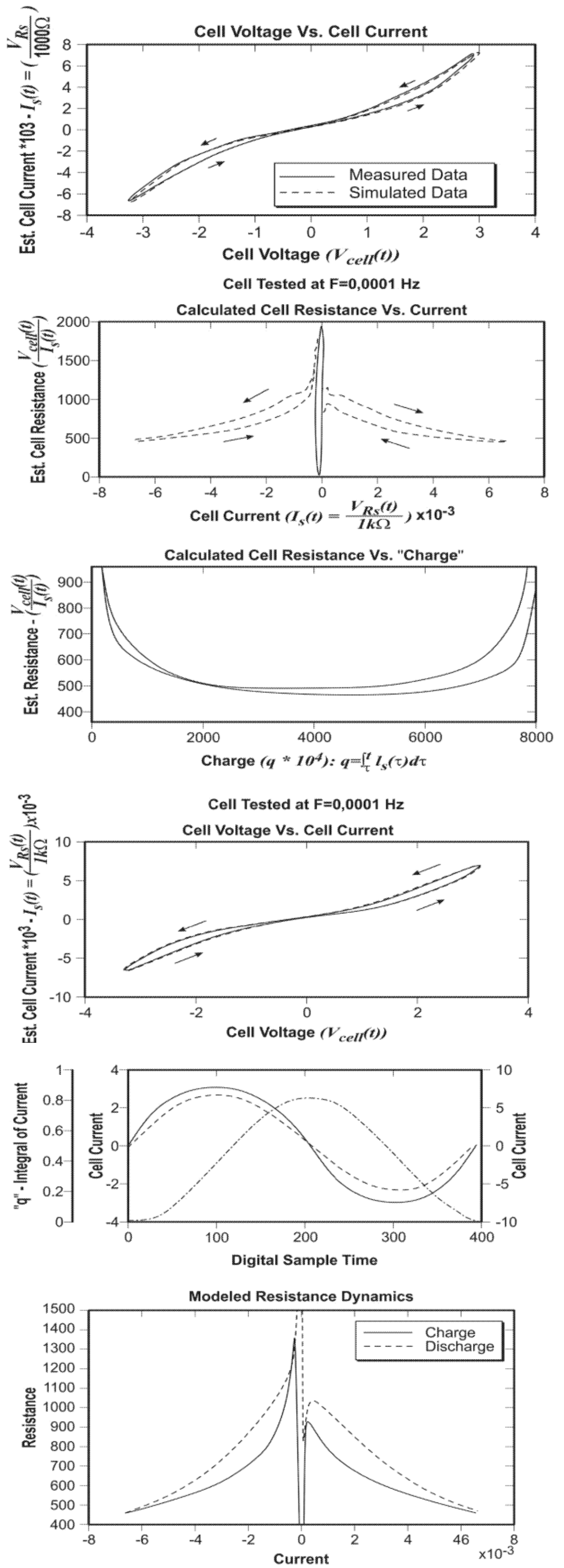

Figure 3: Simulink Model plots of a Simulink Model representation of a memdevice circuit

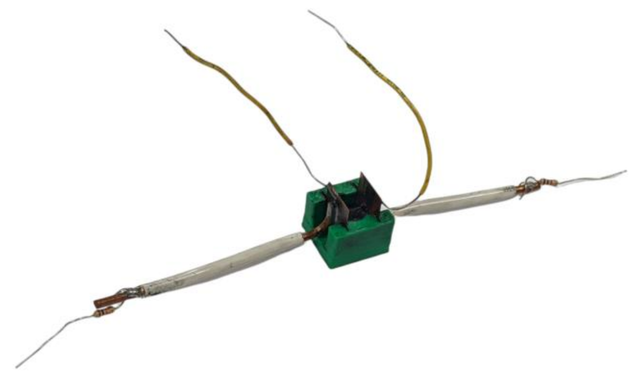

Figure 4: Example of memristor test cell.

4 CONCLSUION

A non-volatile memory circuit in embodiments of the present work may have one or more of the following features: (a) a logic source, and (b) a semi-conductive device being electrically coupled to the logic source, having a first terminal, a second terminal and a nano-grease with significantly reduced amount of carbon nanotube loading located between the first and second terminal, wherein the nano-grease exhibits non-volatile memory characteristics.

Nanoparticle containing memristors can be used as non-volatile analog memories and can mimic classic habituation and learning phenomena. As the frequency tends to infinity, the hysteresis loop degenerates to a linear (straight) or non-linear (curved) line through the origin meaning it would not store energy.

The carbon nanotube structure based memristor resembles the Lissajous curve for a memristor. It is clearly noted that the 3D nanotube structure developed has memristive properties and can be used to implement memristors on a nanoscale.

The memristor developed can handle an input greater than 4 watts an dis not sensitive to ESD (electrostatic discharge). The nanogrease gell cell can be used in most any memory utility to perform non-static memory functions. The cell can function as a memristor, memcapacitor, or meminductor. The function would be decided by the varying input, voltage or magnetic flux.

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