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Designing and Realization of Biological Diode and Transistor Circuit From an Artificial Conducting Liquid

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ABSTRACT:

A lot of research has been carried out based on conventional electronic components. Today's market demands an innovative research which deals with the fundamental physics of the electronic components. In this paper, low frequency basic electronic components have been demonstrated and analysed using conducting liquid fundamentals for further research. The result supports the novel idea to understand the physics behind the electronic component structure and innovate some novel circuit. The claimed research has been extended for implementation of complex electronic circuits, which could be the alternative of human implantable devices.

KEYWORDS: Synthetic plasma,liquid medium.

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INTRODUCTION:

S. P. Kosta has significantly contributed in realising the electronic circuit using liquid medium. Conducting medium has been utilised as biomedical memristor by S. P. Kosta and his team. At the end of their research, they have presented the effects of variables like:[1] distance(d) between device forming probes[2] applied voltages[3] probe's pressure (p) [4] probe polarization, on the input/ output characteristics as well as current gain factor β of the transistor can be formed[1].His team has also developed the first biological memristor circuit using human tissue- skin. The authors claimed that biomedical human body parts like blood, skin or any tissue based electronic circuit has very novel application create human machine interface and cyborg implants[2]. S. P. Kostaet al did analysis on the composition of human blood. Different major particles like positive ions, negative ions, red cells and white cells collectively made the blood. By proper understanding of their characteristics and composition, they could be effectively utilised in developing low frequency electronic components and circuits. Kosta and his team used blood variables like temperature, forming probe distance, flow rate and different density blood groups as a transistor parameters [3]. Using the well-known concept of human body conductivity, field effect transistor can be developed using three points (probes) of human hand palm (first two) fingers. Here, silver coated copper rings have been used by the authors to provide stable and sufficient pressure for all three probes on the palm finger in order to do analysis on a common configuration[4,5].Marc Simon Wegmueller has also tried to project human body as conducting medium for certain circuits and networking protocol. The human body is neutral in nature but every human being live cells are surrounded by a tissue made up of a fatty acid bilayer with proteins implanted in it [6,7].Yogesh P. Patil and his team tried to find out the effect of nano particles in to the human body because they are always present in any humans. For the same research the authors realized that metal can be implanted into the human body and this technique is very useful to understand the chemistry of nano particles[8].Zedong Nie and his team claimed that human body could be the promising and effective path for the short range communication. The authors have talked about the sensors which could be placed on the human body surface. The said sensors are charged using the body energy. The authors have developed S-TDMA protocol for efficiency, traffic control and delay calculation[9].A novel human implantable neural recording system could be developed which can extract the power from live human cell and supply the same power for the biomedical neural recording system [10].Marc Simon Wegmueller and his team have done the experiment on sensor network inside the human body. The authors have put the sensors pills in different locations of the human body and tried to make them interactive in order to form a low frequency sensor network. Authors also reported that below 10 kHz frequency, there was less interference between current and body cells so those frequency range should be avoided[11]. Marc

Simon Wegmueller and his team claimed that four transistors and one receiver set is feasible to implant into the human body at certain frequency range. The authors have successfully demonstrated a wireless communication system on muscle tissue which is capable for data transmission on multiple channels. The authors have used anechoic chamber for noise free atmosphere. In conclusion, they stated that human implantable system is feasible for long and healthy life of a human being with proper medical care[12, 13]. Derek P. Lindsey et al founded the new way of signal transmission in the human body between two points of implantable device. The authors have effectively used the ionic property of human body fluids. Several parameters like distance between two electrodes, the frequency of the transmission and current which had been injected have been carefully studied [14].Killol Pandya and S P Kosta have tried to demonstrate liquid electronic transistor amplifier circuit using synthetic plasma[15].KillolPandya has also investigated that liquid integrated circuit has been feasible to design using afore said fundamentals [16, 17].

In this paper, basic diode and eventually transistor has been realized as biological electronics. Results have been measured and presented as required. Figure 1 shows the conventional diode circuit. Here diode is presented as it is in forward bias region. An ammeter is connected in series in order to measure V-I characteristics of the diode.

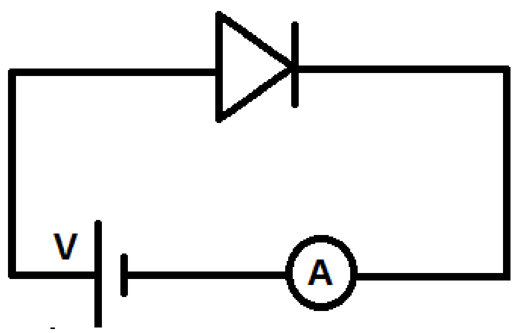

Fig. 1. Ideal diode circuit

LIQUID DIODE CIRCUIT CONFIGURATION:

In order to design liquid based electronic circuits, synthetic plasma(liquid) has been developed in applied science laboratories. This product has been made as alternative of red blood cells. Here special care has been taken to maintain similar chemical composition. Depending upon the type of synthetic plasma, it can be developed in different methods with the help of chemical isolation, recombinant bio technology or synthetic production. Developed synthetic plasma has similar characteristics as conventional red blood cells so developed liquid can be used for current conduction. The developed synthetic plasma must have the following characteristics. First, it must be reliable for use and human friendly in nature for any kind of blood groups. Second, it also means that plasma can be processed to remove all disease-causing agents such as viruses and microorganisms.

Third, it must be shelf stable which is contrast to natural blood because in natural blood clouting takes place if temperature differs or after a longer time.

The Figure 2 shows synthetic plasma(liquid) based diode configuration. Here, in this setup, two copper wire electrodes were inserted in a beaker which is already filled with synthetic plasma. The presented liquid diode circuit has been analysed under positive as well as negative voltages and current at respective voltages has been measured. Power supply equipment has been used to supply voltage and ammeter for current readings. The experiment has been performed under ideal condition and at a room temperature.

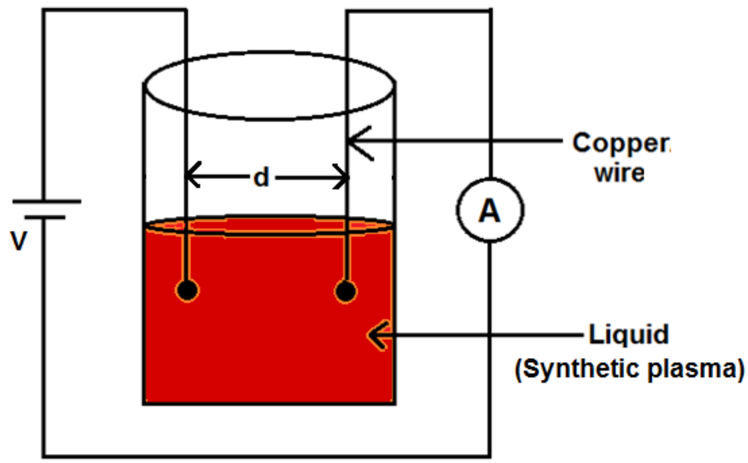

Fig.2. Layout of liquid diode circuit

RESULT AND DISCUSSION:

The table1 shows currentvalues against the variation in voltages when the distance between two inserted probes kept constant at 2.5 mm. Figure 3 shows a graphical representation of V-I characteristics of the diode. As the voltage increases above 0 volt, current is stable and remains negligible up to 1 volt.As the voltage increase above 1 volt,current increases in linear manner. So, it can be observed that linear response has been achievedby a liquid diode circuit which is very closed to ideal V-I characteristics.

Table 1:V-I characteristics of biomedical diode circuit for 2.5mm distance

V(Volt)	I(μA)	V(Volt)	I(μA)
-2	-1.591	0.2	0.005
-1.8	-1.192	0.4	0.035
-1.6	-0.902	0.6	0.079
-1.4	-0.669	0.8	0.032
-1.2	-0.465	1	0.034
-1	-0.304	1.2	0.096
-0.8	-0.405	1.4	0.342
-0.6	-0.5	1.6	0.48
-0.4	-0.605	1.8	0.744
-0.2	-0.115	2	1.15

0	0.03	2.2	1.17

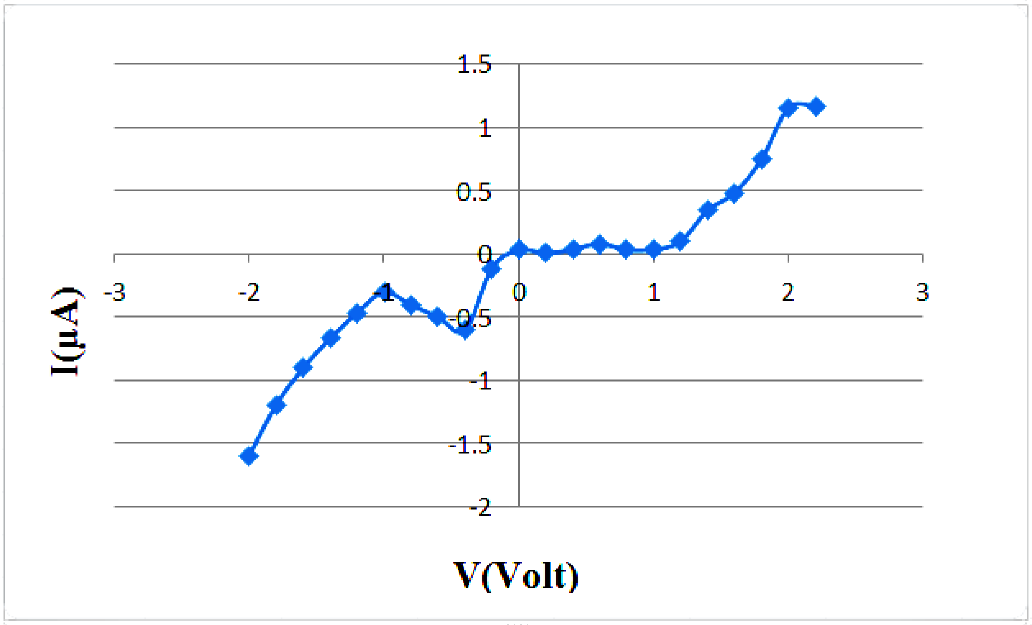

Fig.3. Graphical representation of diode V/I characteristics

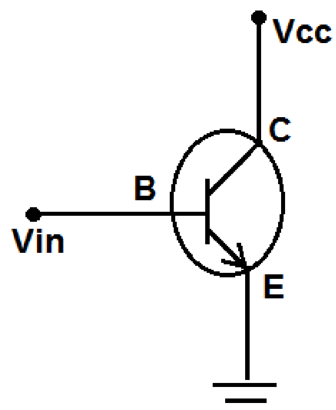

Fig.4. Ideal transistor circuit

Figure 4 shows ideal transistor circuit where power supply is connected directly to the collector and input voltage is given to the base terminal of the transistor. Emitter terminal is connected with ground.

LIQUID TRANSISTOR CONFIGURATION:

Theoretically transistor has two diodes in back to back configuration, one formed by human blood inserted three probes B (base terminal), E (emitter terminal) and other by C (collector terminal) and E (terminal) as depicted in Figure 5.

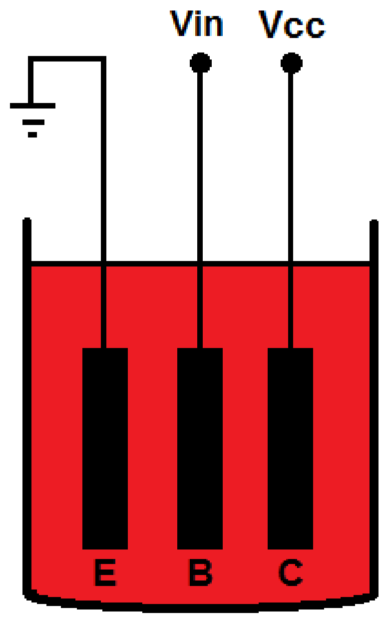

Fig. 5. Liquid based transistor circuit layout

Under DC voltage bias conditions the electrical field coupling between base to emitter probes and collector-emitter probes occurs due to inherent capacitance/inductance coupling. The experimental probes are made of cooper rectangular strips (2.5mm x 8mm). The geometry and distance between forming diode (set of three probes B, E, C) plays vital role in the practical realization of the transistor.

RESULT AND DISCUSSION:

The input circuit (base–emitter) contained variable voltage power supply along with current measuring multi-meter to measure voltage/current input characteristics (V_{BE} v/s I_{BE} by keeping V_{CE} constant) between base and emitter. Similarly, output circuit was realized by another variable voltage supply along with multi-meter (V_{CE} v/s I_{CE} by keeping V_{BE} constant) between collector and emitter. The so developed bio-logical transistor manifested technically acceptable (comparable with conventional semi-conductor device) input and output characteristics of the device. Figure 6 and 7 depicts the transistor input and output characteristics. The result supports the idea that liquid base electronic device is feasible. Here transistor circuit has been tested and desired response has been achieved so in the next chapters, circuits made from transistor have been tested sequentially and effectively presented.

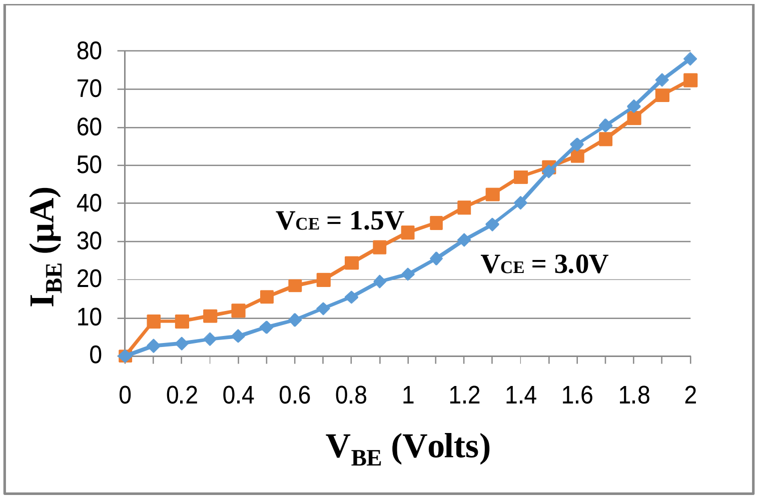

Fig. 6. Graphical representation of transistor input characteristics

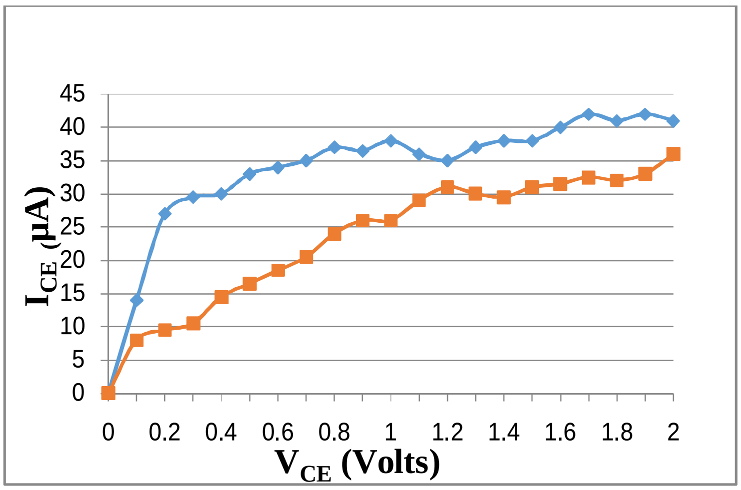

Fig. 7. Graphical representation of transistor output characteristic

CONCLUSION:

Basic biological diode and transistor circuits have been successfully investigated and analysed in this paper. The result depicts the feasibility of similar kind of components and circuits using conducting property of liquid medium. If the research is extended to developed human body friendly circuit using implantable material, it would be the beginning of novel research in the field of biological and biomedical science.

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