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Transitional circuitry for studying the properties of DNA

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Transitional circuitry for studying the properties of DNA

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Abstract. The article is devoted to a new view of the structure of DNA as an intellectual scheme possessing the properties of logic and memory. The theory of transient circuitry, developed by the author for optimal computer circuits, revealed an amazing structural similarity between mathematical models of transition silicon elements and logic and memory circuits of solid state transient circuitry and atomic models of parts of DNA.

1. Introduction

Knowledge of DNA is the most important for humanity. DNA plays a determining biological role in the development of living beings, as it encapsulates their genetic information as a certain development program. A new look at the known object of research will help to a biophysicists to better understand the nature of this object, and use this knowledge for the benefit of man.

2. What is DNA?

There are two ways of looking at what exactly is DNA.

2.1. Overview of the history

It is believed that in 1953 James Watson and Francis Crick unraveled the structure of deoxyribonucleic acid (DNA), a molecule of heredity (Crick, 1981) [1]. In Search of the Double Helix: Quantum Physics and Life. United States of America: McGraw-Hill Book Company. DNA has the form of a swirling rope ladder (spiral), the crossbeams of which are represented by pairs of nucleobases. Adenine is combined with thymine, and cytosine - with guanine.

The main value of DNA is the ability to carry information about the protein and the ability to double.

A sequence of three linked nucleotides is a code for a particular amino acid. From the sequence of amino acids proteins that control the body's biochemical mechanisms of development and metabolism appear. DNA is a replicator molecule. After the DNA molecule is divided into two chains, each nucleic base attracts complimentary to itself. Thus, adenine attracts a new thymine, guanine - a new cytosine, etc. At the end, two new DNA molecules are obtained, which are exact replicas of the original DNA. This [2-7] is a vision of the essence of DNA by biochemists and biophysicists.

2.2. A new look at the structure of DNA

The author is the developer of the optimal computer transitional circuitry [8-13], which allows you to look at DNA as a certain biochemistry, built on the principles of transitional circuitry. And if we understand how this bioscheme works at the level of intellectual functions of logic and memory, we have the possibilities of its circuit redesign, optimization, and elimination of failures.

So the new view is that DNA is an intellectual scheme with all the consequent opportunities of circuit analysis, synthesis and optimization.

3. Fundamentals of the theory of transitional circuitry

A significant difference between transitional circuit technology and transistor circuitry is the determination of the minimum part for the synthesis of a complex circuit.

3.1. Mathematical model of an element of transitional circuitry

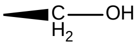
The mathematical model of a functionally integrated element (FIE) is an undirected graph G (X, A, T), where: X = (x1, x2, ... xN) is the vertex set, A = (a1, a2, ... aM) is the set of edges . The predicate Γ is a three-place predicate and is described by a logical statement Γ (xi, ak, xj), which means that the edge ak joins the vertices xi and xj. The element of the set of vertices xi corresponds to the part of the integral structure in which Ti determines the qualitative composition of the part of the integral structure, Fi is the element of the functional set. The set consists of subsets: Tt - subsets of materials of solid-state circuitry, Tb - subsets of atoms of biochemistry. A set of materials with different properties Tt = { } (i = 1, ... n) = (p, n, p+, n+, ... SiO2, ..., Al, Ga ...) = SUDUM corresponds to the subset Tt, where p is the semiconductor region p-type, n is an n-type semiconductor region, SiO2 is a region of silicon dioxide, Al is an aluminum region, Ga is a region of a halide, etc., S is a subset of semiconductor regions, D is a subset of dielectric regions, M is a subset of conductors. The functional set F = Fc U Fp consists of two subsets: Fc = { } = (E1, ..., Ek1, I1, ..., Ik2, φ1, ..., φk3 ...): subsets of control actions in the form of voltage Ei, current Ij, of light φk and Fp = { } = (in1, ..., inm, out1, ..., outn) of the destination subset, which specifies the input and output functions of the area of the set T, relative to which transfer characteristics of the elements that determine their performance. N is the number of regions of the integral structure, the dimension of the element. The elements of the set of edges ak, ai correspond to transitions between different parts of the integral structure that perform certain functions, and there exist xi, xj (xi ≠ xj) & Γ (xi, ak, xj) & Γ (xj, ak, xi). Examples of transitions of solid-state circuitry (graphs of dimension N = 2) are: Si-Sj transition - transition between semiconductors, for example, p-n junction - transition between p and n semiconductors performing a diode (barrier) function; Si - Dj transition - transition between a semiconductor and a dielectric; Si-Mj transition - transition between a semiconductor and a metal (Schottky diode), transitions between transparent and opaque layers in optoelectronic elements, membranes in biological elements, etc. By analogy, in biosystems [14-15], a simple group (R-Z) - a combination of two atoms of element-organogens (C, N, O, P, S), containing a bond, is a system of components of biochemistry.

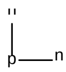
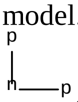
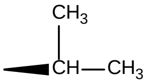
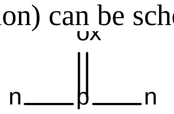
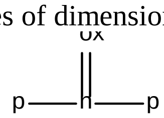
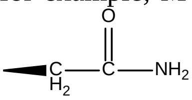
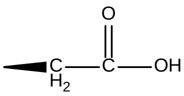
4. What gives the new circuitry for computers and DNA

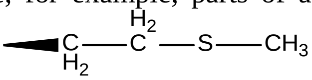
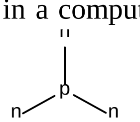
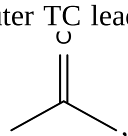
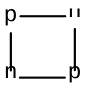
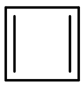
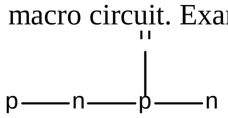
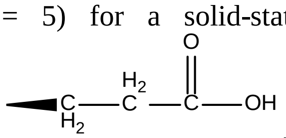
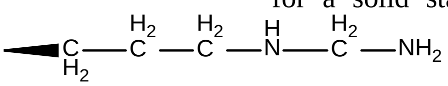
On the basis of the new circuitry for solid-state microcircuits, optimal mathematical models, logical nanostructures and memory nanostructures protected by patents were developed. The new elements contained fewer areas and connections and their mathematical models were surprisingly similar to some molecules and parts of DNA with similar functions of logic and memory. The results of many years of work on the synthesis of intellectual elements in the developed transitional circuitry were brought into the system of elements of various dimensions [16-18].

4.1. Results of comparison of models of transition solid-state nanostructures and organic molecules

Because of the surprising structural similarity of some models of solid-state intelligent circuitry for computers and organic molecules (parts of DNA), they were compared for further in-depth study by biochemists and biophysicists of DNA as some intellectual scheme of bio-transitional circuitry. The results of the comparison are given in [8]. Let us compare the models of transition schemes and parts of bio molecules

4.1.1. Components. The components of transitional circuitry of dimension 1 N = 1 (N is the dimension - the number of minimum parts) from which various structures are built, • for solid-state silicon TC there are materials (for example, p-type semiconductor ——p, oxide ——ox), • for bio carbon TC, these are atoms (for example, hydrogen ——H or groups of atoms, for example ——CH_3). for components of dimension 2 (N = 2): • for a solid-state silicon TC, the component (N = 2) is a transition (the boundary between two materials, for example, a p——n transition). • for a bio carbon TC - this is a valence bond or some other interaction (energy, information, chemical), for example: .

4.1.2. Switching circuits – transistors. From dimension 3 (N = 3), the circuits of transient circuitry (TC) begin. A tree-like model of dimension 3 under certain conditions can be a transistor model. Examples of models of a solid state silicon TC transistor are bipolar transistor models , , for a bio carbon TC, it is part of the amino acids .
Transistors (binary devices capable of transmitting or not passing current, charge, electron, proton, information in any representation) can be schemes of dimension 4 (N = 4). For a solid-state TC this is, for example, MOS transistors  and , for bioplasmics, parts of amino acids  and .

4.1.3. Logical structures. Realization of logic functions begins from the dimension 4 (N = 4).
For solid-state TC, the graph model of the structure of the inverter has the form p——n——p——n. Principal for the implementation of any functions is the availability for the structure of the management system. *Any structure without control is dead*.
There are, for example, parts of amino acids similar in structure to a semiconductor inverter, for example , but the implementation of inversion on them has not yet been considered. As was shown, the inversion in bio TC has been proved for more complex structures.
Using the parallelization of inputs in a computer TC leads to the possibility of implementing logical functions AND, OR, for example, , , , . And parallelization of the outputs, allows you to work with the load in the macro circuit. Examples of parallelizing the output (N = 5) for a solid-state TC is a model , and for a bio TC a model . An increase in the dimensionality of the circuit model to 6 (N = 6) gives inverters with a structure p——n——p——n——p——n for a solid state TC. It can put in correspondence a part of amino acids  with an uncertain yet logical function.

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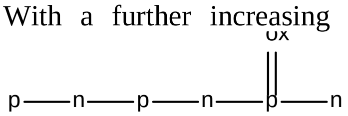
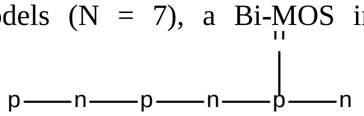
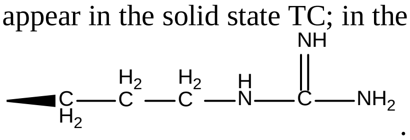
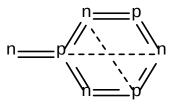
With a further increasing in the dimensionality of the models (N = 7), a Bi-MOS inverter  and an AND circuit with a power  supply appear in the solid state TC; in the bio TC, the analog of the structure may be a part of the amino acids



4.1.4. Memory Structures. Among the structures of dimension 7 (N = 7) there are structures with a cycle of dimension 6.

In a solid state TC, it is a model of a bistable cell  (another name for a bistable cell is an RS trigger) [19]. The synthesis and modeling of the physical nanostructure with the model obtained in the equation was performed in Fig. 1: In the physical simulation of this model in the form of a nanostructure, a system of parameters was found in which the nanostructure was efficient and performed the memory function. In Figure 2 shows the electron density distributions for two states (logical 1 (S = 1, R = 0) and logical zero (S = 0, R = 1) of a bistable cell with a cyclic mathematical model in Figure 1.

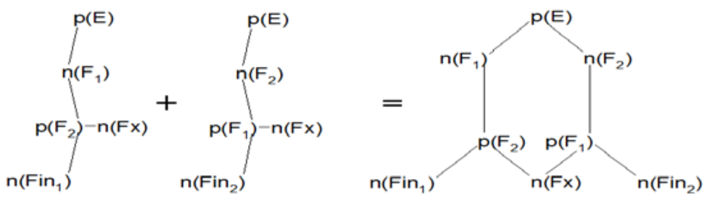


Fig. 1. The equation of synthesis of a model of a disjunctive bistable cell (BC) in a solid state TC

Simulation of current through a direct and inverted output, the results of which are shown in Fig. 3, proves the existence of a memory function for the nanostructure and confirms the execution of the logical "zero" and "unity" recording functions (the asymmetry of physical states).

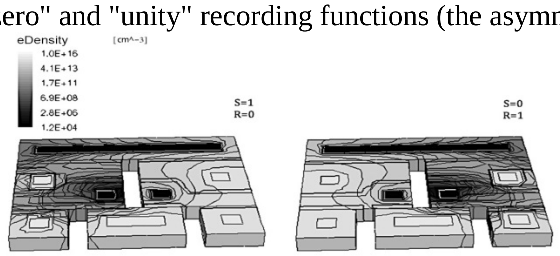


Fig. 2. The distribution of the electron density for two states (logical 1 (S = 1, R = 0) and the logical zero (S = 0, R = 1) of a bistable cell with a cyclic mathematical model in Fig. 1

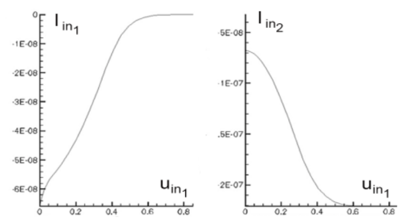
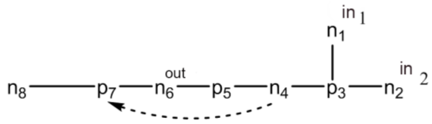
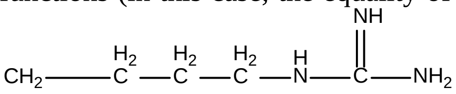
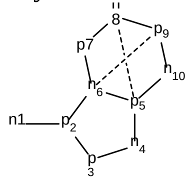
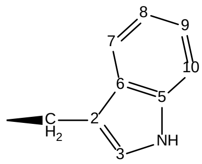


Fig.3. Current curves for direct and inverted outputs

BC (RS-trigger) is the basis of a huge number of different types of memory in a solid state TC. A necessary condition for the realization of the memory function is the presence of cross feedbacks between the inputs and outputs of a pair of logic gates that form the memory structure (they are denoted by dash-dotted lines). If, for example, in the benzene ring, or another hexagonal structure, information is transmitted on such bonds, hexagonal structures can be considered as memory cells in bio-TC under certain conditions (controls). With a further increase in the dimensionality of the structure, models of a functionally complete logical basis for AND-NOT appear in the solid state TC, for example, 

. Here the dash-dot line indicates the internal connection between the regions of the structure, which ensures the equivalence of the control functions (in this case, the equality of potentials). In the bio TC reserve there is a structural analogue 

, the function of which has not yet been determined. Interesting are the model of the structure of the D-trigger in the solid-state TC  and the bioanalog, which is constantly encountered in the structure DNA . Further complication of the TC leads to the generation of models of single-digit memory circuits with control logic circuits (Fig. 4 (a) - adenine in DNA, (b) - D-trigger, driven by a logic circuit in a solid state TC).

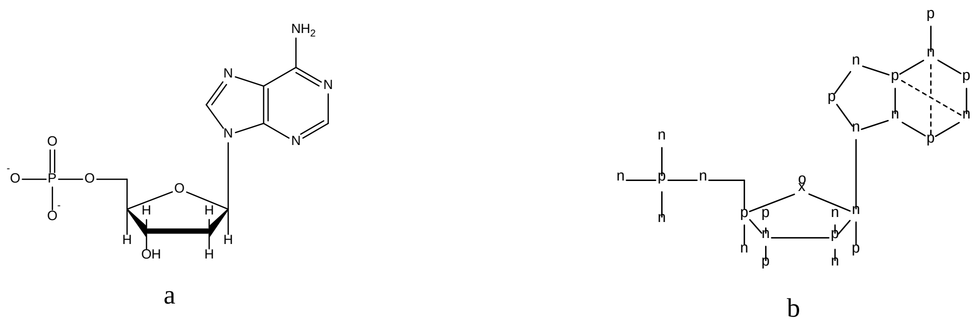


Fig. 4. Comparison of transient models of nanostructures: (a) - adenine in DNA, (b) - D-trigger, driven by a logic circuit in a solid state TC

4.2. Principal differences

With the similarity of the models structures of the intelligent circuits of the solid-state TC and the bio TC, the principal difference, apart from the components (materials and connections), is the various structure management systems and the differences in the representation of the processed information.
Despite the fundamental differences, the surprising repetitive similarity of the models of solid-state TC and bio-TC circuitry makes us think.

5. Conclusion

In continuation to the history of the study of DNA, a new view of the structure of DNA as an intellectual scheme of transient circuitry (TC) was suggested.
The fundamentals of transitional circuitry theory are considered.
A mathematical model of an element of transitional circuitry is proposed.
Advantages of using transitional circuitry for computers and DNA are considered.
The results of models comparison of transitive solid-state nanostructures and organic molecules (parts of DNA) on components, switching, logical structures and memory structures and their fundamental

differences are presented. Knowledge of transitional circuitry and a new view of DNA as an intellectual transitional scheme of bio-transitional circuitry can help researchers look at their objects of research in a new way and reveal secrets that have been closed to them for some time.

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