

Research Article

Powerless Logical Gates Based on Molecular Electronics

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Abstract: In this study, a new AND gate as well as a new OR gate based on Molecular electronics are proposed. Then, these gates are extended to n-input gates which have decreased the number of required elements and they have been designed as modify as possible. The main advantage of these designs is the fact that they are powerless.

Keywords: Benzene ring, carbon nanotube, molecular electronics, polyphenylene, powerless logical gate

INTRODUCTION

During the past 50 years, the size of transistors has been considerably decreased. However, the laws of quantum mechanics and the limitations of fabrication techniques prevent further reduction in the size of today's conventional transistors (Goldhaber *et al.*, 1997). Building electronic circuits based on molecules is a new method to modify the above mentioned limitations. Molecular electronic devices are capable of enhancing some properties such as response time and area. However molecules have disadvantages such as instability at high temperatures. But overall, the above advantages make molecules ideal for electronics applications (Heath and Ratner, 2003). There are two primary types of molecules that have been proposed for use as backbone for current-carrying molecular-scale electronic devices. They are polyphenylene based chains and carbon nanotubes (Kumar, 2007). In this study we consider polyphenylene based molecular electronic devices. As in previous works, there are some logical gates that are powerless. These powerless gates are based on CMOS transistors and some others use ambipolar CNT transistors (Sharifi and Ghasemi, 2010). This study proposes new powerless logical gates including AND and OR gates based on molecular electronics. The proposed structures reduce the occupied area and eliminate the consumed power due to independence of power supply as VCC.

PROPOSED POWERLESS MOLECULAR GATES

Circuits for AND and OR logical gates based on diodes have been known for decades. They are composed of diodes and a resistor. Earlier AND gates

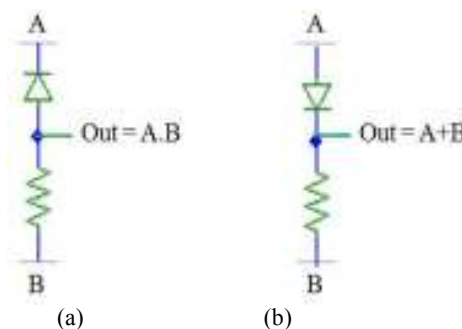


Fig. 1: Modified circuits for (a) AND gate, (b) OR gate

Table 1: Truth table for (a) AND gate, (b) OR gate

(A)			
A	B	Diode	Out
0	0	Off	0
0	1	On	0
1	0	Off	0
1	1	Off	1
(B)			
A	B	Diode	Out
0	0	Off	0
0	1	Off	1
1	0	On	1
1	1	Off	1

based on this structures needed the power supply and also the OR gates required a GND. Previous molecular gates that have been proposed are based on the above mentioned structures. Thus, improving designs at this level will lead to efficient molecular gates. Figure 1 shows efficient powerless AND and OR gates using a diode and resistor, with A and B represent

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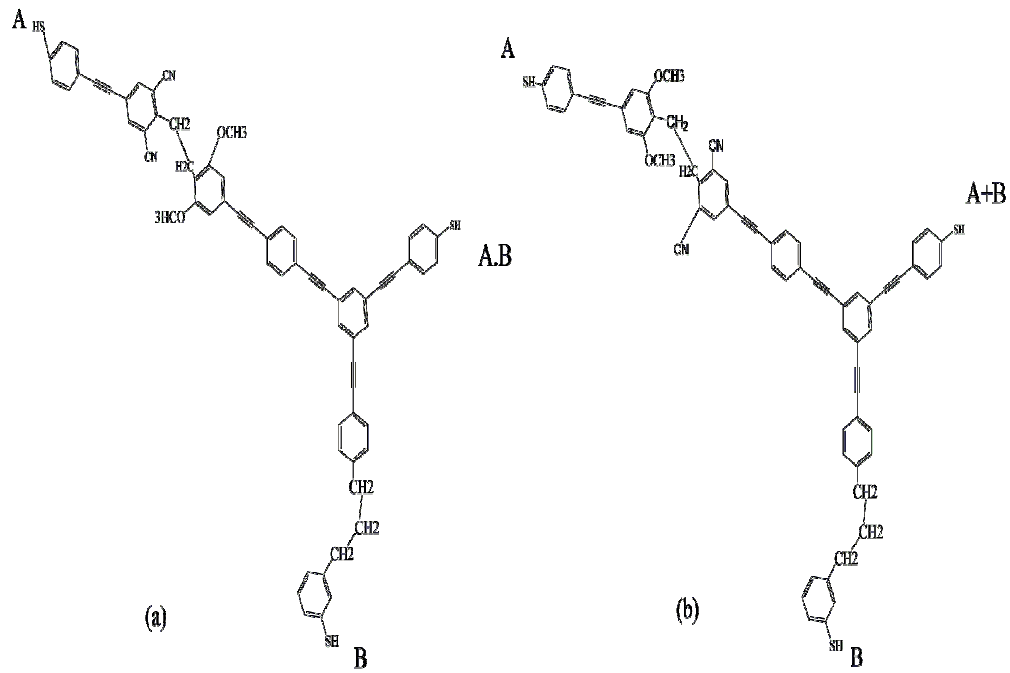


Fig. 2: Proposed powerless molecular logic gates, (a) AND gate, (b) OR gate

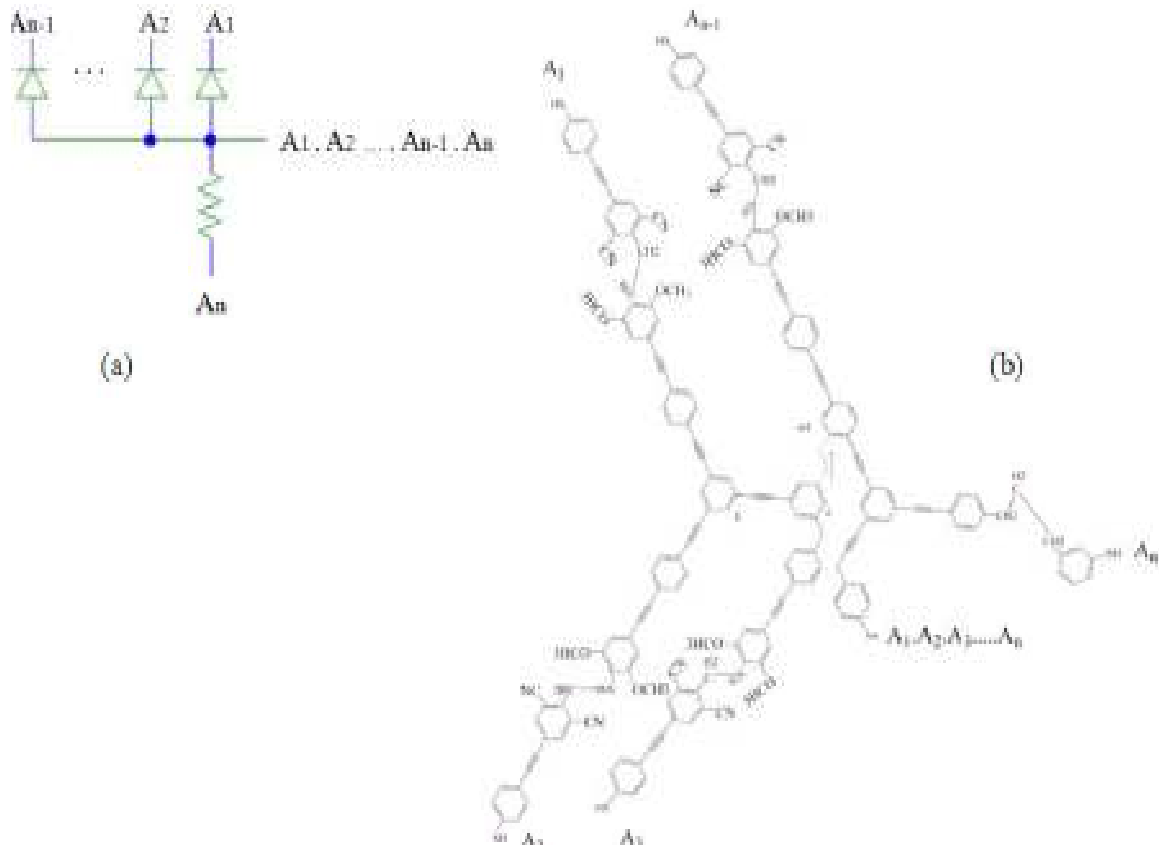


Fig. 3: Modified circuits for, (a) n-input AND gate, (b) molecular structure for n input AND gate

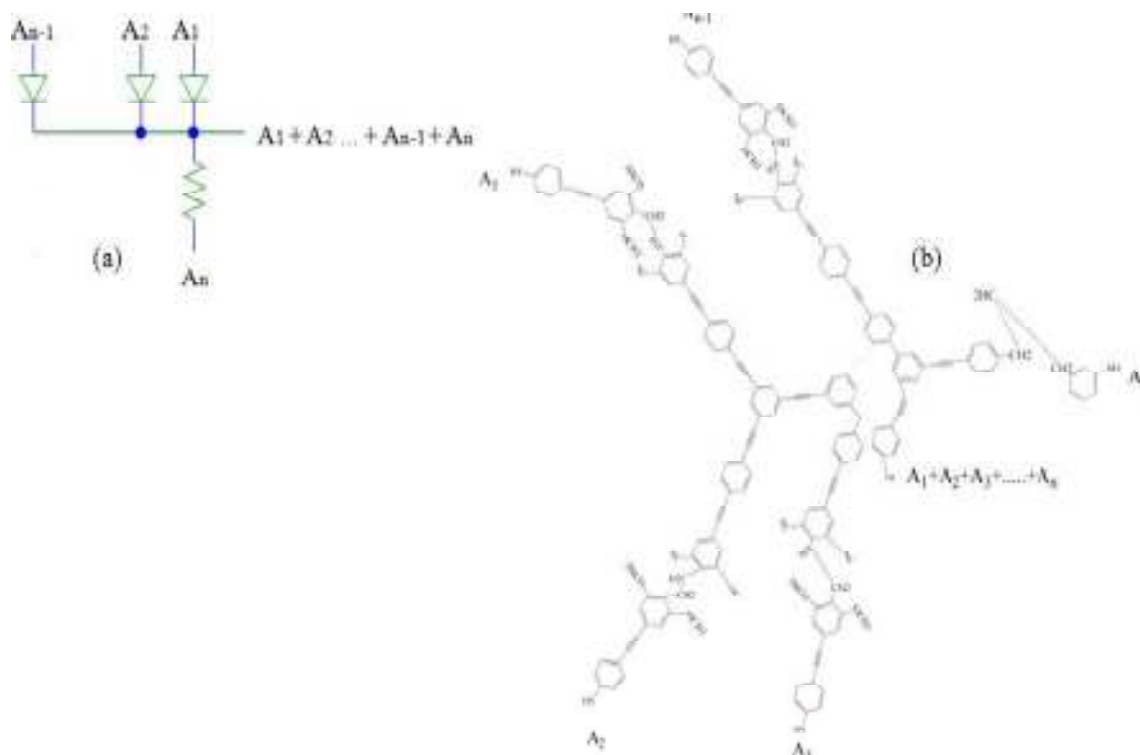


Fig. 4: Modified circuits for, (a) n-input OR gate, (b) molecular structure for n input OR gate

inputs. The truth table for these structures is shown as Table 1.

Proposed structures for corresponding novel molecular implementation of these logic gates are shown in Fig. 2.

Using structures like those in Fig. 1 enable us to create multi-input AND and OR gates. Figure 3 and 4 illustrate n-input AND and OR gates and their equivalent molecular arrangement.

CONCLUSION

The new two-input and n-input powerless AND and OR gates based on molecular electronic devices is presented. Contrary to other studies (Kumar, 2007; Ellenbogen and Love, 2000) using 13 benzene rings for, we have used 8 benzene rings to design the new two-input logic gates improving the occupied area by 38%. Also, the above mentioned logic gates do not require any power supply.

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