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Comparison and analysis between complemantory metallic semiconductor based three satge ring Osillator and carbon nanotube based three stage ring oscillator with Lactor technique and without Lactor technique

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Abstract
Nanoscale device is an optimistic solution to replace complementary metallic oxide semiconductor which is also known as CMOS technology for future nano-electronics. Novel nano-scale semiconductor devices like CNTFET transistor can use for upcoming nanoscale devices because of the magnificent performance and accurate results. A comparison between CMOS based technology and CNTFET based technology is presented as per their several parameters. Carbon nanotube is a modern promising nanoscale device which is used for executing better performance with low power and dense electronics circuits. The major concern of researchers was how to reduce the consumption of power and how to reduce the amount of leakage current in their proposed work. CNTFET technology is the technology which is used for getting the better results in term of leakage power and leakage current. CNTFET utilizes single CNT as its channel material in place of vast silicon in MOSFET.

Keywords: CNTFET, CMOS, Lactor Technique, Leakage Current, Leakage Power

Introduction

According to ITRS, the dimensional scale of complementary metallic oxide-semiconductor (CMOS) is sub-10 nm epoch [1]. Which means is that the complementary metallic oxide semiconductor technology is shrinking so fast that the last of silicon era is not in upcoming one or two years but within a decade is undeniable.

As for decades scientists and researchers had tried to tackle the distinctive properties of carbon nanotube to fabricate high performance of electronics devices that are good in performance and less power consuming and resulting the longer battery life and rapid wireless communication with fast in speed for the wireless devices like mobile phones and wireless walky- talky [2]. But several numbers of ups and downs have impeded the development and progress of developing of high processing transistors which are made of carbon nanotube in which very small cylinders are made of single atom thick. On other hand the dimensional scale of CMOS transistors is reaching at its rudimentary coporal limits and as a result researchers have started switching to nanoscale semiconductor devices and CNTFET technology [4]. The circuit diagrams of three stage cnt oscillator and three stage cmos oscillator are showing respectively-

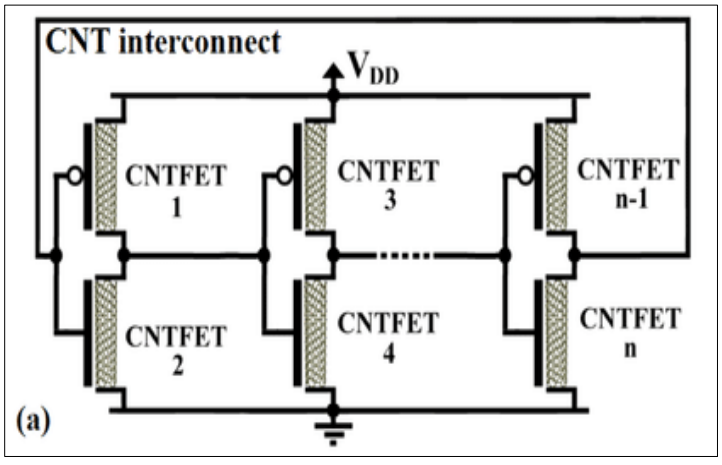

Fig 1: Three stage CNT oscillator

From the figure we can observe that there are odd number of transistors have been used. Vdd is the power supply which is 0.7 used in work for the further results to compare complementary metallic oxide semiconductor based three stage oscillator and carbon nanotube based three stage oscillator.

The circuit diagram of three stage cmos oscillator is showing below-

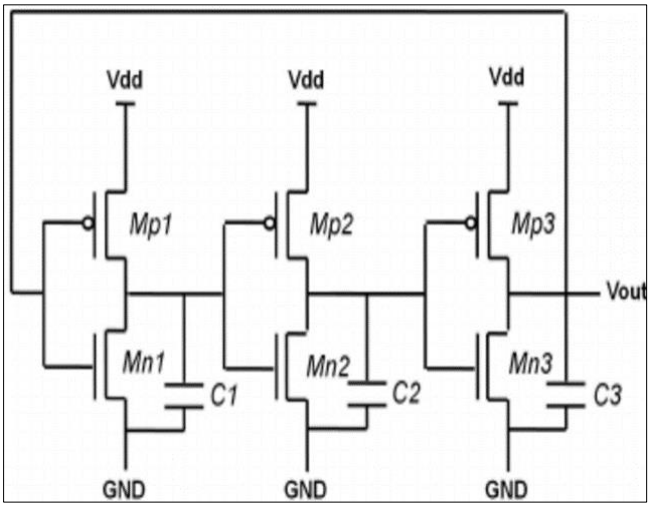

Fig 2: Three stage CMOS oscillator

Based on CNTFET, in this paper a comparison between three stage complementary metallic oxide semiconductor and three stage carbon nanotube oscillator is given, depending on various factors such as leakage power, leakage current and average power. The results of complementary metallic oxide semiconductor and carbon nanotube based oscillator are described below-

Table 1

Parameters	CMOS Oscillator without Lactor Technique	CNT Oscillator without Lactor Technique
Leakage Current	5.8920E-06	4.7392E-06
Leakage Power	4.1241E-06	3.317E-06

From the table of results we can observe that CNT based oscillator is better in performance in terms of, leakage power and leakage current as compare to cmos based oscillator. Thus it has proven that Carbon nanotube based three stage oscillator is better than complementary metallic oxide semiconductor based three stage oscillators in terms of leakage power and leakage current.
In CMOS based ring oscillator the rate of threshold voltage got decreased because the variation of voltage becomes the cause of increase in leakage current as well as static power dissipation which is not a good sign of an ideal circuit. To overcome from this problem we proposed a novel technique which is known as Lactor Technique [7]. This is the technique which is used for minimizing the leakage current significantly without erasing the dynamic power. This Lactor technique is applied in both types of oscillators i.e. carbon nanotube based oscillator and complementary metallic oxide semiconductor based oscillator and the results are better in both cases as compare to without applying Lactor technique [3]. The circuit diagram of CNT based three stage oscillator with Lactor technique and CMOS based three stage oscillator with Lactor technique is showing below respectively-

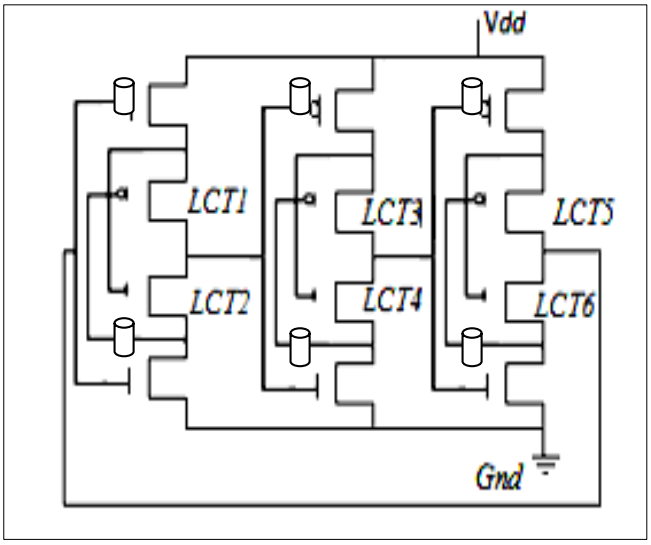

Fig 3: Three stage CNT oscillator with Lactor technique

From the fig (c) we can observe that there are three PMOS and three NMOS are connected. One pair of PMOS-NMOS (LCT1-LCT6) are connected in between the two of their origin of N-MOS as well as with P-MOS of three stage oscillator and the input of the oscillator is connected as a feedback of the output of circuit. The high rate of power supply of the circuit is denoted as Vdd and lower power supply is denoted as Gnd [8].
The circuit diagram of CMOS based ring oscillator is showing below in fig (d) –

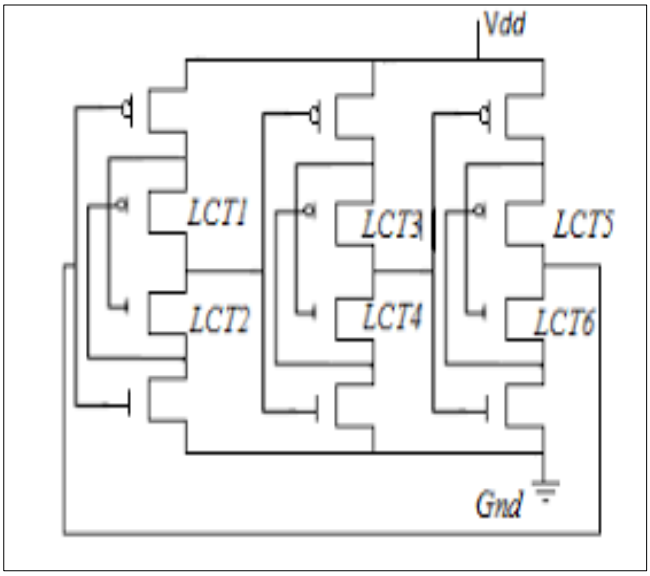

Fig 4: Three stage CMOS ring oscillator with lactor technique

By applying the Lactor technique in both three stage CMOS oscillator and three stage carbon nanotube oscillator the results of CNT oscillators are better than that the result of CMOS based oscillator.
The simulation results of CMOS based oscillator and CNT based oscillator are shown below-

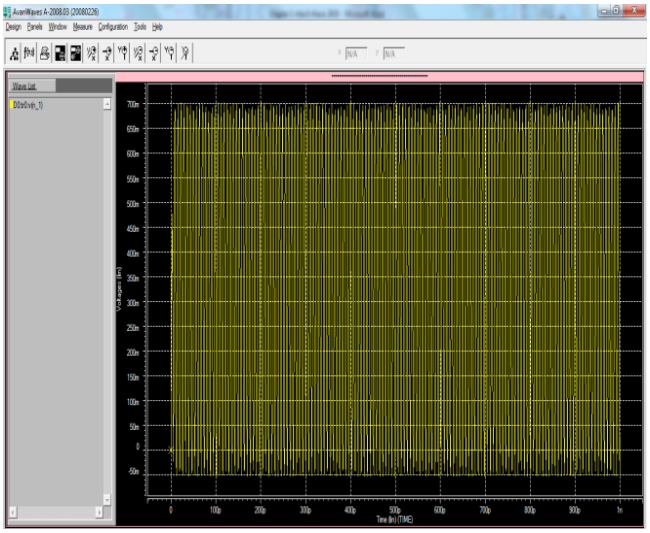

Fig 5: Simulation result of CNT based three stage oscillator

In the fig (e) we can see the number of oscillation which takes place during the simulation process in CNT based three stage oscillator by using Lactor technique.

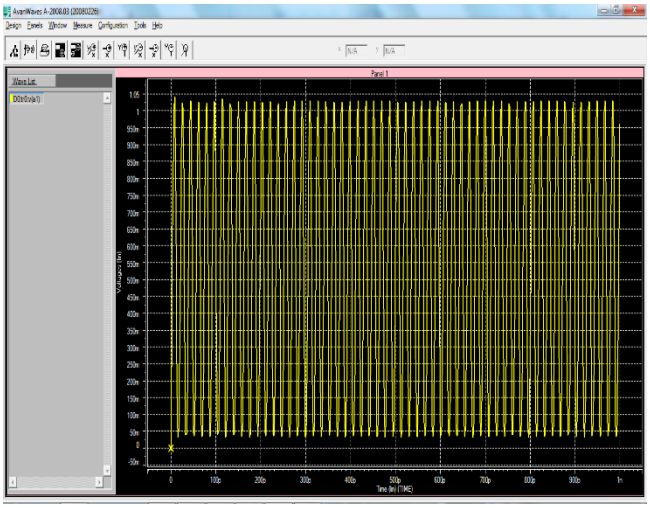

Fig 6: Simulation result of CMOS based three stage oscillator

From the fig (e) we can observe the number of oscillations of CMOS based three stage- oscillator by using Lactor technique [6]. If we compare the result of simulation of both complementary metallic oxide semiconductor (CMOS) based three stage oscillator and carbon nanotube (CNT) based three stage oscillator in terms of leakage power and leakage current, we find that the results of oscillation of carbon naotube (CNT) based three stage oscillator are better as compare to complementary metallic oxide semiconductor (CMOS) based three stage oscillator.

The results of simulation of both CMOS based ring oscillator as well as the results of simulation of CNT based ring oscillator with Lactor technique and the results of leakage power and leakage current of both oscillators by applying Lactor technique are shown in table below-

The simulation results of CMOS based oscillator and CNT based oscillator with Lactor technique are shown below-

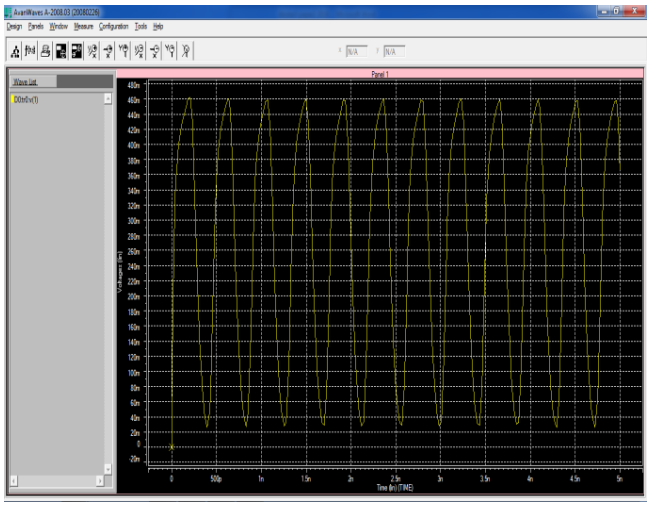

Fig 7: Simulation result of CMOS based ring oscillator with Lactor technique

Table 2

Parameters	CMOS Oscillator with Lactor Technique	CNT Oscillator with Lactor Technique
Leakage Current	3.6989E-06	7.0012E-07
Leakage Power	1.1822E-06	4.9001E-07

The simulation results of CNT based oscillator with Lactor technique are shown below-

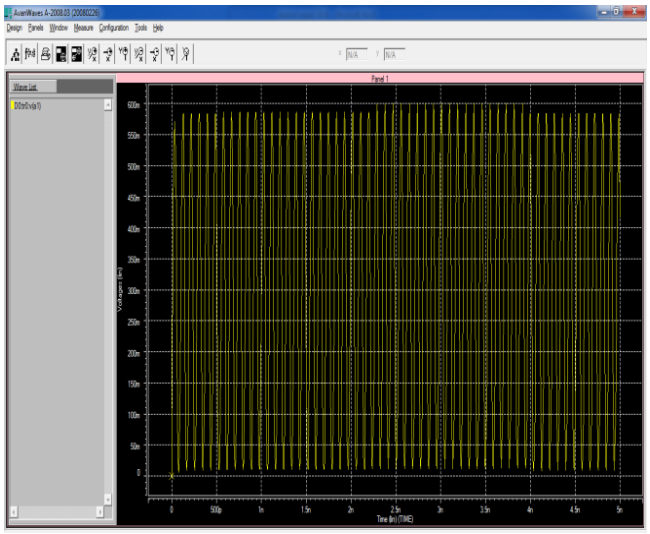

Fig 8: Simulation result of CNT based ring oscillator with lactor technique

From the above table it is clear that the results of Carbon nanotube based oscillator are better than the results of complementary metallic oxide semiconductor based oscillator by applying Lactor technique.

Conclusion

This paper has the comparison between carbon nanotube based three stage oscillator and complementary metallic oxide semiconductor based oscillator on the basis of the results obtained of two parameters, which are, leakage power and leakage current, in which the results of CNT based oscillator are better than the results of CMOS based oscillator. To make the results more better we applied a novel technique i.e. known as Lactor technique the results of CNT based three stage oscillator with Lactor technique are better than the results of CMOS based three stage oscillator with Lactor technique are more better [5]. Hence we can say that carbon nanotube based technology is the best technology which is now considering as the future technology by researchers, scientists and semiconductor manufacturing industries.

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