**DIAMOND CHIP TECHNOLOGY**

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**(ST/CS/ND/20/329)**

**A SEMINAR REPRESENTED TO THE DEPARTMENT OF COMPUTER SCIENCE, SCHOOL OF SCIENCE AND TECHNOLOGY, FEDERAL POLYTECHNIC MUBI, ADAMAWA STATE, NIGERIA**

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**Abstract**

*Diamond Chip or carbon Chip is an electronic chip made on a Diamond basic Carbon wafer or it very well may be likewise characterized as the electronic part made utilizing carbon as the wafer. The real part utilizing carbon is (cnt) Carbon Nanotube. The precious stone chip is the insurgency in IT industry, which replaces the need of silicon. Silicon utilized has thought of certain burdens when utilized in power electronic applications, for example, substantial size, moderate working velocity and so on. The paper directs a review on precious stone chip and its applications.*

**Keywords**: Silicon, Germanium, Carbon Nano tubes, Diamond chip, Graphene.

# Introduction

In single definition, Diamond Chip or carbon Chip is an electronic chip manufactured on a Diamond structural Carbon wafer. OR it can be also defined as the electronic component manufactured using carbon as the wafer. The major component using carbon is (cnt) Carbon Nanotube. Carbon Nanotube is a nano dimensional made by using carbon. It has many unique properties. Pure Diamond structural carbon is non-conducting in nature. In order to make it conducting we have to perform doping process. We are using Boron as the p-type doping Agent and the Nitrogen as the n-type doping agent. The doping process is similar to that in the case of Silicon chip manufacturing. But this process will take more time compared with that of silicon because it is very difficult to diffuse through strongly bonded diamond structure. CNT (Carbon Nanotube) is already a semi-conductor (Raleve *et al.,* 2008).

Silicon chips are at the core of every device in this modern era. Many technological innovations we use regularly have integrated silicon chips in them. Computer chips, sensors and other IC chips all are fabricated using a silicon chip derived from a silicon wafer. The rapid pace of the development in these silicon industries and their great innovations never fail to astonish. This breakthrough technology innovation is called TPU or [Tensor Processing Unit](https://en.wikipedia.org/wiki/Tensor) and being used to power Google’s data centers from almost a year. This new custom chip is more efficient and can perform many operations per second than the conventional chips. In antiquated time, both silicon and germanium were utilized in the assembling of gadgets parts. Unadulterated silicon and germanium are semiconductors in ordinary temperature. However, later it is discovered that germanium has numerous burdens when contrasted with silicon, for example, huge turn around current, less dependability towards temperature and so forth so in the business concentrated on creating electronic parts utilizing silicon wafers (Chen *et al.,* 2012).

**Literature Review**

Aligned carbon nanotubes (CNT’s) are formed on the surface of silicon carbide (SiC) wafers during high temperature anneals. The exposed 4H SiC surface transforms into CNT’s for temperatures in the range of 1400-1700°C and under moderate vacuum conditions (10-2 – 10-5 torr). The rate of formation on the C face (0001¯) is about three times the rate on the Si-face (0001), but both rates increase with anneal temperature. SEM, TEM and Raman scattering measurements have confirmed the presence of both single-wall and multi-wall CNT’s. The carbon source is believed to be residual carbon from the SiC left on the surface after preferential evaporation of Si. CNT formation is believed to be catalyzed by low concentrations of residual oxygen in the chamber. Patterning of both n-type and semi-insulating substrates with Si3N4 masks, prior to annealing, results in CNT-free regions. Vertically aligned carbon nanotubes are desired for applications in vacuum microelectronics as field emission devices (Jorg, 2002).

The growth method primarily used to form dense arrays of vertically aligned carbon nanotubes (CNT’s) is metal catalyzed chemical vapor deposition. An unwanted result from this method is that the CNT’s retain the catalyst after the growth procedure. A catalyst-free CNT growth method dubbed “surface decomposition” results from heating silicon carbide (SiC) wafers in a vacuum furnace. However, the growth mechanism and structural and electrical properties of the CNTs by this method have not been fully understood. Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), and transmission electron microscopy (TEM) were also used to characterize the CNT’s. The effects of variations in growth time, temperature and vacuum level on CNT characteristics are reported. For electrical characterization of the CNT’s, Ni contacts were evaporated on the CNT and non-CNT surfaces. The current vs. voltage (I-V) characteristics were measured across these structures using a general-purpose source-meter (Chen *et al.*, 2012).

Researchers have discovered that carbon is a greater number of preferences than silicon. By utilizing carbon as the assembling material, we can accomplish littler, quicker and more grounded chips. They are prevailing with regards to making littler models of carbon chip. They concocted a noteworthy segment utilizing carbon that is "carbon nanotube", which is generally utilized in most current microchips and it will be a noteworthy segment in the precious stone chip. Diamond chip or carbon chip is an electronic chip fabricated on a jewel basic carbon wafer. Or on the other hand it very well may be additionally characterized as the electronic segment produced utilizing carbon as the wafer. The real segment utilizing carbon is (cnt) carbon nanotube. Carbon nanotube is a nano-dimensional made by utilizing carbon. It has numerous interesting properties (Kaushtubh *et al.,* 2015).

## Diamond Chip Construction

Diamond is unmatched in its ability to diffuse heat, perform as a semiconductor, and create smaller and more powerful electronics. Until now, they have been constrained by the physical limitations of silicon. Akhan’s new process of manufacturing perfect diamonds out of methane gas lifts the barrier of affordability in diamond-based electronics (Chen et al., 2012).

Unadulterated precious stone auxiliary carbon is non-leading in nature. So as to make it leading we need to perform doping process. We are utilizing boron as the p-type doping specialist and the nitrogen as the n-type doping operator. The doping procedure is like that on account of silicon chip producing. In any case, this procedure will take additional time contrasted and that of silicon since it is extremely hard to diffuse through emphatically reinforced precious stone structure. Carbon nanotube is as of now a semiconductor. A precious stone semiconductor works on 81ghz recurrence, and is more than double the speed of prior gadgets. This specific chip was first created by nippon broadcast and phone partnership (ntt), japan. Not at all like silicon and germanium, unadulterated carbon isn't a semiconductor in room temperature. Subsequently, so as to make it a semiconductor, we utilize a portion of the allotropes of carbon (Francis *et al.,* 2009).

Carbon, Germanium, Silicon all belong to the same group in the periodic table. Hence, all of them have four valence electrons in their outer shells. Rather than using silicon, they start using germanium as both of them are very good semiconductors. But later on germanium also showed many disadvantages like temperature irregularities, large reverse current etc. So, the researchers found that carbon has more benefits as compared to both silicon and germanium. Now let’s broadly talk about diamond chips. In clear words, Diamond Chips are manufactured Diamond structural Carbon wafer. Diamond chip are also called carbon chip. Major component in these Diamond Chip are carbon nanotube which were discovered in 1991 (Kusunoki, Shibata, Rokkaku & Hirayama, 2008). Although structure of carbon is non-conducting in nature. So, we have to perform the doping method to fulfill our requirement. We use nitrogen as the n-type doping agent and boron as p-type doping agent. They are made of several concentric walls arranged in hexagonal pattern. However, as compared to that of silicon as it is very tough to diffuse due to strong attraction of diamond atoms. It is assumed that diamond chip can transit power at rate of 100GHz (Kaushtubh et al., 2015).

Graphene is one of the allotropes of carbon which goes about as semiconductor. In this manner, nanotubes, which are gotten from graphene, will likewise go about as semiconductor. Graphene is an allotrope of carbon, whose structure is one particle thick planar sheet of sp2-fortified carbon iotas that are thickly stuffed in a honeycomb precious stone lattice .some of the properties of graphene are (Raleya et al., 2008):

1. Graphene has amazingly high electron portability at room temperature.
2. Graphene structure can be doped effectively by utilizing concoction dopants and can be changed over back to its undoped structure just by warming gradually in vacuum.

Collapsing the graphene sheet into a cylinder like structure produces carbon nanotubes. It is a nano measure chamber of carbon particles. They are made of one or a few concentric dividers in which carbon particles are organized in hexagonal example, having a short of what one nanometer distance across. In a vacuum chamber, the scientists vaporized the metals tantalum and iron, which settled in layers on a silicon wafer. At that point they set the covered wafer toward one side of a quartz tube, which was embedded into a heater. At the wafer's finish of the cylinder, the heater temperature was 475 degrees c; however at the contrary end, the temperature fluctuated. The analysts siphoned ethylene gas into the cylinder from the end inverse the wafer. At the point when the temperature at that end moved toward 800 degrees, the ethylene decayed, and the iron on the wafer catalyzed the arrangement of carbon nanotubes (Mazellier et al., 2008).

## Benefits of Diamond Chip

1. Carbon nanotubes are the most grounded and stiffest materials yet found as far as rigidity and flexible modulus separately. This quality outcomes from the covalent sp² bonds shaped between the individual carbon iotas. In 2000, a multi-walled carbon nanotube was tried to have an elasticity of 63 gigapascal.
2. Standard single walled carbon nanotubes can withstand a weight up to 24GPa without distortion. They at that point experience a change to overly hard stage nanotubes. Most extreme weights estimated utilizing current test systems are around 55GPa. Nonetheless, these new very hard stage nanotubes breakdown at a much higher, but obscure, weight.
3. Multi-walled nanotubes are numerous concentric nanotubes unequivocally settled inside each other. These display a striking extending property whereby an inward nanotube center may slide, nearly without grating, inside its external nanotube shell, subsequently making a molecularly flawless direct or rotational bearing. This is one of the principal genuine instances of sub-atomic nanotechnology, the exact situating of particles to make valuable machines. This property has been used to make the world's littlest rotational engine.
4. Being covalently fortified, as electrical conveyors they don't experience the ill effects of electro movement or nuclear dissemination and consequently can convey high flow densities (107 - 109 A/cm2), which is multiple times that of copper.Both metal and semiconductor can be framed.
5. All nanotubes are required to be generally amazing warm conductors along the cylinder, displaying a property known as "ballistic conduction", yet great covers horizontally to the cylinder pivot.
6. Because of the nanoscale measurements, electrons spread just along the cylinder's hub and electron transport includes numerous quantum impacts. Along these lines, carbon nanotubes are as often as possible alluded to as "one-dimensional".
7. As the extent of the carbon molecule is little contrasted and that of silicon particle, it is conceivable to scratch littler lines through jewel basic carbon. We can understand a transistor whose estimate is one in hundredth of silicon transistor.
8. Diamond is all around unequivocally fortified material. It can withstand higher temperatures contrasted and that of silicon. At high temperature, precious stone structure of the silicon will crumple. Be that as it may, jewel chip can work well in these raised temperatures. Precious stone is excellent conductor of warmth. So if there is any warmth dispersal inside the chip, warmth will all around rapidly exchange to the warmth sink or other cooling mechanics.
9. Carbon chip works quicker than silicon chip. Portability of the electrons inside the doped jewel auxiliary carbon is higher than that of in the silicon structure. As the measure of the silicon is higher than that of carbon, the shot of impact of electrons with bigger silicon molecules increments. Yet, the carbon particle estimate is little, so the shot of crash diminishes. So the versatility of the charge bearers is higher in doped precious stone basic carbon contrasted and that of silicon.
10. For control hardware application silicon is utilized, yet it has numerous drawbacks, for example, mass in size, moderate working velocity, less effectiveness, lower band hole and so on at exceptionally high voltages silicon structure will fall. Precious stone has an emphatically fortified gem structure. So carbon chip can work under high power condition.

## Applications of Diamond Chip

Diamond wafer technology is creating slenderer and less expensive gadgets as of now being used in data innovation, the military and aviation applications. Also, jewel semiconductor will majorly affect the purchaser gadgets, media communications and wellbeing businesses, among numerous others, beginning as ahead of schedule as 2015. Automakers are looking at utilizations of precious stone power gadgets in control modules for electric vehicles (Kusunoki et al, 2008).

Jewel semiconductors can likewise help better oversee battery life and battery frameworks for a wide assortment of gadgets including telephones, cameras and vehicles. For cloud PC servers, which are put away in server farms that devour immense measures of vitality in an exceedingly inefficient way, precious stone semiconductors utilize less vitality all the more effectively while conveying better execution (Kusunoki et al, 2008).

Since precious stone innovation shrivels the size and vitality required for a semiconductor, it makes ready for littler individual hardware from washers and dryers to TVs and advanced cameras. With respect to barrier innovation, it conveys more prominent range, dependability, and execution in both typical and outrageous/perilous working conditions. Jewel semiconductors lead to a more prominent range and vitality effectiveness in their applications. They help drive less expensive, quicker cloud coordination for shopper and business needs. They change the capacity of where and how to utilize our telephones, PCs and other individual electronic gadgets that still can't seem to be developed with the advantages broadening admirably past execution. Power gadgets, for example, jewel semiconductors speak to a colossal chance to decrease electronic waste and cut electronic chilling expenses off the middle (Celler, 2003).

### **Advantages of Diamond Chip over Silicon Chip**

1. It overcomes the disadvantages of silicon as bulky size, it is of small size
2. Diamond chip works at the higher temperature.
3. Diamond chip is faster than silicon chips.
4. Diamond chip provides larger power handling capacity.

#### **Disadvantages of Diamond Chip**

1. As expected, the diamond chip is costlier than the silicon chip.
2. Doping process is very hard to perform due to the diamond structure.

## Conclusion

Carbon is a bigger number of points of interest than Silicon. By utilizing carbon as the assembling material, we can accomplish littler, quicker and more grounded chips. In this way jewel chip replaces the need of silicon in each viewpoint in future age. As the examination proceeds with it uncovers its conceivable application in the fields of science, military, business use and designing. The present paper leads an overview on precious stone chip and its potential applications in not so distant future.

**Recommendations**

This paper recommends that this technology haven reviewed its importance and application be put to effective use so as to derive the benefits it offers.

It is also recommended that they should be more research and discovery in developing carbon chips. The size of the carbon is less than that of silicon, so we can print such a small line through the Diamond structural Carbon. So that we can make smaller dimensional chips.

# References

Celler, S. (2003). Cristoloveanu, *Frontiers of silicon-on-insulator*, *J. Appl. Phys.* 93(1), 112-127.

Chen, C., Lin, L. & Wang, M. (2012). Field emission from aligned carbon nanofibers grown in situ by hot filament chemical vapor deposition*, Appl. Phys. Lett.,* 82(1), 2-15.

Francis, F., Faili, D., Babic, F., Ejeckam, A. & Nurmikko, H. (2009). *Formation and characterization of 4-inch GaN-on-diamond substrates*, *Diamond Relat. Mater.*, article in press.

Jorg, D. (2002). Diamond chip technology, *International Journal of Science and Technology,* 1(1), 22-34.

Kaushtubh, J. Devesh, S. & Pravin, A. (2015). Diamond Chips, *International Journal of Innovative and Emerging Research in Engineering,* 2(3), 41-53.

Kusunoki, J., Shibata, M., Rokkaku, U. & Hirayama, T. (2008). Aligned Carbon Nanotube Film Self-Organized on a SiC Wafer,” *Jpn. J. Appl. Phys.* 37(1), 52-67.

Mazellier, O., Faynot, S., Cristoloveanu, S., Deleonibus, P. & Bergonzo, O. (2008). Integration of diamond in fully-depleted silicon-on-insulator technology as buried insulator: A theoretical analysis, *Journal of Diamond Related Materials,* 17(1), 12-48.

Raleva, D., Vasileska, S. & Goodnick, M. (2008). Is SOD technology the solution to heating problems in SOI devices? *IEEE Trans. Electron Devices* 29(1)**,** 6-21.