APPTRONICS review

Volume 2, Issue 9, 2009 Dec.

From the HoD's desk

Dear Reader,

"What is the scope of Applied Electronics and Instrumentation?" This is a question very often asked by many.

To begin answering this question let me point out that the potential for the *application of electronics* to improve human living conditions on earth is limited only by human imagination. To learn all about such applications is a task not achievable within a life time. To be more realistic we have marked our boundaries in this limitless space.

The area of study for Applied Electronics and Instrumentation engineers is focussed on applying electronics to observe, measure and control any phenomenon, process or environment. The title of our course is therefore named appropriately. Instrumentation is that branch of study that deals with measurement and control. There are a variety of phenomena which can be measured as physical quantities.

The primary focus of instrumentation engineering is the development and implementation of electrical and electronic instruments for the purpose of measuring, monitoring, and recording physical phenomena. Electronic instruments include analogue, digital, and mixed signal devices. These instruments are used for automation of various processes, which depend on these devices for measurements, control, safety, improvement of productivity and reliability.

Modern industrial processes are complex with numerous interacting systems. Automation is achieved by programmable devices such as PLCs, SCADAs, Distributed Control Systems which permits greater flexibility in design, development and use of such complex systems.

Electronics and Instrumentation Engineers work in a wide variety of areas some of which are Aerospace, Chemical and Petroleum, Food and Pharmaceuticals, Mining and Metal, Paper and Pulp, Transportation, Automobiles, Power, Robotics, Biomedical, Telemetry, and many more.

Today *Smart Sensor*s acquire data as well as report it in a form so that analysis is fast and direct. Powerful new *Wireless technologies* enable easier installation and maintenance of field devices. *Embedded intelligence* is providing improved networking, monitoring and real time control. *Machine to Machine* (*M2M*) *Communication* enables sharing of process and maintenance information between machines. Machines working in the same manufacturing line, synchronize their operations, eliminating wastage and unnecessary inventory pile-up.

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Introducing journals:

Introducing Journals: Advances in Space Research

This is the Official Journal of the Committee on Space Research (COSPAR), a Scientific Committee of the International Council for Science (ICSU).

This is an open journal covering all areas of space research including: space studies of the Earth's surface, meteorology, climate, the Earth-Moon system, planets and small bodies of the solar system, upper atmospheres, ionospheres and magnetospheres of the Earth and planets including reference atmospheres, space plasmas in the solar system, astrophysics from space, materials sciences in space, life sciences as related to space, fundamental physics in space, space debris, space weather, earth observations of space phenomena, etc.

All submissions are reviewed by two scientists in the field. It also includes COSPAR's Information Bulletin, Space Research Today (SRT) which provides COSPAR Associates and subscribers to Advances in Space Research with special guest articles on current topics in space research by practitioners in the field, regular information on meetings, COSPAR and space research-related news, information on COSPAR committees and activities, on scientific activities of interest, including launch lists, profiles of key personnel and letters from the community.

Space Research Today is issued three times each year, in April, August and December. The August issue in odd numbered years includes the Call for Papers for the Scientific Assembly of the following year. Thus, Space Research Today is a key tool in communication of information within the COSPAR community.

Abstract submission page at : http://www.cospar-assembly.org

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Thinking *SILLY!*

Why is forward biasing of a p-n junction called so?

The word forward means ‘in advance’[Chambers Dictionary]. When somebody says “the country is moving forward”, what he means is that the country is progressing. That is what we expect, what we want. When something happens as we expect we can describe it is as forward.

Take the case of a simple circuit as shown in figure 1. Direction of current is as shown. We know that this current obeys Ohm’s law. The case is so familiar to us to have generated a mind set in all of us to expect current direction to be so [from ‘plus’ of supply to ‘minus’ of supply] in any case.

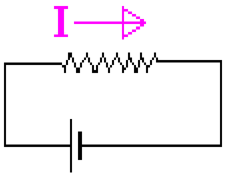


Fig. 1

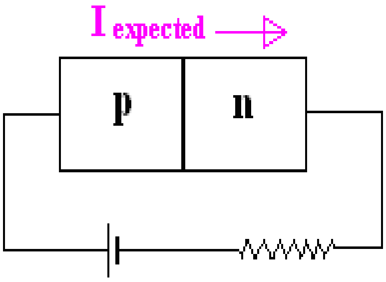


Fig. 2

With this mindset we approach the case of biasing of p-n junction; see figure 2. When we connect supply positive to the p-end and supply negative to the n-end [Don’t worry about the resistance in series included for limiting the current], we expect the current to be again in the direction shown, from positive to negative. As the current direction is as expected we say it is forward. [*Out of context:* Current internal to the diode does not follow Ohm’s law, it is diffusion current.]

You may comment that when we connect the supply in opposite direction also, the current direction is as expected [positive to negative]; then why not call this also forward? But then, you will immediately admit that the magnitude of this current is no way comparable to the current you get with supply positive connected to p, and can easily be neglected. In other words, you may say that instead of current in the expected direction, it has turned the other way about. This description is well represented by the usage of reverse biasing.

Is it not a case of silly thinking?

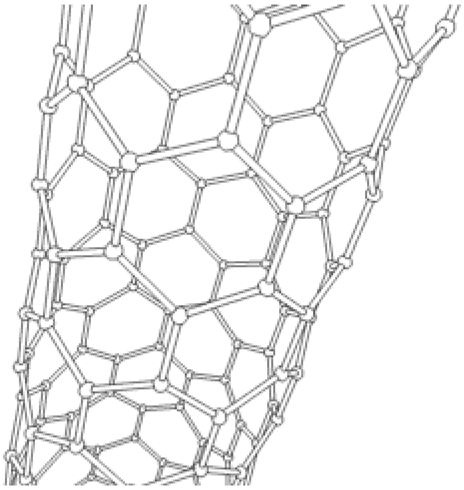
[Readers are requested to forward questions which could make me think silly. - PRM]

Carbon nanotubes

In this modern era of miniaturization, the development of devices that are small, light, self-contained and that will replace larger microelectronic equipment is one of the goals of the nanotechnology revolution. Nanotechnology has application in many fields, including medicine, technology, computers, weapons, etc. One of the most promising things about it in the near future is carbon nanotubes. Using nanotech, they can create materials out of these nanotubes that are 100 times stronger than steel and 10 times lighter. Advances in understanding carbon nanotubes have a major impact on the whole field of nanotechnology. Carbon nanotubes have found their applications in fabricating tear-resistant textiles, in concrete to increase the tensile strength and to halt crack propagation, ultra capacitors for storing large amount of electric charge, reinforcing structural materials in buildings, cars and airplanes etc.

Carbon nanotubes are allotropes of carbon with a cylindrical nanostructure. An ideal nanotube can be thought of as a hexagonal network of carbon atoms that has been rolled up to make a cylinder. The cylinder can be tens of microns long, and each end is “capped” with half of a fullerene molecule. Since each unit cell of a nanotube contains a number of hexagons, each of which contains two carbon atoms, the unit cell of a nanotube contains many carbon atoms. If the unit cell of a nanotube is N times larger than that of a hexagon, the unit cell of the nanotube in reciprocal space is $1/N$ times smaller than that of a single hexagon. The chemical bonding of nanotubes is composed entirely of $sp2$ bonds, similar to those of graphite. This bonding structure, which is stronger than the $sp3$ bonds found in diamonds, provides the molecules with their unique strength.

Nanotubes are categorized as single-walled nanotubes (SWNTs) and multi-walled nanotubes (MWNTs). Single-wall nanotubes can be thought of as the fundamental cylindrical structure, and these form the building blocks of multi-wall nanotubes. The ordered arrays of single-wall nanotubes are called ropes. Single-walled nanotubes consist of a single thick layer of graphite which is rolled in the form of a cylinder. One-atom-thick layer of graphite is called graphene.The arrangement of graphene is represented by a pair of indices (n, m) called the chiral vector. The integer’s n and m denote the number of unit vectors along two directions in the crystal lattice of graphene. If $m = 0$, the nanotubes are called “zigzag”. If $n = m$, the nanotubes are called “armchair”. Otherwise, they are called “chiral”. Most single-walled nanotubes (SWNT) have a diameter of 1 nanometer, with a tube length that can be many millions of times longer.Multi-walled nanotubes (MWNT) consist of multiple rolled layers (concentric tubes) of graphite and are constructed of multiple



cylinders, one inside the other. The simplest form of multi-walled nanotubes is double-walled nanotubes whose properties are similar to SWNT but their resistance to chemicals is significantly improved. Multi-wall carbon nanotubes do not need a catalyst for growth but single-wall nanotubes can only be grown with a catalyst. Single-wall carbon nanotubes are also expected to be very strong and to resist fracture under extension. Single-wall nanotubes are remarkably flexible. They can be twisted, flattened and bent into small circles or around sharp bends without breaking, and severe distortions to the cross-section of nanotubes do not cause them to break. In many cases the nanotube should regain its original shape when the stresses distorting it are removed.

How to make nanotubes

A relatively efficient way to produce bundles of ordered single-wall nanotubes was found in 1996. These ordered nanotubes are prepared by the laser vaporization of a carbon target in a furnace at 1200 °C. A cobalt-nickel catalyst helps the growth of the nanotubes, because it prevents the ends from being capped during synthesis, and about 70-90% of the carbon target can be converted to single-wall nanotubes. By using two laser pulses 50 ns apart, growth conditions can be maintained over a larger volume and for a longer time. This scheme provides more uniform vaporization and better control of the growth conditions. Flowing argon gas sweeps the nanotubes from the furnace to a water-cooled copper collector just outside of the furnace.

The most commonly used method for synthesizing carbon nanotubes is arc discharge method. In this method, the cathode used is a movable graphite rod. The anode includes a cylinder pressed from a mixture of evenly dispersed graphite powder, catalyst metal, and growth promoter. The atmosphere is selected from the group consisting of pure hydrogen and a mixture of at least 80% hydrogen and 20% argon by volume. The catalyst metal includes at least two metals selected from the group consisting of Fe, Co, Ni, and Y. The anode and the cathode are perpendicular to each other. Inducing an electric arc across the anode and cathode to thereby consume the anode and produce the single-walled carbon nanotube product.

Applications

Many of the applications now being considered involve multi-wall nanotubes than single-wall nanotubes. It has also been suggested that carbon nanotubes could be used in displays or for the tips of electron probes. Other applications could result from the fact that carbon nanotubes can retain relatively high gas pressures within their hollow cores. Carbon nanotubes could act as a template for synthesizing new carbides structured on the nanoscale. Structures based on carbon nanotubes offer exciting possibilities for nanometre-scale electronic applications. Carbon nanotubes could be combined with a host polymer to tailor their physical properties to specific applications. Since carbon nanotubes are so small, they could be used in polymer composites that could be formed into specific shapes, or in a low-viscosity composite that could be sprayed onto a surface as a conducting paint or coating. In the future, nanotubes may replace silicon in electronic circuits, and prototypes of elementary components have been developed. Carbon nanotubes may eventually replace the standard silicon computer chip, allowing increased performance in a smaller size. Nanotubes are also expected to be used in the construction of sensors and display screens.

- Aparna George

Your views Please:

We are thinking of changing the name of this journal redefining its scope.

Proposed Name: BIRDS Eye view.

Scope: We plan to start this year a registered forum of engineers and practicing physicians. This forum will discuss about potential research areas related to bio medical instruments, and take up research and development of new instruments. Details on its working are yet to be finalized.

This journal is proposed to be developed into an attractive lead journal presenting the activities of the forum. The forum is to be named Biomedical Instruments Research and Development Society (BIRDS).

Your Comments/Views please.

Tutorial 2: LABVIEW: For-loop and While-loop

You can use the *For Loop* and the *While Loop* to control repetitive operations.

For Loops

A *For Loop* executes a subdiagram a set number of times. Figure 1 shows a *For Loop* in LabVIEW.

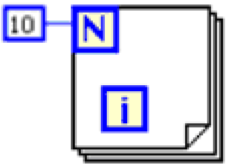


Figure 1 For Loop

The value in the count terminal (an input terminal), shown in Figure 2, indicates how many times to repeat the subdiagram.

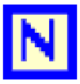


Figure 2
Count terminal

You can set the count explicitly by wiring a value from outside the loop to the left or top side of the count terminal as shown in Figure 1.

The iteration terminal (an output terminal), shown in Figure 3, contains the number of completed iterations. The iteration count always starts at zero. During the first iteration, the iteration terminal returns **0**.

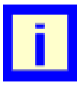


Figure 3
Iteration terminal

Both the count and iteration terminals are 32-bit signed integers. If you wire a floating-point number to the count terminal, LabVIEW rounds it and coerces it to within range. If you wire 0 or a negative number to the count terminal, the loop does not execute and the outputs contain the default data for that data type.
We'll deal with integers and floating point numbers in the next issue.

While Loops

Just like a *Repeat-Until Loop* in text-based programming languages, a *While Loop*, shown in Figure 4, executes a subdiagram until a condition is met.

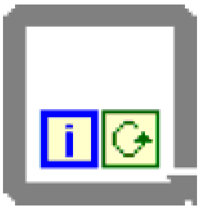


Figure 4 While Loop

The *While Loop* executes the subdiagram until the conditional terminal, an input terminal, receives a specific Boolean value. The default behavior and appearance of the conditional terminal is **Stop if True**, shown in Figure 5.

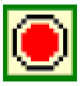


Figure 5

When a conditional terminal is **Stop if True**, the *While Loop* executes its subdiagram until the conditional terminal receives a TRUE value.

You can change the behavior and appearance of the conditional terminal by right-clicking the terminal or the border of the *While Loop* and selecting **Continue if True**, shown in Figure 6, from the shortcut menu. When a conditional terminal is **Continue if True**, the *While Loop* executes its subdiagram until the conditional terminal receives a FALSE value.

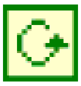


Figure 6
Appearance of the conditional terminal
if it is set as **Continue if True.**

The iteration terminal (an output terminal), shown in Figure 7, contains the number of completed iterations.

The iteration count always starts at zero. During the first iteration, the iteration terminal returns **0**.

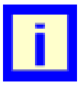
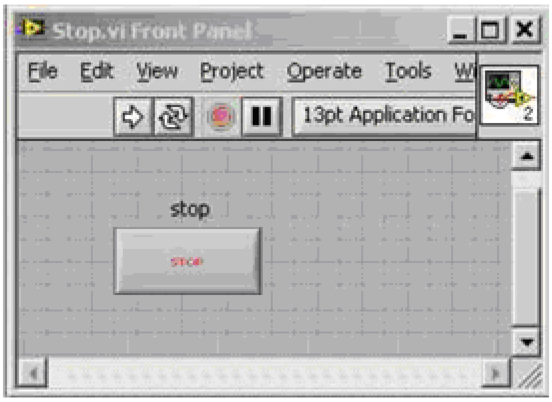
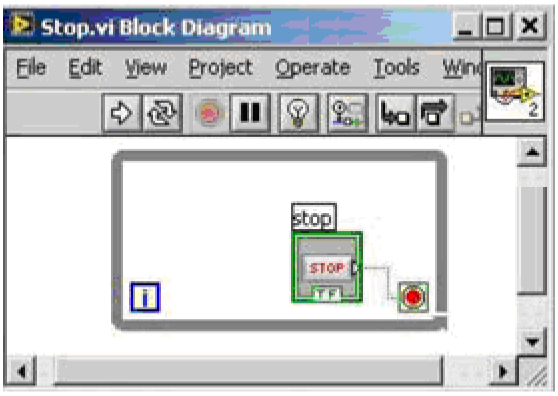


Figure 7
Iteration terminal

Note: The While Loop always executes at least once.

As you know *while loops* run until some condition is met. Something like this: *"loop while the stop button has not been pushed."* Put a Boolean control on your panel. Use a ***stop button***, but any Boolean control will work.
Set up a *while loop* as indicated below. Save as ***Stop.VI***. Press the run button in the taskbar and then stop using your stop button, ***not*** the LabVIEW stop sign icon (abort execution).





CPU Time

Hit the run button and then Ctrl+Alt+Del and look at the Task Manager and then Performance. What percentage of the CPU time is being used? Ouch. Now add a delay of 50 ms to your loop and repeat. This can be done by placing the '**Wait Until Next ms Multiple**' function, located on the Functions ----> All Functions ----> Time & Dialog palette, on the block diagram. Right click the input and input and select Create ---> Constant from the shortcut menu. Enter a value of 50 to set the wait to every 50 ms. What percentage of the CPU time is in use now?

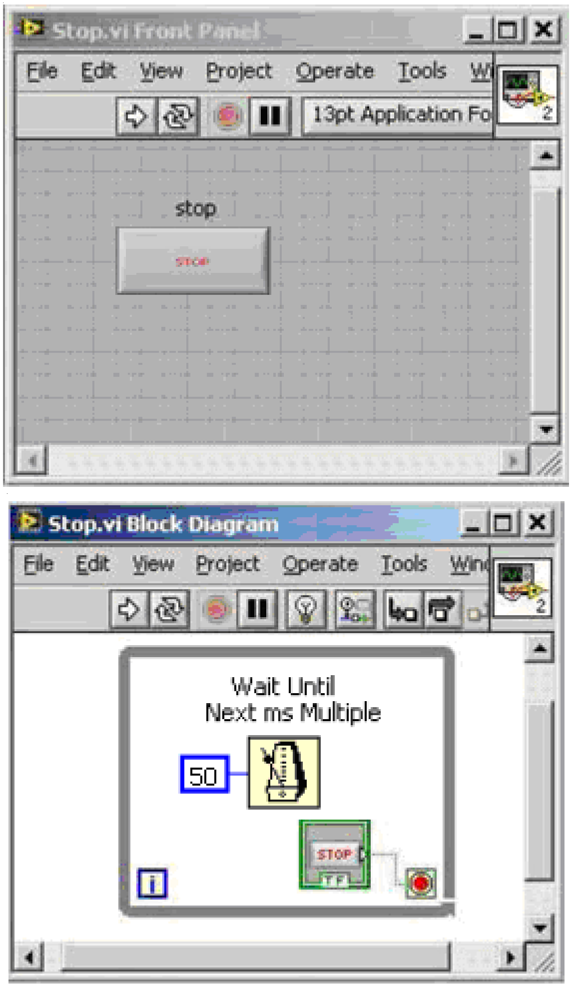


Figure 9

A simple LabVIEW program using While Loop and Wait Until Next ms Multiple

Whenever you use a loop to wait for user input make sure you include a short delay. The user won't notice a delay of 50 ms

- Allen Joseph

continued from page1.............

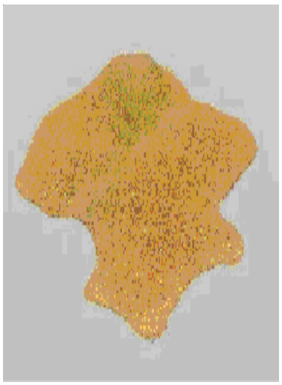
Web-enabled servers embedded in many industrial controllers and communication devices make real time information available, about production processes and plant operations in the board rooms located at the other side of the globe.

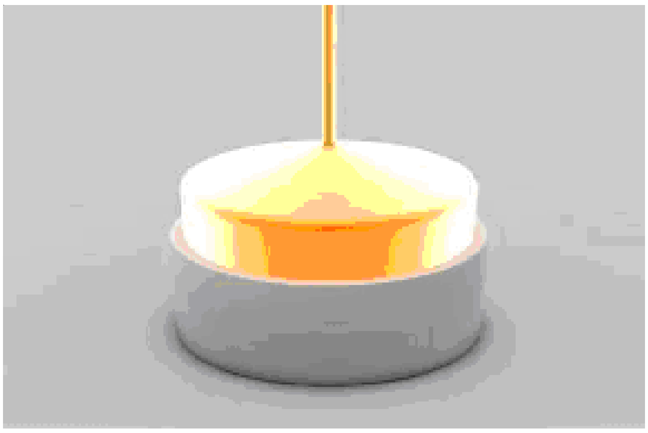
The size of modern electronics devices is reducing to nano-scale very fast. *Nano electronics* is going to change the way we humans will look upon ourselves. The possibilities in this area is mind boggling.

The frontiers of our field of study is ever expanding. The scope of Applied Electronics and Instrumentation is thus limited only by as far you can imagine.

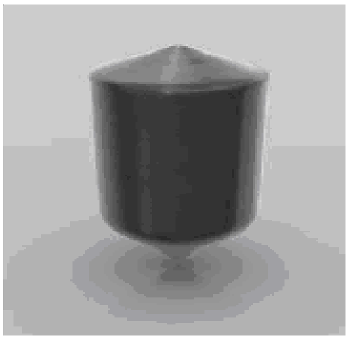
How a processor is made?

Sand - Made up of 25 percent silicon, is, after oxygen, the second most abundant chemical element that's in the earth's crust. Sand, especially quartz, has high percentages of silicon in the form of silicon dioxide (SiO_2) and is the base ingredient for semiconductor manufacturing.



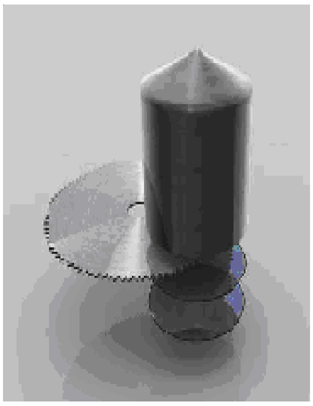


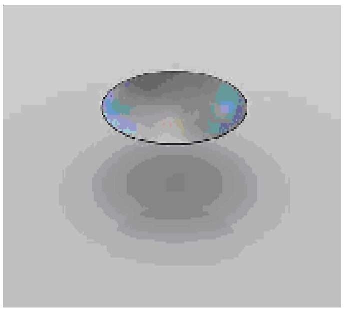
After procuring raw sand and separating the silicon, the excess material is disposed of and the silicon is purified in multiple steps to finally reach semiconductor manufacturing quality which is called electronic grade silicon. The resulting purity is so great that electronic grade silicon may only have one alien atom for every one billion silicon atoms. After the purification process, the silicon enters the melting phase. In this picture you can see how one big crystal is grown from the purified



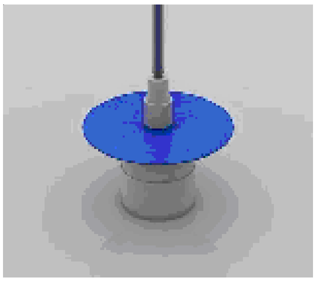
A mono-crystal ingot is produced from electronic grade silicon. One ingot weighs approximately 100 kilograms (or 220 pounds) and has a silicon purity of 99.9999 percent.

The ingot is then moved onto the slicing phase where individual silicon discs, called wafers, are sliced thin. Some ingots can stand higher than five feet. Several different diameters of ingots exist depending on the required wafer size. Today, CPUs are commonly made on 300 mm wafers.

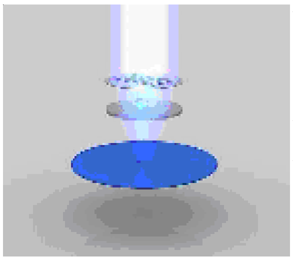




Once cut, the wafers are polished until they have flawless, mirror-smooth surfaces. Intel doesn't produce its own ingots and wafers, and instead purchases manufacturing-ready wafers from third-party companies. Intel's advanced 45 nm High-K/Metal Gate process uses wafers with a diameter of 300 mm (or 12-inches). When Intel first began making chips, it printed circuits on 50 mm (2-inches) wafers. These days, Intel uses 300 mm wafers, resulting in decreased costs per chip.

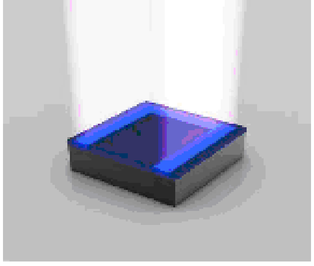


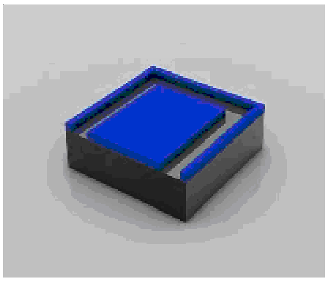
The blue liquid, depicted above, is a photo resist finish similar to those used in film for photography. The wafer spins during this step to allow an evenly-distributed coating that's smooth and also very thin.



At this stage, the photo-resistant finish is exposed to ultra violet (UV) light. The chemical reaction triggered by the UV light is similar to what happens to film material in a camera the moment you press the shutter button.

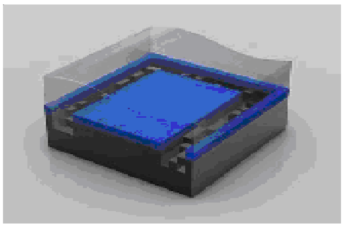
Areas of the resist on the wafer that have been exposed to UV light will become soluble. The exposure is done using masks that act like stencils. When used with UV light, masks create the various circuit patterns. The building of a CPU essentially repeats this process over and over until multiple layers are stacked on top of each other.A lens (middle) reduces the mask's image to a small focal point. The resulting "print" on the wafer is typically four times smaller, linearly, than the mask's pattern.



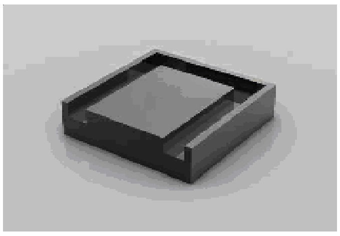


In the picture we have a representation of what a single transistor would appear like if we could see it with the naked eye. A transistor acts as a switch, controlling the flow of electrical current in a computer chip. Intel researchers have developed transistors so small that they claim roughly 30 million of them could fit on the head of a pin.

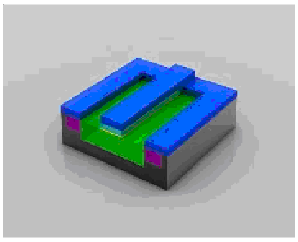
After being exposed to UV light, the exposed blue photo resist areas are completely dissolved by a solvent. This reveals a pattern of photo resist made by the mask. The beginnings of transistors, interconnects, and other electrical contacts begin to grow from this point.

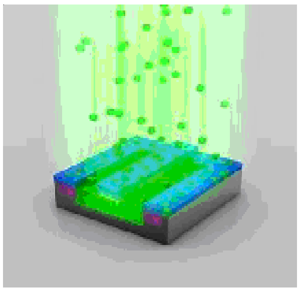


The photo resist layer protects wafer material that should not be etched away. Areas that were exposed will be etched away with chemicals.



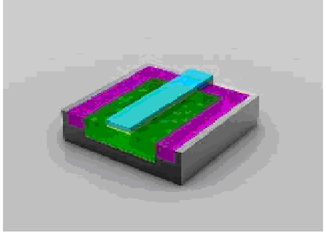
After the etching, the photo resist is removed and the desired shape becomes visible.



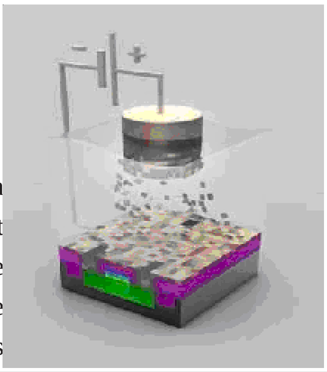


More photo resist is applied and then re-exposed to UV light. Exposed photo resist is then washed off again before the next step, which is called ion doping. This is the step where ion particles are exposed to the wafer, allowing the silicon to change its chemical properties in a way that allows the CPU to control the flow of electricity.

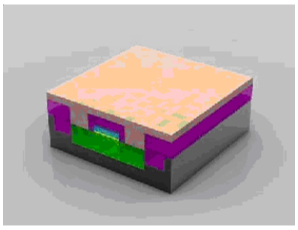
Through a process called ion implantation (one form of a process called doping) the exposed areas of the silicon wafer are bombarded with ions. Ions are implanted in the silicon wafer to alter the way silicon in these areas conduct electricity. Ions are propelled onto the surface of the wafer at very high velocities. An electrical field accelerates the ions to a speed of over 300,000 km/hour (roughly 185,000 mph)



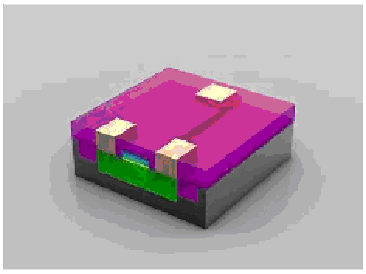
This transistor is close to being finished. Three holes have been etched into the insulation layer above the transistor. These three holes will be filled with copper, which will make up the connections to other transistors.



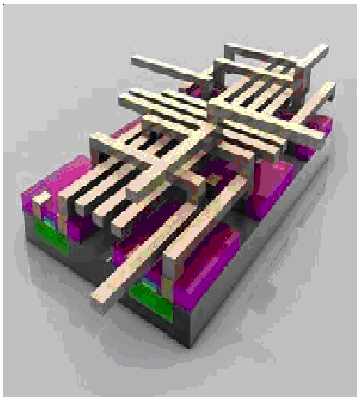
The wafers are put into a copper sulphate solution at this stage. Copper ions are deposited onto the transistor through a process called electroplating. The copper ions travel from the positive terminal (anode) to the negative terminal (cathode) which is represented by the wafer.



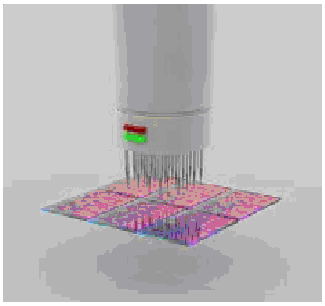
The copper ions settle as a thin layer on the wafer surface.



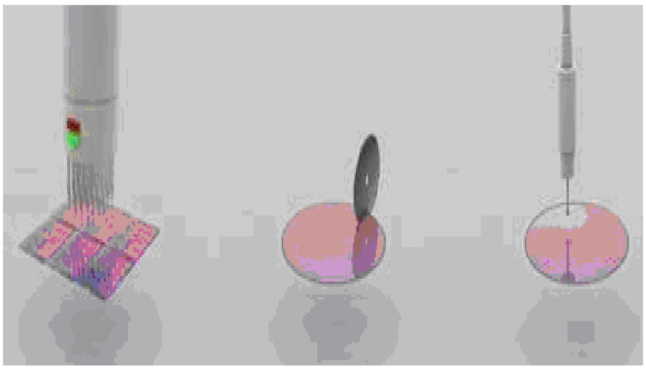
The excess material is polished off leaving a very thin layer of copper



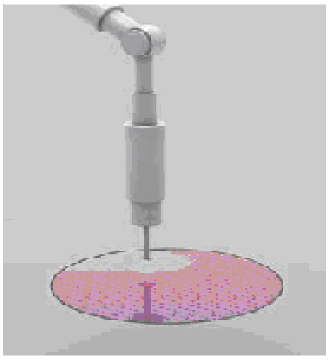
Multiple metal layers are created to interconnects (think wires) in between the various transistors. How these connections have to be "wired" is determined by the architecture and design teams that develop the functionality of the respective processor (for example, Intel's Core i7 processor). While computer chips look extremely flat, they may actually have over 20 layers to form complex circuitry. If you look at a magnified view of a chip, you will see an intricate network of circuit lines and transistors that look like a futuristic, multi-layered highway system.



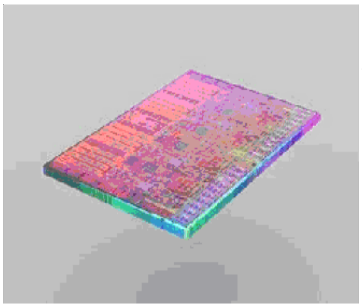
This fraction of a ready wafer is being put through a first functionality test. In this stage test patterns are fed into every single chip and the response from the chip monitored and compared to "the right answer."



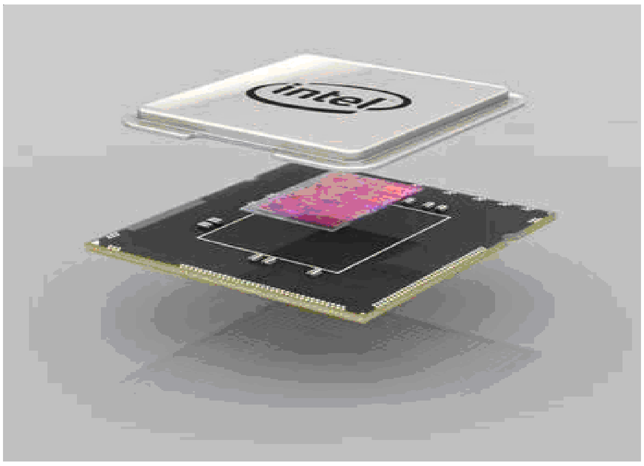
After tests determine that the wafer has a good yield of functioning processor units, the wafer is cut into pieces (called dies).



The dies that responded with the right answer to the test pattern will be put forward for the next step (packaging). Bad dies are discarded. Several years ago, Intel made key chains out of bad CPU dies.



This is an individual die, which has been cut out in the previous step (slicing). The die shown here is a die of an Intel Core i7 processor.



The substrate, the die, and the heatspreader are put together to form a completed processor. The green substrate builds the electrical and mechanical interface for the processor to interact with the rest of the PC system. The silver heatspreader is a thermal interface where a cooling solution will be applied. This will keep the processor cool during operation.

A microprocessor is the most complex manufactured product on earth. In fact, it takes hundreds of steps and only the most important ones have been visualized in this picture story. During this final test the processors will be tested for their key characteristics (among the tested characteristics are power dissipation and maximum frequency).

Based on the test result of class testing processors with the same capabilities are put into the same transporting trays. This process is called "binning". Binning determines the maximum operating frequency of a processor, and batches are divided and sold according to stable specifications.

- Karthikeyan K. B.

Lecturer, EEE

Students' Page ✓

Brain computer interface and neuroprosthetics

Brain computer interface

A brain–computer interface (BCI), sometimes called a direct neural interface or a brain–machine interface, is a direct communication pathway between brain and an external device. BCIs were aimed at assisting, augmenting or repairing human cognitive or sensory-motor functions. Research on BCIs began in the 1970s at the University of California Los Angeles (UCLA) under a grant from the National Science Foundation followed by a contract from DARPA. The field has since blossomed spectacularly, mostly toward neuroprosthetics applications that aim at restoring damaged hearing, sight and movement. Thanks to the remarkable cortical plasticity of the brain, signals from implanted prostheses can, after adaptation, be handled by the brain like natural sensor or effector channels. Following years of animal experimentation, the first neuroprosthetic devices implanted in humans appeared in the mid-nineties.

Neuro prosthetics

Neuroprosthetics (also called neural prosthetics) is a discipline related to neuroscience and biomedical engineering concerned with developing neural prostheses. Neural prostheses are a series of devices that can substitute a motor, sensory or cognitive modality that might have been damaged as a result of an injury or a disease. An example of such devices is Cochlear implants. The development of such devices has a profound impact on the quality of human life, and research in this field intends to resolve disabilities. The first cochlear implant dates back to 1957.

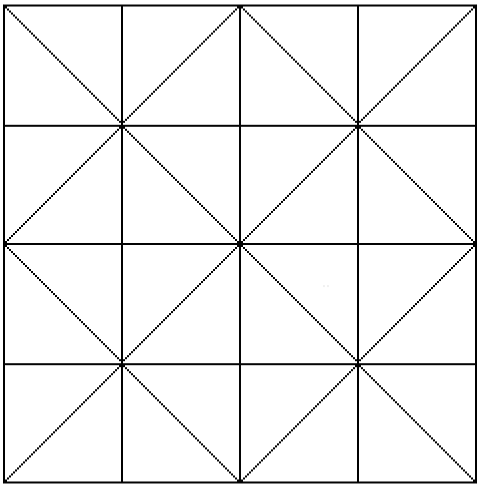
In order to achieve these devices there are many challenges. Any implanted device has to be very small in order to be to minimally invasive, especially in the brain, eye, cochlea. Also this implant would have to communicate with the outside world wirelessly. Having wires sticking out of the head, eye, etc is not an option. Besides the discomfort and restrictions it would impose on the subject this could lead to infection in the tissue. This bidirectional wireless communication requires a high bandwidth for real-time data transmission; this is a great challenge considering that this data link has to operate through the skin. The minimal size of the implant means no battery can be embedded in the implant, the implant works on wireless power transmission through the skin which is equally challenging as the data transmission. The tissue surrounding the implant is usually very sensitive to temperature rise so the implant must have very low power consumption in order to assure it won't harm the tissue. Another very important issue is the bio compatibility of the material that the implants are coated with. The more biocompatible these materials are, lesser the tissue reaction that they will cause, thus resulting in less implant risk and longer implant period. Gradually, as these devices become safer and our understanding of how the brain works is enhanced, the use of these devices will become more and more common and help people with severe disabilities live a normal life. The most widely used neuroprosthetic device is the cochlear implant. There are approximately 100,000 implanted devices in worldwide as of 2006 [update]. Today, the use of cochlear implants and pacemakers has become an indispensable fact of life. The future holds an exciting prospect for the everyday use of a variety of neural prostheses.

- Gavin Marcel Lewis

Try not to become a man of success, but try to become a man of values

- Albert Einstein

Curiosity Corner



Count the number of triangles in the square. See if there exists a relation of the series
0, 2, 8, 16, 32, ...
First correct answer will win a prize.
Answers can be mailed to meenav@rajagiritech.ac.in

Answer to the question in the previous issue.

Kleenex, Xerox, Kodak

For us, generally these are product names. But these are all company names.