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Pottapalayam -630612,Sivagangai District,Tamilnadu

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VISION

To become a high standard of excellence in Education, Training and Research in the field of Electrical and Electronics Engineering and allied applications

MISSION

To Produce excellent, innovative and Nationalistic Engineers with Ethical values and to advance in the field of Electrical and Electronics Engineering and Allied Areas

K.L.N. College of Engineering

Pottapalayam – 630 612, Sivagangai District,

Tamil Nadu, India

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MESSAGE FROM HEAD OF THE DEPARTMENT

In this issue articles on the most recent topics presented by the student Electrical vehicles are desired of the future economic of our country.

A Briefly note on this presented opportunity are very high on this field.

Some of the articles guide lines for technical paper written in presentation. Once work will be appreciated only when it is presented well. As the paper will be presented in the National/International forum, special care should be taking before publishing in the articles. The recent fire accident hospitals and temples required more precaution measure to be taken to safe guards. Our loved only and properties and document protected for long period of time. Examination reforms and challenges will definitely improve the confidence of the student.

Best Wishes

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DIGITAL INTEGRATED CIRCUITS

AMIRTHA S

202030

II YEAR /EEE

Digital ICs are the more common variety, mainly because of the vast number of digital devices (not just computers) that make use of these types of ICs. The transistors inside digital ICs are being used not as amplifiers, but as switches. This means that the heat dissipation for each transistor is very low, allowing digital ICs to be constructed using hundreds, thousands, and even millions of transistors. In addition, heat-dissipating components (resistors) can be designed out because substituting a transistor for a resistor is easy when both use the same techniques (and an IC transistor can be physically smaller than a resistor). Passive components are much less important in digital circuits than in analog circuits.

Definition

Digital ICs deal with pulse inputs and outputs and use switching actions with very low dissipation.

The simplest digital ICs carry out just one type of switching action, and they can perform the operations that are called **logic actions** (Chapter 10). The type of circuits that can be constructed using these ICs would typically be used as controllers for machines, using several inputs to decide whether an output should be on or off.

When should your washing machine start a cycle? Obviously, it is when the main switch is on, a program is selected, the drum contains some clothes, the water supply is switched on, and the main door is closed. The machine must not switch on unless all of these 'inputs' are present, and this action of providing an output only for some particular set of inputs is typical of the type of circuits we call **combinational**. We will come back to all that in Chapter 10. All of the first generation of digital ICs were intended to solve that type of problem, and these ICs are still in production more than 40 years on.

The next development was to make ICs that dealt with **sequential** actions, such as counting. These ICs required more transistors in each circuit, and as manufacturing methods improved designers found that they could produce not just the ICs that could be assembled into counters but the complete counters in IC form. At the same time, IC methods were being used to create displays, the LED and LCD displays that are so familiar now, so that all the components that were needed for a pocket calculator were being evolved together, and soon enough a complete calculator could be made using just one chip.

The pocket calculator story is a useful one to trace this part of the history of electronics. The first pocket calculators used several ICs, and they needed a considerable amount of assembly work. You could at that time buy DIY kits if you were curious to find out how the calculator was assembled, and such kits were also cheaper than a complete calculator. Nowadays, the calculator consists of just one IC, and there is practically no assembly. It costs more to assemble and package the components as a kit than to make and package the complete calculator, and costs are so low that the calculators can often be given away as a sales promotion.

Another thread of the story concerns the power required. The first pocket calculators needed four AA cells and gave about one month of use before these were exhausted. Power requirements have been so much reduced that some calculators are likely to be thrown away before the single cell that they use is exhausted, and it is possible to run calculators on the feeble power from a photocell (which converts light energy into electrical energy).

The early digital ICs were constructed using bipolar transistors, mainly because at the time these were easier to construct. The snag with bipolar transistors is that they need current inputs: no current flows between collector and emitter unless a current flows between base and emitter. The base current might be small, but some base current must exist, and so a bipolar transistor must inevitably dissipate more power than the MOSFET type, which needs no current between gate and source terminals.

Eventually, then, digital ICs started to be manufactured using MOSFET methods, and this allowed the number of transistors per IC to be dramatically increased. This packing of transistors was measured roughly by names that we use for **scale of integration**. This is described in terms of the number of simple logic circuits (**gates**) that can be packed into a chip, and the first ICs were small-scale integration (SSI) devices, meaning that they contained the equivalent of 3–30 logic circuits. The pace of development at that time (the 1960s) was very fast, so that the terms medium-scale integration (MSI) and large-scale integration (LSI) had to be introduced, corresponding to the ranges 30–300 and 300–3000 logic circuits, respectively.

This is a good example of how technology runs ahead of expectation. LSI soon became commonplace, and we had to start using very-large-scale integration (VLSI) for chips with more than 3000 gates per chip. Soon enough, chips containing 20,000 or more gates were being manufactured, but a new label, extra-large-scale integration (ELSI), was not introduced until more than one million gates could be put on a single chip. Scale-of-integration names are not normally used nowadays. Moore's law once predicted that the number of transistors that could be placed on an IC would double each year, dating from the start in 1958. Gordon Moore (founder of Intel) thought in 1965 that this trend would flatten after 10 years, but it holds true at the time of writing in 2010 and may continue as new ways of producing ICs are developed.

Summary

Digital ICs are classed in terms of the number of simple gate circuits that they replace on average. Modern chips are usually of the VLSI class, equivalent to 20,000 or more gates, and computer ICs are often in the ELSI class, equivalent to one million or more gate circuits.

3.6 Digital Integrated Circuits

Digital integrated circuits (Figs. 13 and 14) are the most frequently used semiconductor die in hybrid microcircuits. They consist of gates, flip-flops, counters, memory devices (random access memories and read-only memories), shift registers, multiplexers, gate arrays, and combinations of other digital devices. The major types are bipolar and metal oxide semiconductors.

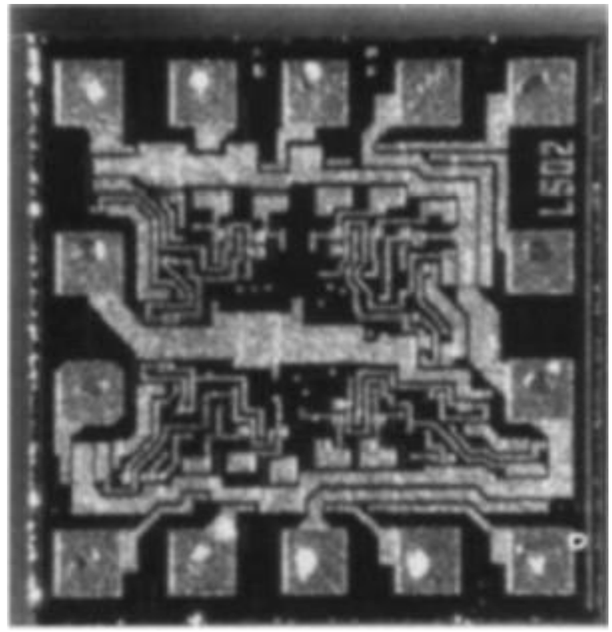

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Figure 13 . Digital gate die.

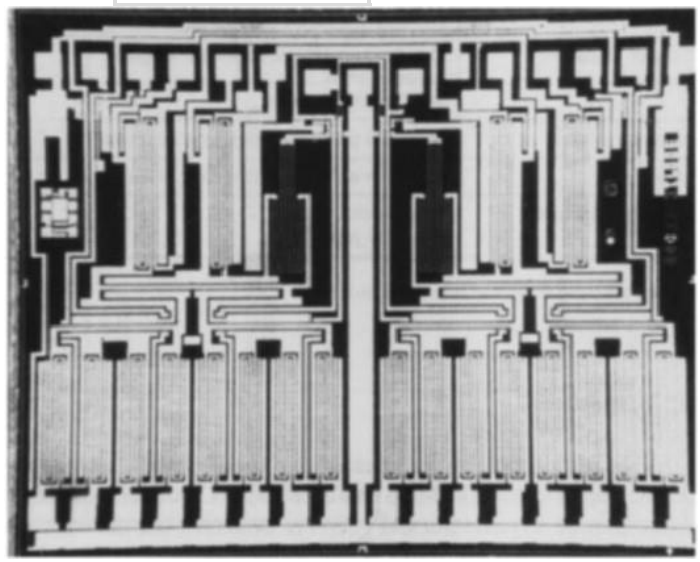

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Figure 14 . Multiplex integrated circuit die.

Bipolar devices are fabricated with npn and pnp transistors including: standard TTL (transistor-transistor logic), high-speed TTL, low-power Schottky TTL, emitter-coupled logic (ECL), small-scale integration (SSI), medium-scale integration (MSI), large-scale integration (LSI), and very high-speed integrated circuit (VHSIC).

Metal oxide semiconductors (MOS) are fabricated by p-channel and n-channel techniques. The two techniques are combined in Complementary MOS (CMOS).

HIGH ENERGY LASER WEAPON

T.NAVEEN KUMAR

212911

II YEAR / EEE

A **laser weapon**[2] is a directed-energy weapon based on lasers. After decades of R&D, as of January 2020 directed-energy weapons including lasers are still at the experimental stage and it remains to be seen if or when they will be deployed as practical, high-performance military weapons.[3][4] Atmospheric thermal blooming has been a major problem, still mostly unsolved, and worsened if fog, smoke, dust, rain, snow, smog, foam, or purposely dispersed obscurant chemicals are present. Essentially, a laser generates a beam of light which needs clear air, or a vacuum, to work[5] without thermal blooming.

Many types of laser can potentially be used as incapacitating weapons, through their ability to produce temporary or permanent vision loss when aimed at the eyes. The degree, character, and duration of vision impairment caused by eye exposure to laser light varies with the power of the laser, the wavelength(s), the collimation of the beam, the exact orientation of the beam, and the duration of exposure. Lasers of even a fraction of a watt in power can produce immediate, permanent vision loss under certain conditions, making such lasers potential non-lethal but incapacitating weapons. The extreme handicap that laser-induced blindness represents makes the use of lasers even as non-lethal weapons morally controversial, and weapons designed to cause permanent blindness have been banned by the Protocol on Blinding Laser Weapons.

Weapons designed to cause temporary blindness, known as dazzlers, are used by military and sometimes law enforcement organizations. Incidents of pilots being exposed to lasers while flying have prompted aviation authorities to implement special procedures to deal with such hazards.[6] See Lasers and aviation safety for more on this topic. Laser weapons capable of directly damaging or destroying a target in combat are still in the experimental stage. The general idea of laser-beam weaponry is to hit a target with a train of brief pulses of light. The power needed to project a high-powered laser beam of this kind is beyond the limit of current mobile power technology, thus favoring chemically powered gas dynamic lasers. Example experimental systems included MIRACL and the Tactical High Energy Laser, which are now discontinued. The United States Navy has tested the very short range (1 mile), 30-kWLaser Weapon System or LaWS to be used against targets like small UAVs, rocket-propelled grenades, and visible motorboat or helicopter engines.[7][8] It has been defined as "six welding lasers strapped together." A 60 kW system, HELIOS, is being developed for destroyer class ships as of 2020.

Electro laser

An electro laser first ionizes its target path, and then sends an electric current down the conducting track of ionized plasma, somewhat like lightning. It functions as a giant, high-energy, long-distance version of the Taser or stun gun

HOW DO HIGH-ENERGY LASERS WORK?

How do high-energy lasers work, anyway? At the simplest level, electrical power is used to generate a laser beam, getting rid of the waste heat from that process. You also need a system that knows where to point the laser beam and can hold it precisely on the target for long enough to kill it. Of course, this description oversimplifies what is a sophisticated series of steps.

It all starts with a radar somewhere – typically on the platform itself or in an adjacent platform – that sends a message to say: 'there is something out there that might be a threat.' The laser system slews and points in the direction of the threat. A camera looks at the threat, often providing a better, higher resolution picture than the radar could provide. The decision-maker then determines whether the object is a threat that must be engaged.

Once that decision is made, the beam control system engages sensors to ensure that the target is precisely tracked despite motion of both the platform and the target. Based on prior knowledge of the identified target, the most vulnerable point is selected – either manually or via automation. The beam control system ensures that the high energy laser continues to hit the same point on the target with high precision until the target is neutralized.

To further understand how the system works, it helps to look at the four subsystems that make up the HEL.

First, there is the power subsystem, which reconditions electrical power to whatever voltage is needed to drive the laser. The power can come from the platform that the laser is mounted on, such as a destroyer ship, or from lithium-ion batteries, like those in the Polaris MRZR ATV that was adapted.

Then there is the thermal subsystem. It removes the large amount of waste heat generated by the laser system and disposes of it in a way that doesn't degrade the performance of the laser.

The third subsystem is the laser beam itself, one of the most complicated parts of the whole system. In the first step, arrays of thousands of low power semiconductor diode lasers, each similar to a laser pointer, convert the electrical power into divergent beams of laser light. In the next step, each fiber laser acts as a brightness converter, efficiently converting the divergent diode light beams into highly directional fiber laser beams. A range of different techniques are used to efficiently combine the multiple beams from multiple fiber lasers into a single, high-power, low-divergence beam.

Two of the main beam-combining techniques are spectral and coherent beam combining. With coherent beam combining, sensors measure a distorted probe laser beam at, or near, the target, then use algorithms to provide phase corrections and compensate for the distortions. Matching phase corrections can then be applied to individual fiber laser beams comprising the high-energy laser beam, correcting for the distortions in that high-power laser beam.

Spectral beam combining provides a simpler technique for generating low to moderate power level laser beams (up to ~50 kW-class). But for higher power lasers in the presence of atmospheric distortion, a separate adaptive optics system is required, including components that are unproven for long term operation in field environments. Both techniques are still being developed and refined across the industry. RI&S believes that each solution has a mission set that is better-suited to address.

The fourth subsystem, beam control, serves a critical role: pointing the beam precisely at the chosen aim point on the target with sufficient intensity to neutralize it. Any jitter in the position of impact on the target is equivalent to a lower laser power that will take longer to kill the target.

TARGETING AND OPTICS

RI&S's high-energy laser weapon system uses a modified version of our Multi-Spectral Targeting System, or MTS, to hold the laser beam on a target with ultra-high precision. The MTS, an electro-optical and infrared sensor commonly seen on manned and unmanned aircraft, makes for a near-ideal effective beam control system. A highly integrated design philosophy makes our HEL system more robust, providing lower jitter than other beam control systems.

In addition to the four subsystems, future laser systems may also need adaptive optics. To understand adaptive optics, imagine being outside on a hot day. As you look at the horizon, the image becomes blurry or distorted. The same distortion effect happens to a laser beam as it moves towards its target – it becomes distorted and can start to break up. If you are close to the ground, dealing with threats at a similar altitude, adaptive optics becomes important. To solve this challenge, there are different adaptive optical techniques that can be used with the two, previously mentioned beam combining techniques.

There will be more challenges to overcome as lasers move to the field and towards volume manufacturing. Since the timing of a strong demand signal from the government has been uncertain, the defense industry hasn't yet invested in largescale manufacturing infrastructure for laser weapons. At RI&S, we are drawing on existing manufactured components as much as possible – leveraging our MTS production facility, as well as readily-available fiber lasers from established commercial manufacturers. In this way, we can lower the additional investment needed to reach volume production.

The next few years will help determine whether high-energy lasers become a staple of the battlefield. The upcoming field deployment, as well as further development of the technology, will provide important milestones in the future of laser weapon systems.

SMART SOUND TECHNOLOGY

K.BHARATHI DASAN

202902

III YEAR /EEE

Everybody has the experience of talking aloud in the cell phone in the midst of the disturbance while travelling in trains or buses. There is no need of shouting anymore for this purpose. ‘Silent sound technology’ is the answer for this problem.

The Silent sound technology is an amazing solution for those who had lost their voice but wish to speak over phone. It is developed at the Karlsruhe Institute of Technology and you can expect to see it in the near future. When demonstrated, it seems to detect every lip movement and internally converts the electrical pulses into sounds signals and sends them neglecting all other surrounding noise. It is definitely going to be a good solution for those feeling annoyed when other speak loud over phone.

‘Silent Sound’ technology aims to notice every movements of the lips and transform them into sounds, which could help people who lose voices to speak, and allow people to make silent calls without bothering others. Rather than making any sounds, your handset would decipher the movements your mouth makes by measuring muscle activity, then convert this into speech that the person on the other end of the call can hear. So, basically, it reads your lips. This new technology will be very helpful whenever a person looses his voice while speaking or allow people to make silent calls without disturbing others, even we can tell our PIN number to a trusted friend or relative without eavesdropping . At the other end, the listener can hear a clear voice. the awesome feature added to this technology is that "it is an instant polyglot" I.E, movements can be immediately transformed into the language of the user's choice. This translation works for languages like English, French & German. But, for the languages like Chinese, different tones can hold many different meanings. This poses Problem said Wand. he also said that in five or may be in ten years this will Be used in everyday's technology.

Methods

Silent Sound Technology is processed through some ways or methods. They are:

1. Electromyography (EMG)
2. Image Processing

Electromyography

- The Silent Sound Technology uses electromyography, monitoring tiny muscular movements that occur when we speak.
- Monitored signals are converted into electrical pulses that can then be turned into speech, without a sound uttered.
- Electromyography (EMG) is a technique for evaluating and recording the electrical activity produced by skeletal muscles.

- An electromyography detects the electrical potential generated by muscle cells, when these cells are electrically or neurologically activated.
- Electromyographic sensors attached to the face records the electric signals produced by the facial muscles, compare them with pre recorded signal pattern of spoken words
- When there is a match that sound is transmitted on to the other end of the line and person at the other end listen to the spoken words .

Image Processing

- The simplest form of digital image processing converts the digital data tape into a film image with minimal corrections and calibrations.
- Then large mainframe computers are employed for sophisticated interactive manipulation of the data.
- In the present context, overhead prospective are employed to analyze the picture.
- In electrical engineering and computer science, image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or, a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.

Application of Silent Sound Technology

It will help people who have lost their voice as a result of accident or cannot speak loudly again as result of old age

ii. It can be use a military for communication of secrete or sensitive information.

iii. It is applicable if you want to make a call in conference meeting or library without disturbing the others

iv. Speaker can speak his native language like German and listener can listen to it in his native language like English

v. It is applicable for those who want to make a call in nosily environment e.g. people working in train station, Movies Theater, market etc.

vi. As we know in space there is no medium for sound to travel therefore this technology can be best utilized by astronauts.

THE TRANSFER OF HEAT ENERGY

R.YUVA PRASATH

202908

III YEAR / EEE

The heat source for our planet is the sun. Energy from the sun is transferred through space and through the earth's atmosphere to the earth's surface. Since this energy warms the earth's surface and atmosphere, some of it is or becomes heat energy. There are three ways heat is transferred into and through the atmosphere:

- radiation
- conduction
- convection

Radiation

If you have stood in front of a fireplace or near a campfire, you have felt the heat transfer known as radiation. The side of your body nearest the fire warms, while your other side remains unaffected by the heat. Although you are surrounded by air, the air has nothing to do with this transfer of heat. Heat lamps, that keep food warm, work in the same way. Radiation is the transfer of heat energy through space by electromagnetic radiation.

Most of the electromagnetic radiation that comes to the earth from the sun is invisible. Only a small portion comes as visible light. Light is made of waves of different frequencies. The frequency is the number of instances that a repeated event occurs, over a set time. In electromagnetic radiation, its frequency is the number of electromagnetic waves moving past a point each second.

Our brains interpret these different frequencies into colors, including red, orange, yellow, green, blue, indigo, and violet. When the eye views all these different colors at the same time, it is interpreted as white. Waves from the sun which we cannot see are infrared, which have lower frequencies than red, and ultraviolet, which have higher frequencies than violet light. [more on electromagnetic radiation] It is infrared radiation that produce the warm feeling on our bodies.
Most of the solar radiation is absorbed by the atmosphere and much of what reaches the earth's surface is radiated back into the atmosphere to become heat energy. Dark colored objects, such as asphalt, absorb radiant energy faster than light colored objects. However, they also radiate their energy faster than lighter colored objects.

Learning Lesson: Melts in your bag, not in your hand

Conduction

Conduction is the transfer of heat energy from one substance to another or within a substance. Have you ever left a metal spoon in a pot of soup being heated on a stove? After a short time, the handle of the spoon will become hot.

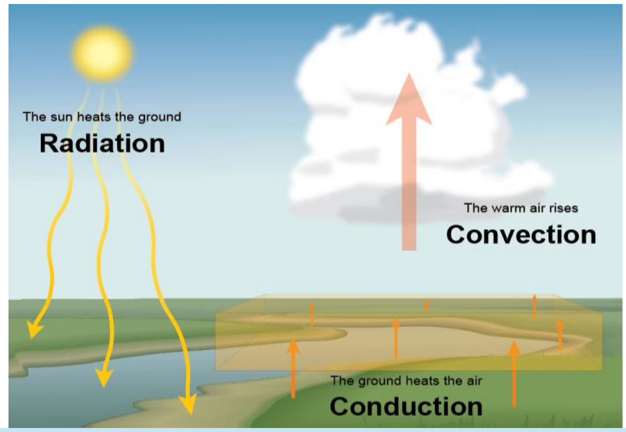
This is due to transfer of heat energy from molecule to molecule or from atom to atom. Also, when objects are welded together, the metal becomes hot (the orange-red glow) by the transfer of heat from an arc.

This is called conduction and is a very effective method of heat transfer in metals. However, air conducts heat poorly.

Convection

Convection is the transfer of heat energy in a fluid. This type of heating is most commonly seen in the kitchen with a boiling liquid.

Air in the atmosphere acts as a fluid. The sun's radiation strikes the ground, thus warming the rocks. As the rock's temperature rises due to conduction, heat energy is released into the atmosphere, forming a bubble of air which is warmer than the surrounding air. This bubble of air rises into the atmosphere. As it rises, the bubble cools with the heat contained in the bubble moving into the atmosphere.

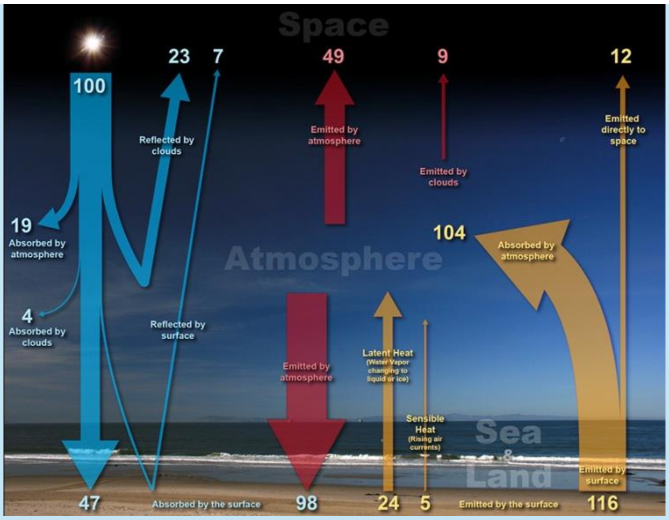


As the hot air mass rises, the air is replaced by the surrounding cooler, more dense air, what we feel as wind. These movements of air masses can be small in a certain region, such as local cumulus clouds, or large cycles in the troposphere, covering large sections of the earth. Convection currents are responsible for many weather patterns in the troposphere.

The earth-atmosphere energy balance is the balance between incoming energy from the Sun and outgoing energy from the Earth. Energy released from the Sun is emitted as shortwave light and ultraviolet energy. When it reaches the Earth, some is reflected back to space by clouds, some is absorbed by the atmosphere, and some is absorbed at the Earth's surface.

Learning Lesson: Canned Heat
However, since the Earth is much cooler than the Sun, its radiating energy is much weaker (long wavelength) infrared energy. We can indirectly see this energy radiate into the atmosphere as heat, rising from a hot road, creating shimmers on hot sunny days.

The earth-atmosphere energy balance is achieved as the energy received from the Sun *balances* the energy lost by the Earth back into space. In this way, the Earth maintains a stable average temperature and therefore a stable climate. Using 100 units of energy from the sun as a baseline the energy balance is as follows:



The Earth-Atmosphere Energy Balance

At the top of the atmosphere - Incoming energy from the sun balanced with outgoing energy from the earth.

Incoming energy		Outgoing energy	
Units	**Source**	**Units**	**Source**
+100	Shortwave radiation from the sun.	-23	Shortwave radiation reflected back to space by clouds.
		-7	Shortwave radiation reflected to space by the earth's surface.
		-49	Longwave radiation from the atmosphere into space.
		-9	Longwave radiation from clouds into space.
		-12	Longwave radiation from the earth's surface into space.
+100	Total Incoming	-100	Total Outgoing

The atmosphere itself - Energy into the atmosphere is balanced with outgoing energy from atmosphere.

Incoming energy		Outgoing energy	
Units	**Source**	**Units**	**Source**
+19	Absorbed shortwave radiation by gases in the atmosphere.	-9	Longwave radiation emitted to space by clouds.
+4	Absorbed shortwave radiation by clouds.	-49	Longwave radiation emitted to space by gases in atmosphere.
+104	Absorbed longwave radiation from earth's surface.	-98	Longwave radiation emitted to earth's surface by gases in atmosphere.
+5	From convective currents (rising air warms the atmosphere).		
+24	Condensation /Deposition of water vapor (heat is released into the atmosphere by process).		

The atmosphere itself - Energy into the atmosphere is balanced with outgoing energy from atmosphere.			
Incoming energy		**Outgoing energy**	
Units	**Source**	**Units**	**Source**
+156	Total Incoming	-156	Total Outgoing

At the earth's surface - Energy absorbed is balanced with the energy released.			
Incoming energy		**Outgoing energy**	
Units	**Source**	**Units**	**Source**
+47	Absorbed shortwave radiation from the sun.	-116	Longwave radiation emitted by the surface.
+98	Absorbed longwave radiation from gases in atmosphere.	-5	Removal of heat by convection (rising warm air).
		-24	Heat required by the processes of evaporation and sublimation and therefore removed from the surface.
+145	Total Incoming	-145	Total Outgoing

The absorption of infrared radiation trying to escape from the Earth back to space is particularly important to the global energy balance. Energy absorption by the atmosphere stores more energy near its surface than it would if there was no atmosphere.

The average surface temperature of the moon, which has no atmosphere, is 0°F (-18°C). By contrast, the average surface temperature of the Earth is 59°F (15°C). This heating effect is called the greenhouse effect.

SOLAR CELL IN FILM TECHNOLOGY

AKASH A S

182026

IV YEAR / EEE

Thin-film solar cells, a second generation of photovoltaic (PV) solar cells:

- Top: thin-film silicon laminates being installed onto a roof.
- Middle: CIGS solar cell on a flexible plastic backing and rigid CdTe panels mounted on a supporting structure
- Bottom: thin-film laminates on rooftops

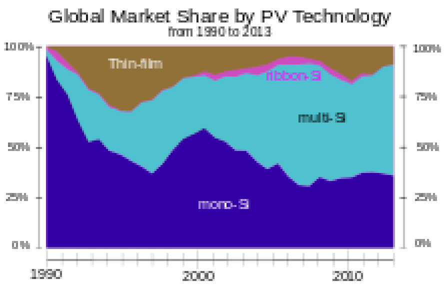
A **thin-film solar cell** is a second generation solar cell that is made by depositing one or more thin layers, or thin film (TF) of photovoltaic material on a substrate, such as glass, plastic or metal. Thin-film solar cells are commercially used in several technologies, including cadmium telluride (CdTe), copper indium gallium diselenide (CIGS), and amorphous thin-film silicon (a-Si, TF-Si).

Film thickness varies from a few nanometers (nm) to tens of micrometers (µm), much thinner than thin-film's rival technology, the conventional, first-generation crystalline silicon solar cell (c-Si), that uses wafers of up to 200 µm thick. This allows thin film cells to be flexible, and lower in weight. It is used in building-integrated photovoltaics and as semi-transparent, photovoltaic glazing material that can be laminated onto windows. Other commercial applications use rigid thin film solar panels (interleaved between two panes of glass) in some of the world's largest photovoltaic power stations.

Thin-film technology has always been cheaper but less efficient than conventional c-Si technology. However, it has significantly improved over the years. The lab cell efficiency for CdTe and CIGS is now[*when?*] beyond 21 percent, outperforming multicrystalline silicon, the dominant material currently used in most solar PV systems.Accelerated life testing of thin film modules under laboratory conditions measured a somewhat faster degradation compared to conventional PV, while a lifetime of 20 years or more is generally expected.Despite these enhancements, the market-share of thin-film never reached more than 20 percent in the last two decades and has been declining in recent years to about 9 percent of worldwide photovoltaic installations in 2013.

Other thin-film technologies that are still in an early stage of ongoing research or with limited commercial availability are often classified as emerging or third generation photovoltaic cells and include organic, dye-sensitized, as well as quantum dot, copper zinc tin sulfide, nanocrystal, micromorph, and perovskite solar cells.

History



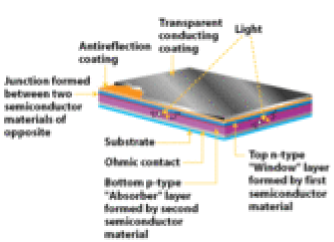
Market-share of thin-film technologies in terms of annual production since 1990

Thin film cells are well-known since the late 1970s, when solar calculators powered by a small strip of amorphous silicon appeared on the market.

They are now available in very large modules used in sophisticated building-integrated installations and vehicle charging systems.

Although thin-film technology was expected to make significant advances in the market and to surpass the dominating conventional crystalline silicon (c-Si) technology in the long-term,market-share has been declining for several years now. While in 2010, when there was a shortage of conventional PV modules, thin-film accounted for 15 percent of the overall market, it declined to 8 percent in 2014, and is expected to stabilize at 7 percent from 2015 onward, with amorphous silicon expected to lose half of its market-share by the end of the decade.

Material



Cross-section of a TF cell

Thin-film technologies reduce the amount of active material in a cell. Most sandwich active material between two panes of glass. Since silicon solar panels only use one pane of glass, thin film panels are approximately twice as heavy as crystalline silicon panels, although they have a smaller ecological impact (determined from life cycle analysis).[5] The majority of film panels have 2-3 percentage points lower conversion efficiencies than crystalline silicon.[6] Cadmium telluride (CdTe), copper indium gallium selenide (CIGS) and amorphous silicon (a-Si) are three thin-film technologies often used for outdoor applications.

Cadmium telluride

Main article: Cadmium telluride photovoltaics

Cadmium telluride (CdTe) is the predominant thin film technology. With about 5 percent of worldwide PV production, it accounts for more than half of the thin film market. The cell's lab efficiency has also increased significantly in recent years and is on a par with CIGS thin film and close to the efficiency of multi-crystalline silicon as of 2013.Also, CdTe has the lowest Energy payback time of all mass-produced PV technologies, and can be as short as eight months in favorable locations. A prominent manufacturer is the US-company First Solar based in Tempe, Arizona, that produces CdTe-panels with an efficiency of about 18 percent.

Although the toxicity of cadmium may not be that much of an issue and environmental concerns completely resolved with the recycling of CdTe modules at the end of their life time,there are still uncertainties and the public opinion is skeptical towards this technology.The usage of rare materials may also become a limiting factor to the industrial scalability of CdTe thin film technology. The rarity of tellurium—of which telluride is the anionic form—is comparable to that of platinum in the earth's crust and contributes significantly to the module's cost.

Copper indium gallium selenide

A copper indium gallium selenide solar cell or CIGS cell uses an absorber made of copper, indium, gallium, selenide (CIGS), while gallium-free variants of the semiconductor material are abbreviated CIS. It is one of three mainstream thin-film technologies, the other two being cadmium telluride and amorphous silicon, with a lab-efficiency above 20 percent and a share of 2 percent in the overall PV market in 2013.[13] A prominent manufacturer of cylindrical CIGS-panels was the now-bankrupt company Solyndra in Fremont, California. Traditional methods of fabrication involve vacuum processes including co-evaporation and sputtering. In 2008, IBM and Tokyo Ohka Kogyo Co., Ltd. (TOK) announced they had developed a new, non-vacuum, solution-based manufacturing process for CIGS cells and are aiming for efficiencies of 15% and beyond.[14]

Hyperspectral imaging has been used to characterize these cells. Researchers from IRDEP (Institute of Research and Development in Photovoltaic Energy) in collaboration with Photon etc.¸ were able to determine the splitting of the quasi-Fermi level with photoluminescence mapping while the electroluminescence data were used to derive the external quantum efficiency (EQE).[15][16] Also, through a light beam induced current (LBIC) cartography experiment, the EQE of a microcrystalline CIGS solar cell could be determined at any point in the field of view.

As of April 2019, current conversion efficiency record for a laboratory CIGS cell stands at 22.9%.[18]

Silicon

Three major silicon-based module designs dominate:

- amorphous silicon cells
- amorphous / microcrystalline tandem cells (micromorph)
- thin-film polycrystalline silicon on glass.[19]

Amorphous silicon

Main article: Amorphous silicon

United Solar Ovonic roll-to-roll solar photovoltaic production line with 30 MW annual capacity

Amorphous silicon (a-Si) is a non-crystalline, allotropic form of silicon and the most well-developed thin film technology to-date. Thin-film silicon is an alternative to conventional *wafer* (or *bulk*) crystalline silicon. While chalcogenide-based CdTe and CIS thin films cells have been developed in the lab with great success, there is still industry interest in silicon-based thin film cells. Silicon-based devices exhibit fewer problems than their CdTe and CIS counterparts such as toxicity and humidity issues with CdTe cells and low manufacturing yields of CIS due to material complexity. Additionally, due to political resistance to the use non-"green" materials in solar energy production, there is no stigma in the use of standard silicon.

Aerospace product with flexible thin-film solar PV from United Solar Ovonic

This type of thin-film cell is mostly fabricated by a technique called plasma-enhanced chemical vapor deposition. It uses a gaseous mixture of silane (SiH_4) and hydrogen to deposit a very thin layer of only 1 micrometre (µm) of silicon on a substrate, such as glass, plastic or metal, that has already been coated with a layer of transparent conducting oxide. Other methods used to deposit amorphous silicon on a substrate include sputtering and hot wire chemical vapor deposition techniques.

a-Si is attractive as a solar cell material because it's an abundant, non-toxic material. It requires a low processing temperature and enables a scalable production upon a flexible, low-cost substrate with little silicon material required. Due to its bandgap of 1.7 eV, amorphous silicon also absorbs a very broad range of the light spectrum, that includes infrared and even some ultraviolet and performs very well at weak light. This allows the cell to generate power in the early morning, or late afternoon and on cloudy and rainy days, contrary to crystalline silicon cells, that are significantly less efficient when exposed at diffuse and indirect daylight.

However, the efficiency of an a-Si cell suffers a significant drop of about 10 to 30 percent during the first six months of operation. This is called the Staebler-Wronski effect (SWE) – a typical loss in electrical output due to changes in photoconductivity and dark conductivity caused by prolonged exposure to sunlight. Although this degradation is perfectly reversible upon annealing at or above 150 °C, conventional c-Si solar cells do not exhibit this effect in the first place.

Its basic electronic structure is the p-i-n junction. The amorphous structure of a-Si implies high inherent disorder and dangling bonds, making it a bad conductor for charge carriers. These dangling bonds act as recombination centers that severely reduce carrier lifetime. A p-i-n structure is usually used, as opposed to an n-i-p structure. This is because the mobility of electrons in a-Si:H is roughly 1 or 2 orders of magnitude larger than that of holes, and thus the collection rate of electrons moving from the n- to p-type contact is better than holes moving from p- to n-type contact. Therefore, the p-type layer should be placed at the top where the light intensity is stronger, so that the majority of the charge carriers crossing the junction are electrons.

Tandem-cell using a-Si/μc-Si

A layer of amorphous silicon can be combined with layers of other allotropic forms of silicon to produce a multi-junction solar cell. When only two layers (two p-n junctions) are combined, it is called a *tandem-cell*. By stacking these layers on top of one other, a broader range of the light spectra is absorbed, improving the cell's overall efficiency.

In micromorphous silicon, a layer of microcrystalline silicon (μc-Si) is combined with amorphous silicon, creating a tandem cell. The top a-Si layer absorbs the visible light, leaving the infrared part to the bottom μc-Si layer. The micromorph stacked-cell concept was pioneered and patented at the Institute of Microtechnology (IMT) of the Neuchâtel University in Switzerland,and was licensed to TEL Solar. A new world record PV module based on the micromorph concept with 12.24% module efficiency was independently certified in July 2014.

Because all layers are made of silicon, they can be manufactured using PECVD. The band gap of a-Si is 1.7 eV and that of c-Si is 1.1 eV. The c-Si layer can absorb red and infrared light. The best efficiency can be achieved at transition between a-Si and c-Si. As nanocrystalline silicon (nc-Si) has about the same bandgap as c-Si, nc-Si can replace c-Si.

Tandem-cell using a-Si/pc-Si

Amorphous silicon can also be combined with protocrystalline silicon (pc-Si) into a tandem-cell. Protocrystalline silicon with a low volume fraction of nanocrystalline silicon is optimal for high open-circuit voltage.[25] These types of silicon present dangling and twisted bonds, which results in deep defects (energy levels in the bandgap) as well as deformation of the valence and conduction bands (band tails).

Polycrystalline silicon on glass

A new attempt to fuse the advantages of bulk silicon with those of thin-film devices is thin film polycrystalline silicon on glass. These modules are produced by depositing an antireflection coating and doped silicon onto textured glass substrates using plasma-enhanced chemical vapor deposition (PECVD). The texture in the glass enhances the efficiency of the cell by approximately 3% by reducing the amount of incident light reflecting from the solar cell and trapping light inside the solar cell. The silicon film is crystallized by an annealing step, temperatures of 400–600 Celsius, resulting in polycrystalline silicon.

These new devices show energy conversion efficiencies of 8% and high manufacturing yields of >90%. Crystalline silicon on glass (CSG), where the polycrystalline silicon is 1–2 micrometres, is noted for its stability and durability; the use of thin film techniques also contributes to a cost savings over bulk photovoltaics. These modules do not require the presence of a transparent conducting oxide layer. This simplifies the production process twofold; not only can this step be skipped, but the absence of this layer makes the process of constructing a contact scheme much simpler. Both of these simplifications further reduce the cost of production. Despite the numerous advantages over alternative design, production cost estimations on a per unit area basis show that these devices are comparable in cost to single-junction amorphous thin film cells.

Gallium arsenide

Gallium arsenide (GaAs) is a III-V direct bandgap semiconductor and is a very common material used for single-crystalline thin-film solar cells. GaAs solar cells have continued to be one of the highest performing thin-film solar cells due to their exceptional heat resistant properties and high efficiencies.As of 2019, single-crystalline GaAs cells have shown the highest solar cell efficiency of any single-junction solar cell with an efficiency of 29.1%.This record-holding cell achieved this high efficiency by implementing a back mirror on the rear surface to increase photon absorption which allowed the cell to attain an impressive short-circuit current density and an open-circuit voltage value near the Shockley–Queisser limit.As a result, GaAs solar cells have nearly reached their maximum efficiency although improvements can still be made by employing light trapping strategies.

GaAs thin-films are most commonly fabricated using epitaxial growth of the semiconductor on a substrate material. The epitaxial lift-off (ELO) technique, first demonstrated in 1978, has proven to be the most promising and effective. In this method, the thin film layer is peeled off of the substrate by selectively etching a sacrificial layer that was placed between the epitaxial film and substrate. The GaAs film and the substrate remain minimally damaged through the separation process, allowing for the reuse of the host substrate.[1]With reuse of the substrate the fabrication costs can be reduced, but not completely forgone, since the substrate can only be reused a limited number of times. This process is still relatively costly and research is still being done to find more cost-effective ways of growing the epitaxial film layer onto a substrate.

Despite the high performance of GaAs thin-film cells, the expensive material costs hinder their ability for wide-scale adoption in the solar cell industry. GaAs is more commonly used in multi-junction solar cells for solar panels on spacecraft, as the larger power to weight ratio lowers the launch costs in space-based solar power (InGaP/(In)GaAs/Ge cells). They are also used in concentrator photovoltaics, an emerging technology best suited for locations that receive much sunlight, using lenses to focus sunlight on a much smaller, thus less expensive GaAs concentrator solar cell.

Emerging photovoltaics

Main article: Third-generation photovoltaic cell

An experimental silicon based solar cell developed at the Sandia National Laboratories

The National Renewable Energy Laboratory (NREL) classifies a number of thin-film technologies as emerging photovoltaics—most of them have not yet been commercially applied and are still in the research or development phase. Many use organic materials, often organometallic compounds as well as inorganic substances. Despite the fact that their efficiencies had been low and the stability of the absorber material was often too short for commercial applications, there is a lot of research invested into these technologies as they promise to achieve the goal of producing low-cost, high-efficient solar cells.

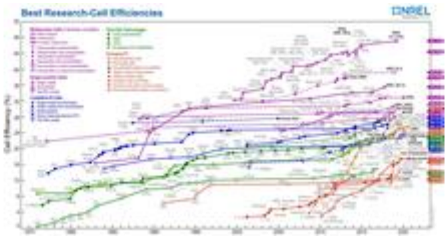
Emerging photovoltaics, often called third generation photovoltaic cells, include:

- Copper zinc tin sulfide solar cell (CZTS), and derivates CZTSe and CZTSSe
- Dye-sensitized solar cell, also known as "Grätzel cell"
- Organic solar cell
- Perovskite solar cell
- Quantum dot solar cell

Especially the achievements in the research of perovskite cells have received tremendous attention in the public, as their research efficiencies recently soared above 20 percent. They also offer a wide spectrum of low-cost applications.In addition, another emerging technology, concentrator photovoltaics (CPV), uses high-efficient, multi-junction solar cells in combination with optical lenses and a tracking system.

Efficiencies

Main article: Solar cell efficiency



Solar cell efficiencies of various cell technologies (including both single-crystal and thin film technologies) as tracked by NREL

The achievable efficiency of thin-film solar cells is extremely dependent on the semiconductor chosen and the growth technology. Incremental improvements in efficiency began with the invention of the first modern silicon solar cell in 1954. By 2010 these steady improvements had resulted in modules capable of converting 12 to 18 percent of solar radiation into electricity.The improvements to efficiency have continued to accelerate in the years since 2010, as shown in the accompanying chart.

Cells made from newer materials tend to be less efficient than bulk silicon, but are less expensive to produce. Their quantum efficiency is also lower due to reduced number of collected charge carriers per incident photon.

The performance and potential of thin-film materials are high, reaching cell efficiencies of 12–20%; prototype module efficiencies of 7–13%; and production modules in the range of 9%.The thin film cell prototype with the best efficiency yields 20.4% (First Solar), comparable to the best conventional solar cell prototype efficiency of 25.6% from Panasonic.

NREL once predicted that costs would drop below $\$100/m^2$ in volume production, and could later fall below $\$50/m^2$.

A new record for thin film solar cell efficiency of 22.3% has been achieved by Solar Frontier, the world's largest CIS (copper indium selenium) solar energy provider. In joint research with the New Energy and Industrial Technology Development Organization (NEDO) of Japan, Solar Frontier achieved 22.3% conversion efficiency on a 0.5 cm^2 cell using its CIS technology. This is an increase of 0.6 percentage points over the industry's previous thin-film record of 21.7%.

Absorption

Multiple techniques have been employed to increase the amount of light that enters the cell and reduce the amount that escapes without absorption. The most obvious technique is to minimize the top contact coverage of the cell surface, reducing the area that blocks light from reaching the cell.

The weakly absorbed long wavelength light can be obliquely coupled into silicon and traverses the film several times to enhance absorption.

Multiple methods have been developed to increase absorption by reducing the number of incident photons being reflected away from the cell surface. An additional anti-reflective coating can cause destructive interference within the cell by modulating the refractive index of the surface coating. Destructive interference eliminates the reflective wave, causing all incident light to enter the cell.

Surface texturing is another option for increasing absorption, but increases costs. By applying a texture to the active material's surface, the reflected light can be refracted into striking the surface again, thus reducing reflectance. For example, black silicon texturing by reactive ion etching(RIE) is an effective and economic approach to increase the absorption of thin-film silicon solar cells.A textured backreflector can prevent light from escaping through the rear of the cell.

In addition to surface texturing, the plasmonic light-trapping scheme attracted a lot of attention to aid photocurrent enhancement in thin film solar cells. This method makes use of collective oscillation of excited free electrons in noble metal nanoparticles, which are influenced by particle shape, size and dielectric properties of the surrounding medium.

In addition to minimizing reflective loss, the solar cell material itself can be optimized to have higher chance of absorbing a photon that reaches it. Thermal processing techniques can significantly enhance the crystal quality of silicon cells and thereby increase efficiency. Layering thin-film cells to create a multi-junction solar cell can also be done. Each layer's band gap can be designed to best absorb a different range of wavelengths, such that together they can absorb a greater spectrum of light.

Further advancement into geometric considerations can exploit nanomaterial dimensionality. Large, parallel nanowire arrays enable long absorption lengths along the length of the wire while maintaining short minority carrier diffusion lengths along the radial direction. Adding nanoparticles between the nanowires allows conduction. The natural geometry of these arrays forms a textured surface that traps more light.

Production, cost and market

Global PV market by technology in 2013.[49]: 18, 19

multi-Si (54.9%)

mono-Si (36.0%)

CdTe (5.1%)

a-Si (2.0%)

CIGS (2.0%)

With the advances in conventional crystalline silicon (c-Si) technology in recent years, and the falling cost of the polysilicon feedstock, that followed after a period of severe global shortage, pressure increased on manufacturers of commercial thin-film technologies, including amorphous thin-film silicon (a-Si), cadmium telluride (CdTe), and copper indium gallium diselenide (CIGS), leading to the bankruptcy of several companies. As of 2013, thin-film manufacturers continue to face price competition from Chinese refiners of silicon and manufacturers of conventional c-Si solar panels. Some companies together with their patents were sold to Chinese firms below cost.

SMART TECHNOLOGY IN PAPER BATTERY

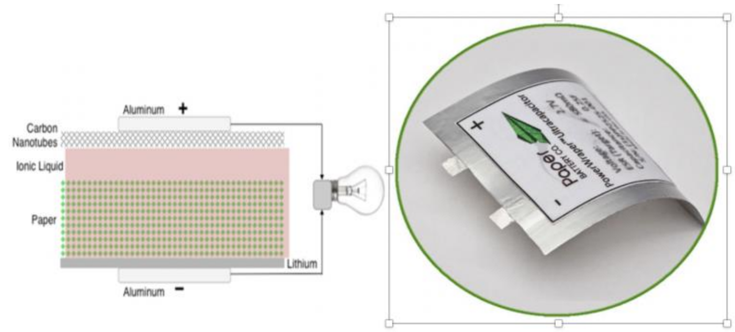
PRATHYUSH BABU S G

202002

II YEAR / EEE

The continuously advancing technology of portable electronic devices requires more flexible batteries to power them. Batteries power a wide range of electronic devices including phones, laptop computers and medical devices such as cardiac pacemakers and defibrillators. With the ever increasing demand for efficiency and design, there is a need for ultrathin, safe and flexible energy storage options. A paper battery is a flexible, ultra-thin energy storage and production device formed by combining carbon nanotubes with a conventional sheet of cellulose based paper. A paper battery acts as both a high energy battery and supercapacitor, combining two components that are separate in traditional electronics.

This combination allows the battery to provide long term, steady power production and bursts of energy. Through the use of super capacitors, batteries can be made that will deliver renewable energy from bodily fluids such as blood or sweat. This technology can be greatly utilized by medical devices. It combines two essential materials, cellulose and carbon nanotubes (CNTs), that fit the characteristics of spacer and electrode and provide inherent flexibility as well as porosity to the system. Cellulose, the main constituent of paper and an inexpensive insulating separator structure with excellent biocompatibility, can be made with adjustable porosity. CNTs, a structure with extreme flexibility, have already been widely used as electrodes in electrochemical devices.



Need for Paper Battery:

The ordinary Electro-Chemical battery faces many problems like:

1. **Limited life time**: The primary batteries can't be recharged like secondary batteries. They irreversibly convert chemical energy into the electrical energy. Although the secondary batteries may be rechargeable, the life time may be very short and also they are very costlier than the primary ones. The paper battery provides a better advantage of all these problems.
2. **Environmental Influence**: The extensive use of batteries can generate environmental pollutions like toxic metal pollutions etc. But the Paper batteries are environmentally friendly and can decompose very easily without any abuse.

3. **Leakage**: If by chance any leakage of batteries occurred, the chemical released may be very dangerous to the environment and also to the nearby metals which are in contact with the batteries. But there is no toxic chemical in the paper batteries.

Carbon nanotubes:

Carbon is accomplished with many allotropes. Some renowned form of carbon allotropes are diamonds, graphite etc. Currently different forms of allotropes of carbon have been ascertained and researched like carbon nano tubes. In Carbon nanotubes, each carbon atom is amalgamating with all other three carbon atoms in order to form a nanosize cylindrical structure. The nanosize cylindrical structure along with its novel properties makes the carbon nanotube conceivably beneficial in wide range of applications in materials science, electronics, nanotechnology and optics. The carbon nanotube unveils outstanding strength along with its distinctive electrical properties also the carbon nanotube is an effective heat conductor too.

Three ways to construct the paper batteries:

1. **First Method:** First fabricate the cathode and anode with Zinc and manganese dioxide respectively. With the help of a standard silk screen printing press, these batteries are printed on to the surface of a paper. After that this printed paper is infused with the carbon nanotubes (electrode). Now let this printed paper to dip into the electrolyte (Ionic liquid solution).

- Cathode – Zinc
- Anode - Manganese dioxide
- Electrode - Carbon nanotubes
- Electrolyte - Ionic liquid solution

2. **The second method:** This method is little complex than the first method. Here silicon is used as the substrate. And the nanotube grows on this substrate. Cellulose is used to fill the gaps in the matrix substrate and also to form a combination with the nanotubes. When the matrix dried, the amalgamated nanotubes and cellulose is striped off. Thus we can create paper sheets having layers of Carbon nanotubes. By combining these two sheets together, we can construct a super capacitor with an ionic solution like urine, sweat or human blood as an electrolyte.

3. **The Third Method**: This method is comparatively simple and can be fabricate in the laboratory.

- First take a rectangular shaped Xerox paper.
- Now made a coating of ionic solution in to this paper surface.
- Then spread the specially prepared carbon nanotubes ink over this ionic coated Xerox paper.
- The other side of the Xerox paper is laminated with a thin film or layer of lithium.
- Aluminum rods are used to transfer current between the 2 electrodes.

Working Principle of Paper Battery

The internal performance of paper batteries is identical to that of a traditional battery by generating a voltage about 1.5V. We can recall the working principles of a traditional batteries where ions (+ ve charged particles) and electrons (- ve charged particles) moves between the electrodes, anode (+ve electrode) and cathode (-ve electrode). Due to the flow of electrons from cathode to anode, current start flowing from anode to cathode along the conductor.

- Cathode: Carbon Nanotube
- Anode: Lithium metal (Li+)
- Electrolyte: bio electrolytes like urine, blood and sweat. (All electrolytes can be used)
- Separator: Cellulose or Paper

Similarly in Paper Batteries, the metal (Lithium) is used as the anode and carbon nanotubes as cathode and also the paper or cellulose is used as the separator. Due to the chemical reaction between the electrolyte and carbon, electrons are generated. Similarly due to the chemical reaction between electrolyte and metal, ions are generated. These generated electrons starts flow through the external circuit from cathode to the anode.

Where can Paper Batteries be used

- Paper Battery can be now implemented in wearable technology like Google Glass, Wearable Biosensors, and Wearable computer etc.
- Used in entertainment devices.
- Used in tags and smart cards.
- For medical applications like disposable medical diagnostic devices and also can be used in pacemakers due to the paper batteries nontoxic and biodegradable nature.
- Ideal for aircraft, automobiles, remote controllers etc.

Advantages of Paper Battery

- Paper battery can be used as both super capacitor and battery.
- Paper batteries are very flexible, ultrathin, nontoxic and biodegradable battery
- Long life.
- Provides a steady power.
- Can be available in different shapes and sizes.
- They offer high energy efficiency.
- Paper Batteries are low cost and can be easily disposed.
- They can be used to produce 1.5V energy and also paper batteries are rechargeable.

VISION

TO BECOME A HIGH STANDARD OF EXCELLENCE IN EDUCATION, TRAINING AND RESEARCH IN THE FIELD OF ELECTRICAL AND ELECTRONICS ENGINEERING AND ALLIED APPLICATIONS

MISSION

TO PRODUCE EXCELLENT, INNOVATIVE AND NATIONALISTIC ENGINEERS WITH ETHICALVALUES AND TO ADVANCE IN THE FIELD OF ELECTRICAL AND ELECTRONICS ENGINEERING AND ALLIED AREAS