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The Microchip

In today' modern world technology is seen everywhere how we transport, communicate, entertain, and lean and it all depends on thousands even millions of transistors place on a silicon plate know as the integrated circuit, the microchip. The microchip has revolutionized the modern world in many ways; it has taken humans to outer space, explores the universe, and is the key element behind our computerized society. The integrated circuits functions are virtually limitless as time moves forward the microchips are cheaper and efficient as results high-speed, small devices are created to enhance the human kind.

The integrated circuit has its origin in the invention of the transistor in 1947 by William B. Shockley in AT&T Company's Bell Laboratories. He discovered under the right circumstances, electrons can form a barrier at the surface of several crystals that led him to control the flow of electricity by manipulation the barrier, it allowed him to create a device that perform certain electrical actions know as the transistor. With the same principle of making the transistor, other electrical components were invented such as capacitor, but the problem with all the components was the wiring called "tyranny of numbers." Two scientists without knowing of each other existence, they begin working a solution that led to the discovery of the integrated circuit.

Jack Kilby was born on November 8, 1923 in Missouri. Kilby was introduced to electricity by his father who was the president of the Kansas Power Company. Right after

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graduation from the University of Illinois in 1947 he started working with Centralab Division of Globe Union Inc. in Wisconsin, but after realizing the limitations they gave him, not working with germanium he left. Jack move to Dallas after resigning and headed straight to Texas Instruments where he started working during summer when everybody was gone for vacation. Working by himself TI assigned him a project where he had to find a way to put all the electrical components in a single base, with the whole lab for himself, he begin the journey.

In 1958, Jack Kilby came with a solution called “monolithic idea”, the idea was to make all the electrical components transistor, capacitors, and resistors including the base out of silicon, this was the revolution Jack Kilby begin. In September 12, 1958 he showed the world his invention that came to be known as the integrated circuit and the computerized industries begin. After his success with the integrated circuit he stayed with TI and led a team to create the first calculator and the laser printer. From 1978 to 1984 he was Distinguished Professor of Electrical Engineering at Texas A&M University. Jack Kilby died on June 20, 2005 after a brief battle with cancer.

Robert Noyce was born on December 12, 1927, in Iowa. Noyce received his B.A. degree and membership in Phi Beta Kappa at Grinnell College in 1949 at Iowa and his Ph.D. degree in Physical Electronics at Massachusetts Institute of Technology in 1953. Upon completion of school, he joined the Research Division of Philco Corporation where he worked in developing high-performance germanium surface barrier transistors, but quit because he sense the company didn’t have a lot of interest in silicon. Soon after he

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joined Shockley in his new company Shockley semiconductor Laboratory of Beckmann Instruments in Palo Alto, California, he started working with silicon devices and liked the idea the company was focus producing silicon devices. In 1957 Noyce uncomfortable with Shockley attitude and management of the company left to form a new company, financed by Fairchild Camera and Instrument, called Fairchild Semiconductor. At age twenty-nine, Noyce was the manager of Fairchild. In his capacity as director of research and development, he joined Fairchild co-founder Gordon Moore in investigating methods of connection transistors in a solid block of silicon. Noyce began making notes in his lab notebook, unaware that a similar idea had already been produced Noyce continue working with his invention that also came to be called the integrated circuit. Fairchild Semiconductor filed a patent on the new invention in July 1959 as well as Texas Instrument in February 1959, naturally, both companies engaged a legal battle that lasted almost a decade, and decided to cross-license their technologies. Although Jack Kilby holds the patent for the integrated circuit, Robert Noyce can be named the co-inventor of the microchip. In 1970, Jack Kilby was awarded the National Medal of Science, and was inducted in the National Inventors Hall of Fame in 1982. After leaving Fairchild Semiconductor, Noyce when on to found Intel in 1958, the company responsible for the invention of the microprocessor, although he left Fairchild Noyce kept a strong connection with the company. Robert Noyce died on June 3, 1990 of sudden heart attack.

Making an integrated circuit is quite complicated it takes time and precision, and a lot of high tech equipment that only mass-production companies can afford. The microchip is made up of large numbers of transistor ranging from hundreds to billions.

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These small circuits are measure in microns or 1/1000 of a millimeter and are approximately 70 times smaller than the width of human hair.

Transistors are the fundamental building blocks of a microchip and are built in silicon bases that are called wafers. In creating wafer silicon crystals or seed crystals are used, the crystals are dope into molted silicon in a rotating motion and slowly retreated forming a silicon cylinder named ingot. These ingots are then cut into hundreds of pieces called wafers the foundation element of the transistors. Wafers are then taken and introduce to several process that are repeated layer after layer to create the transistors, there process are film deposition, photolithography, and film removal.

In film deposition a thin layer of semi conducting material is deposited on the wafer surface. Photolithography is then applied where a mask, the pattern of the chip's circuitry, is place in a precise location above the wafer this is also known as pattering. In photolithography the wafer is covered with a light sensitive material call photoresist. The mask is then place above the wafer and ultraviolet light where is flashed by ultra light creating a pattern, this process is repeated for every layer in a microchip. Once the photolithography is done the Etch process is started where the wafer is place in a process chamber, and the area protected by the mask is etched away leaving a three-dimensional pattern on the wafer, the pattern of the circuit, after completion the remaining photoresist is removed. The next step in creating a transistor is Ion implantation, where dopants (purities) are accelerated to a high-velocity, so they penetrate, or implant into the wafer surface, changing the electrical properties of the silicon. The wafer is then expose to a

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high temperature anneal also known as rapid thermal processing (RTP), RTP activates the dopants and repairs the silicon crystal structure that was damaged during the ion implantation step. During RTP the wafer is exposed to a very short, high controlled thermal cycle that heats up the wafer from room temperature to 1100 degrees Celsius within seconds transforming the natural properties of the silicon.

Once the transistors are made, they are connected with many levels of metal wiring called interconnects, which are separated from each other using insulators. The final combination of transistors and interconnects forms the structure know as an integrated circuit. Because a single processed wafer can have a value of tens of thousands of dollars, checking the process for success is very important. Various metrology and inspections steps are used to monitor wafer manufacturing process throughout the fabrication sequence. Metrology and Inspection includes defect inspection, defect review scanning electron microscopy (DR-SEM), and critical dimensions measurement scanning electron microscopy (DD-DEM). DR-SEM use electrons to image and then automatically classify the defect on the wafer such as particles, scratches and residue. CD-SEM's measures the "critical dimension" (CD) of the sub micron-sized circuits in a microchip, assuring the accuracy of the manufacturing process this is usually perform after the photolithography and etch steps.

All of these processing steps have to be done in extreme clean manufactories facilities called Fabrication Plants (Fabs) where the air is two million times clear that of the air of outside. To keep the air clean, portions of the fabs are called clean rooms, and special clothing called bunny suits are worn by engineers working inside with chip.

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These suits are made of special material that stops hair and skin fro entering the clean room. Once the wafer is completed, the wafer is cut into individual chips, which are the tested, packaged and assembled.

Every time some one turns their car, computer, televisions, etc., etc. It is the microchip that enables those devices that have shaped today's modern society. The impact of Jack Kilby"s chip was tremendous, without the chip man could not have reached the space or landed on the moon. The microchip is in education, entertainment, and manufacturing, in other words the integrated circuit is the basis of the computerize world we have today.

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