Compact Disc Technology

The **Compact Disc** popularly known as **CD** is the data storage device used to store and retrieve datas encoded in digital format. It is an optical disc made of a special polycarbonate plastic known as **Polymethyle Meta Acrylic**. The CD reading and writing uses **Laser beam** generating from the Laser diode of the CD drive. Using the **780 nanometer** near infrared Laser beam, the data can be stored in the Bits and Pits of the CD. Based on the **Reflection** and **Scattering** of the Laser light, The Optoelectronic tracking module in the CD drive retrieve the data.

The CD weighs 15 – 20 grams and has a thickness of 1.2 mm. Its reflecting side is coated with a thin layer of Aluminium and protected with a layer of Lacquer. Standard CD has a diameter of 120 mm and can store 700 MB uncompressed data. This can run around 80 minutes. Mini CD and Digital Video CD are also available to suit the requirements of the user.

CD may be Recordable CD and Rewritable CD.

Recordable CD

It is injection molded with a **"blank"** data spiral. A photosensitive dye is then applied, after which the discs are Metalized and lacquer-coated. The write laser of the CD recorder changes the color of the dye to allow the read laser of a standard CD player to see the data, just as it would with a standard stamped disc. The resulting discs can be read by most CD-ROM drives and played in most audio CD players.

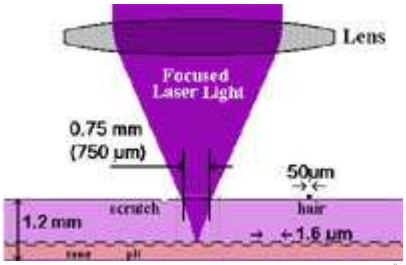
Re Writable CD.

Rewritable CD is designed for **'Write and Erase'** functions so that it is easy to erase the old data and record new data over it. Unlike the readable CD, the Rewritable CD has a **Phase change compound** coated in its reflective surface. This phase change substance is the compound of silver, antimony, tellurium and indium. This compound changes its physical state on heating depending on the temperature applied. When the temperature rises above its melting point (around 600 degree) it changes to liquid form and in its crystallization point (around 200 degree) it becomes solid. Unlike the ordinary CD, in Rewritable CD, the bumps are represented by the phase changes in the compound. When it is in the **'Crystalline form'**, it remains translucent so that laser light can reflect back. When the compound becomes **'Amorphous'** due melting, it becomes non translucent and laser light will not reflect back. These changes during melting can 'lock' the phase change in place.

The erasing process changes the crystalline and amorphous states of the compound through melting. The high temperature from the Laser beam will change the states of the compound so that the data in the form of translucent and non translucent areas in the reflective layer will be erased. During writing, the high power laser beam melts points corresponding to the bumps of the conventional CD. They block the read laser so that it will not reflect. These non reflective melted points remain as opaque and represent 0s. The crystalline reflective areas represent 1s.

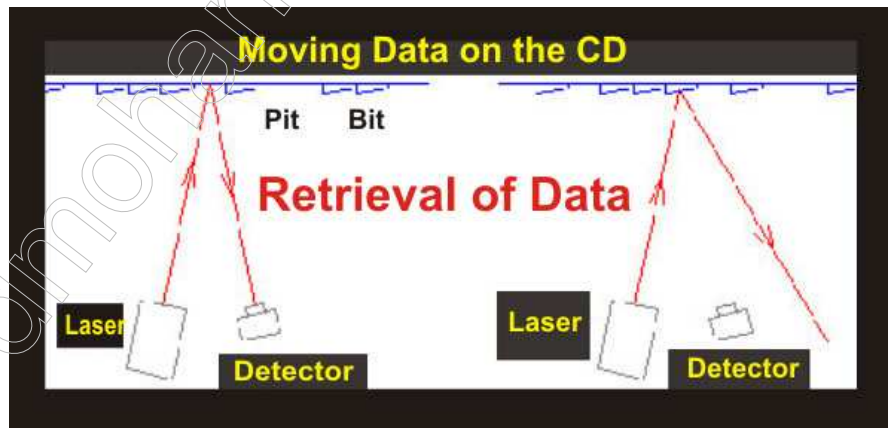
Storage Capacity

The CD can store large quantity of data as series of tiny indentations known as "***pits***", encoded in a spiral track molded into the top of the polycarbonate layer. The areas between pits are known as **"lands".** Each pit is approximately 100 nm deep by 500 nm wide, and varies from 850 nm to 3.5 µm in length. CD-ROM capacities are normally expressed with binary prefixes, subtracting the space used for error correction data. A standard 120 mm, 700 MB CD-ROM can actually hold about 737 M. Scanning velocity of the CD is 1.2–1.4 m/s (constant linear velocity) – equivalent to approximately 500 rpm at the inside of the disc, and approximately 200 rpm at the outside edge. (A disc played from beginning to end slows down during playback.)



CD Reading

CD players use laser technology to read the optically recorded data in the form of Bits and Pits on a CD. About **20000** or more tracks are found in a CD's recording surface. The distance between the tracks, the pitch, is 1.6 µm. A CD is read by focusing a 780 nm wavelength (near infrared) semiconductor laser through the bottom of the polycarbonate layer. The change in height between pits and lands results in a difference in intensity in the light reflected. By measuring the intensity change with a photodiode, the data can be read from the disc. The digital information is defined as the length of pits and distance between them. The pits and reflective surface represents logic 0 and logic 1. The pits and lands themselves do not directly represent the zeros and ones of binary data. Instead, **Non-return-to-zero**, inverted (NRZI) encoding is used: a change from pit to land or land to pit indicates a one, while no change indicates a series of zeros. There must be at least two and no more than ten zeros between each one, which is defined by the length of the pit.



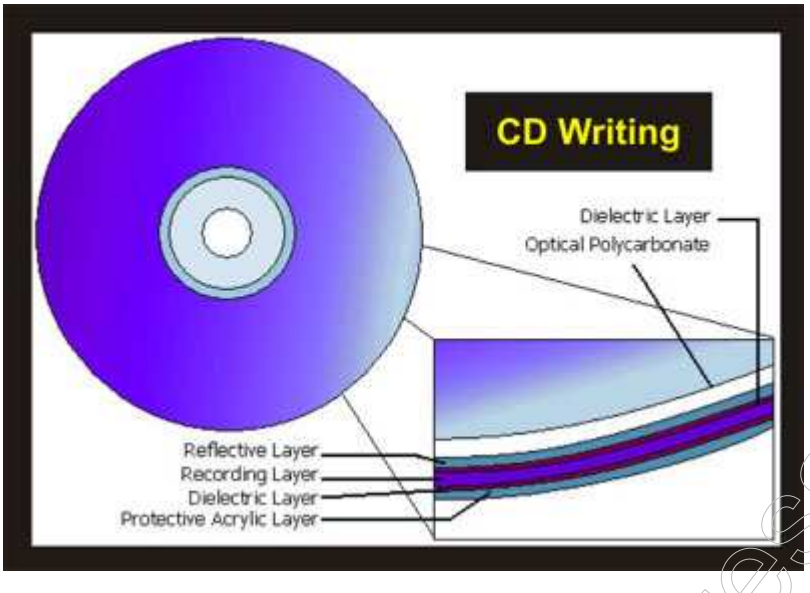
The Magic of Eye

The laser diode- lens assembly forms the optical system of the CD player. The laser diode- lens assembly is generally known as **'Eye of CD player".** The lens system focuses the laser beam reflected onto the CD and reflected back light is collected by the objective lens and transmitted to the detector system. When a Laser beam is focused on to the CD, because of a difference between the depth of pits and wavelength of the laser beam, a phase difference develops between the light reflected from pits and the reflecting surface. The reflected light is then modulated by the receiver system. Before passing to the detector, the reflected laser beam is polarized and aligned to 90 degrees. The detector is a photo sensor that produces corresponding electrical signals which are then amplified and separated into corresponding video and audio signals.

CD Burning

CD burning is an amazing technology and its working principle is really fascinating. CD burners encode music and other datas on to the blank CD which can be retrieved through CD reading. CD stores the datas in digital form represented by a series of 1s and 0s. The 1s are represented by tiny bumps and the 0s as flat areas. Such millions of bumps and flats areas are present in a standard size CD.

CD-R recordings are designed to be permanent. Over time the dye's physical characteristics may change, however, causing read errors and data loss until the reading device cannot recover with error correction methods. The design life is from 20 to 100 years, depending on the quality of the discs, the quality of the writing drive, and storage conditions. The bumps and flat areas are present on the reflective side of the CD which is arranged in continuous tracks. These tracks measures about 0.5 microns and can stretch about 5 Kms. During CD reading, a 'Read laser beam' passes over the flat area in the track. The laser beam will reflect back which will be passed onto a photo sensor assembly. The Photo sensor interprets the reflected laser light as 1. When the laser light bounce back from the bumps, the photo sensor will not get it and the CD player recognize it as 0.



CD writer is used to burn the CD to record the data in the digital format. The CD burner darkens microscopic areas in the reflective side of the 'Blank CD'. During burning, both reflective and non reflective areas are created in the CD that can be interpreted as 1 and 0 by the CD player. The CD burner has a laser assembly similar to the CD reader. But the laser is 'Write Laser' with high power around 40 mW. The write laser interacts with the CD and alters its surface.

The movement of the Write laser assembly is exactly similar to the read laser assembly. It moves outward from the centre of the CD while the CD is spinning. The bottom layer of the 'Blank CD' has grooves pre pressed into it to guide the write laser in the correct path. By calibrating the spin speed and speed of the laser assembly, the burner will guide the laser assembly exactly through the track at a constant speed. During the movement, the laser diode will turn on and off in synch with the pattern of 1s and 0s in the track. The high power laser then darkens the CD material to encode 0 and leaves the material translucent to represent 1.

The CD writing speed can be varied depending on the choice. The CD burner can write at multiple speeds. 1x is the writing speed exactly similar to the reading speed. That is ,it takes 60 minutes to write 60 minute duration data. At 2x rate, the burner will take 30 minute to write 60 minutes data. The general writing speeds are 8x, 16x, 24x, 32x etc. It is better to avoid high speed writing since at high speed, some of the data will not be stored especially when writing Music files. The normal writing speed is 16x or 24x.

CD Writing Software

To control all the functions of the CD writer, software like Nero is used. The datas accessible for all types of CD players are encoded in the understandable form by the software. The programme also reduces the data errors during writing. This is achieved by incorporating a number of extra digital information with the recorded data and arranges them carefully. The format gives 'Time Codes' during writing so that the CD player can recognize which part is reading at a particular time. The format also gives 'Table of contents' at the beginning of the track (centre of CD) so that the CD player can recognize, which file is reading. 'Extra data bits' are also added so that the player can fix the mistakes if the laser misread the data bit. The recorded data is not arranged sequentially but in an 'inter laced pattern'. This prevents the loss of complete data from the CD, if a portion of the CD is damaged

CD damage

CDs are susceptible to damage from both daily use and environmental exposure. Pits are much closer to the label side of a disc, so that defects and dirt on the clear side can be out of focus during playback. Consequently, CDs suffer more scratch damage on the label side whereas scratches on the clear side can be repaired by refilling them with similar refractive plastic, or by careful polishing.