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Nano tech enables mega storage

Optical storage is poised to make a quantum jump, says S.Ananthanarayanan.

Peter Ziltstra, James Chon and Min Gu at Swinburne University, Australia report the use of nanotechnology to create extra dimensions of storage in CDs and DVDs, which could increase their capacity by a factor of thousands

Early storage

The first storage devices were mechanical media, the ***disk or cylinder*** that stored information of sound waves in a groove. A stylus that ran over the groove could then sense the sound information and play it back through a loudspeaker. This was the medium which saw advanced stages in the Extended Play (EP) and Long Play (LP) records and witnessed the era of the Beatles.

The next family was of magnetic storage. Here, the waveforms of sound were transferred to magnetic tape, which could be wound in spools and run across a magnetic recording and pick-up head. The major development in this technology was the ***compact cassette***, which consisted of a pair of miniature spools, carrying a thin strip of magnetised tape, all packed into a compact plastic holder, or box, for which the French word is ‘cassette’.

Digital recording

The next step was digital recording, where the information stored was not a sound waveform but information about the mix of frequencies, rapidly scanned several hundred times a second, and the information was stored in the form of ***binary digits***. Binary digits are numbers expressed using only ‘1’s and ‘0’, and this kind of number system can be recorded on a magnetic tape, with only 2 types of magnetization – one for ‘1’ and the other for ‘0’.

Soon this kind of data, not only for sounds but also to represent text or pictures, all in binary form, could also be written on ‘tracks’ and ‘sectors’ in magnetized disks, instead of lengthwise on tape and it was the time of the ***floppy disk*** and ***hard disk*** of computers.

Optical recording

This is the current generation of storage, which uses a series of reflecting or dull surfaces to record digital data, which can then be read by scanning with a laser beam. The CD and DVD basically differ in the packing of the data and the frequency of the laser used. The DVD packing density is better than twice that of the CD and hence its greater capacity. The Dual Layer DVD is like a double decker, using an extra recording layer below a semitransparent upper one – and it does a little better than double the capacity of the DVD. The version that is even better is the Blu Ray, which uses a laser beam of even shorter wavelength to store 6 times the data of the DVD/

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What we can see in the development of recording media is that we have change from the single dimension of a spiraling groove of gramophone records and the magnetic tape to the two dimensional recording on the surface of the floppy or had disk and also the CD and DVD. The dual layer design then went one more and added a third dimension and there is some work in recording data in a cube, to fully use three dimensions.

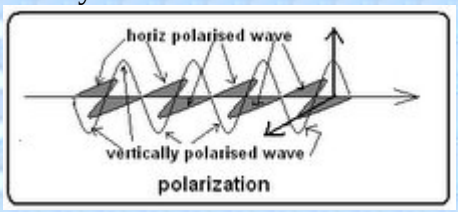
New kid on the block

But the latest thing is to add another two dimensions by addressing data not only along the length of track or position on a disk, but also the frequency and the polarization (see below) of light. Thus, while the standard DVD has 8.4 GB of data in two layers, use of two frequencies (or colours) of laser would allow a further 8.4 GB. And yet another colour yet another 8.4GB.

Just as colour has to do with the frequency of the light waves, polarization is a property of the 'plane of vibration' of the light waves. If we could use lasers at different polarizations, then, we could similarly add 8.4 GB for each distinct polarization. But how can the recording medium be made selectively sensitive to different frequencies and polarizations? This has been done by embedding the medium with nano-rods of metallic gold

The electron cloud around gold rods at nano dimensions display quantum effects when excited by photons and this can be used for selective absorption of light. When a photon is absorbed, the nano-rods melts and forms a glob. And because the surrounding medium has a threshold of heat required for melting, a 'pit' is formed only at the places where the incident light has resonated. As the nanorods are selective in frequency and polarization, only a small number of the nanorods respond to a given light wave. Different light waves then make recordings through different groups of nanorods.

The recorded data is read using a process called 'two photon luminiscence', a kind of microscopy where a low laser beam selects the nanorods that have been reshaped by a given frequency and polarization. This technique then makes it possible to record and read back data for different frequencies and polarizations, thus adding extra dimensions to the three dimensions already available!



The method of using more dimensions has been tried out with three frequencies and two polarisation orientations. Further development would enable the use of very large numbers of frequencies and polarization planes.

The present method of recording and retrieving data on CDs is that there is 'directory' which gives the 'sector and cylinder' which contains the start of the data. Parts of the data are recorded at different parts of the CD, depending on where space is available and each segment ends with the 'sector and cylinder' of the continuation. In the five dimensional system, this data would typically contain the sector, cylinder, layer and also the frequency and polarization