

Technology Update

Data Storage for Eternity

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Storage technique: Researchers in Great Britain have shown that data storage with 500 T-Byte is principally possible. They utilize for that definite material property of glass in order to generate two additional storage dimensions.

On 28 October 2021 in the international scientific technical journal “Optica” was published a publication which so sounds so as it could give a return to the old data carrier holder.

To recapitulate shortly: The optical data discs celebrated their breakthrough in the digital media world from the 1980s with Audio CD (1982), CD-ROM and DVDs (1996). It followed from the beginning of millennium the slightly bigger HD-DVDs (2005) and the blue ray disc (2006).

Important for the further context: A marketable CD-ROM offers 700 MByte at the storage periphery, a one-sided blue-ray disc with its 4 data layers (BDXL) has about 180 times so much whole of 128 GByte.

Back to science and the laser optical storage methods

High speed ultrafast laser anisotropic nanostructuring by energy deposition control via near field enhancement. With that it goes about that to set up with one special definite laser bound nanostructures in materials and so to store the data. Anisotropic means here that the refraction is direction dependent instead as with isotropy from all directions are alike. The storage method as developed at the optoelectronics research

centre of the British University of Southampton and caused worldwide resonance.

But the series after: What are the principles and manufacturing methods of the new laser storage which are designated by the researcher as five dimensional. It aims at its high storage density on big data volume and through the storage in glass on extremely long data preservation. The authors promise an all previous standard exploding number of 13.8 Mrd years. The new laser storage steps in with that competition with the utopian future conception how DNA based media should store data according to the principle of human heredity.

With that certainly hundreds of Terabyte per gram DNA can be stored, certainly the duration of its data preservation might be restricted. The present optical depository can retain data for a few decades readable.

How the researchers of the University of Southampton therefore realize the new standards of data density and the data preservation. With a few right sophisticated and not simple to negotiate details with the generation of a fine spiral spur, how they came for the data storage also to the insertion on the CD. It consists of a series of microscopic deepening on the surface of the plate so-called pits which represent the individual bits of dataflow. With the CD it composed of polycarbonate.

The new 5D-storage on the contrary takes place in quartz glass disc in the shape of voxel of

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three dimensional grid points in a multilayered arrangement. That is nanoscale anisotropic structure with locally varying refraction. These are with extremely short laser impulses of a few femto seconds (10^{-15} s) and in the repetition rate of few megahertz (10^6 Hz) burnt in the surface.

The pits (microscopic hole) are in a two stage process produced. First of all through high energy laser impulse of which energy lies above the threshold of so-called “micro explosions” in quartz glass. With that the generated grooves are locked per close field intensification through numerous low energetic series of impulses to lamellar anisotropic grooves lengthened to measurements of $500 \text{ nm} \times 50 \text{ nm}$.

The laminae (plate, disc) disperse in the direction of scan track with subsequent reading from the data. This extension minimizes thermal damages through the initial megahertz-impulse – the method is however also much time consuming.

The so produced anisotropic nanostructures are used for data storage. They allow scanning rates of 10^6 voxel/s. That gives the possibility of reading off speed of 225 kByte/s that corresponds about 100 pages of a typical text presentation. The first CD mechanisms for computer gets with mechanisms read a CD 150 Kbyte/s. On the other hand, with a modern mechanism reads upto 10800 kbyte/s. On the surface of a traditional CD could be stored however with the 5D-storage theoretically 500 TByte data. That is equivalent to a number of more than 700000 CD-ROMs.

To the three-dimensional spatial representations of Vowel in regard to the position, the set up and size of nano scale lamina (disc)

structures tread however two further dimensions. Their optical properties covering the anisotropic of storage materials. Their anisotropic behavior with the direction dependent refraction generate namely one good known optical anomaly of refraction: rays with differing polarization are doubly refracted and certainly along twin crystallographic axes from which each one has different refractive index. They are therefore with varying phases respectively diffusing velocities in two different directions deflected.

This yields slow and quicker axes of refraction of light with a retarded expansion on the slower axis. Both these sizes – the set ups along the nano lamina and the produced retardation, get utilized as two additional optical dimensions of 5D-storage by the side of the three spatial dimensions.

Still we discuss about a laboratory achievement. It accommodates the research team also. There exists quartz glass disc of the size of a CD with 5 GByte at text data which can be read without mistake. Each voxel represents 4 bit (microscopic holes, indentations and two voxels construct a letter of the text). Before all the writing speed says the team must decisively increase and with that the bearing storage range (periphery) of 500 TByte in less than 60 days can be produced. That circuit of 5D-data storage is therefore not its fastness but its size and longevity. The store suits therefore well before all for the professional data storage and not for back up personal holiday photos.

Source: VDI nachrichten 25 February 2022, Nr. 4 Technik & Wirtschaft, Seite 11, Von Werner Schulz.
