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5 D Optical Storage Devices: Superman of All Storages

[1] Abhinandan Das,
Department of Electrical and Electronics Engineering,
SRM University, Chennai

***Abstract*—Storage of data is very essential for the continuity of human race. Storage devices like pen drives, hard discs or even the internal storage offered in our mobile phones are not enough for storage of special types of data which may include microscopy, digital images and all sorts of computing data. Moreover, we face problems like crashing of the hard disc, pen drives etc. untimely. It is sometimes difficult to retrieve those vital data. Hence, we need to device a storage medium that can be used to read, write, store and erase data including those of medical imaging and microsurgery. At this juncture, nanotechnology comes into the foreplay, which has successfully recorded, read, and erased data from a piece of Nano-structured glass. This technique could revolutionize microscopy in general and medical imaging in specific — and, perhaps more importantly for computing, it could also be used to store binary data, like an optical disc. Unlike DVDs or Blue-rays, which seem to be capable of storing data for an unlimited period of time without a reduction in data integrity, the 5D optical storage could allow for densities as high as 360 terabytes per disc, and unless it is crushed in a vice, these discs are so non-volatile that data stored on them should survive the human race. However the implementation of digital data storage, which is a crucial step towards the real world applications, has not been demonstrated by ultrafast laser writing. Here, a digital copy of the text file in 5D using polarization controlled self-assembled ultrafast laser Nano structuring in silica glass has been successfully recorded and retrieved.**

Key words:- imaging, microsurgery, nanotechnology, laser, terabytes, polarization.

I.INTRODUCTION

There arose a wide spectrum of possibilities in creating five-dimensional (5D), ultra-high-density storage on standard silica glass discs that, unlike DVDs or Blue-rays seem to be capable of storing data for an unlimited period of time without a reduction in data integrity. It is said that 5D optical storage could allow for densities as high as 360 terabytes per disc, and unless you crush it in a vice, these discs are so non-volatile that data stored on them should preserve the human race.

At first glance, five-dimensional storage sounded hypothetical — but, in this case, the data really is stored on five different dimensions (surfaces, planes). There are the usual two dimensions (width, height) provided by a piece of silica glass, and depth is provided by writing at three different depths (layers) within the glass. The fourth and fifth dimensions are provided by Nano structuring the surface of the glass, so that it refracts and polarizes light. as well as infrared, which shows the difference between the distressed and healthy plants which can't be viewed with naked eyes

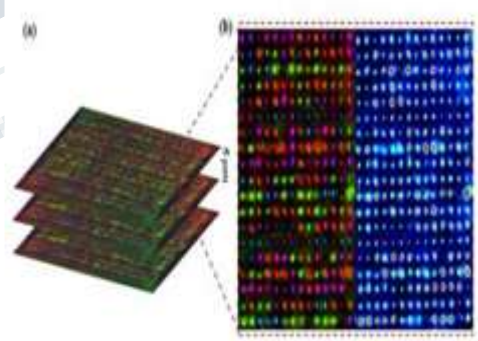

***Fig1: Storage of data*.**

The crystal can store digital information in five dimensions the three dimensions of space and two extra dimensions of the crystal lattice – and pack up to 360 terabytes of data on to single disc, equivalent to about half a million conventional CDs.

The storage allows unprecedented properties including 360TB/disc data capacity, thermal stability up to 1,000°C and virtually unlimited lifetime at room temperature (13.8 billion years at 190°C) opening a new era of eternal data archiving. As a very stable and safe form of portable memory, the technology could be highly useful for

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organizations with big archives, such as national archives, museums and libraries, to preserve their information and records.

II.WORKING

The experiments were performed with a fem to second laser system Pharos (Light Conversion Ltd.)Operating at 1030 nm and delivering 8 µJ pulses of 280 is at200 kHz repetition rate. The distribution at the focal plane was modulated via a spatial light modulator (SLM), which split the incident light into 256 beams. The hologram generated on the SLM was reimaged via a4-foptical system on the back pupil of the objective (Fig. 3 (a)). In addition, a half-wave plate matrix, imprinted by the lasernano structuring of fused silica, was added to the 4-f opticalsystem for the motion free polarization control.

The laser beam was focused with a 1.2 NA water immersion microscope objective at the depth of 140 µm below the surface of the silica glass sample mounted on a three-axial translation stage.

The combination of the SLM and a half-wave plate matrix allowed the removal of relatively slow rotating and moving components for retardance and slow axis orientation control. An adapted weighted Gerchberg-Saxton algorithm was used to set the split beam energy at several levels at the back focal plane ofthe objective. Combined with a phase distribution of Fresnel lens, various levels of intensity at different depths of the focal plane could be achieved. The polarization direction was controlled by the half-wave plate), where beams passing through the selected segment can generate the targeted polarization state.

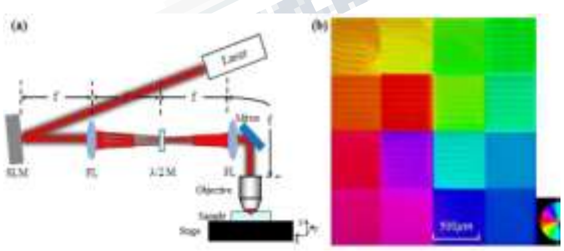

Figure.3. (Color online): (a) 5D optical storage writingsetup: femtosecond laser, spatial light modulator (SLM), Fourier lens (FL), half-wave plates matrix (λ/2 M), dichroic mirror, 1.2 NA water immersion objective, silica glass sample, translation stage. (b) Color-coded slow axis orientation of the half wave-plates matrix imprinted in silica glass

The technology was first experimentally demonstrated in 2013 when a 300 kb digital copy of a text file was successfully recorded in 5D.

Now, major documents from human history such as Universal Declaration of Human Rights (UDHR), Newton's Optics, Magna Carta and Kings James Bible, have been saved as digital copies that could survive the human race.

The documents were recorded using ultrafast laser, producing extremely short and intense pulses of light. The file is written in three layers of nanostructured dots separated by five micromeres (one millionth of a meter).

The self-assembled nanostructures change the way light travels through glass, modifying polarization of light that can then be read by combination of optical microscope and a polarizer, similar to that found in Polaroid sunglasses.

Coined as the 'Superman memory crystal', as the glass memory has been compared to the "memory crystals" used in the Superman films, the data is recorded via self-assembled nanostructures created in fused quartz. The information encoding is realised in five dimensions: the size andorientation in addition to the three dimensional position of these nanostructures.

III. ADVANTAGES

The memory crystals open the era of unlimited lifetime data storage as well as providing unprecedented capacity and high-speed reading, fused quartz is exceptionally stable and can withstand temperatures up to 1000 °C. Optical storage media such as DVDs are more stable, but with standard single-layer discs maxing out at 4.7 GB of data, they are an unwieldy option for vast digital archives. Data written to a glass “memory crystal” could remain intact for a million years. The data-storage technique uses a laser to alter the optical properties of fused quartz at the Nano scale. It has the potential to store a staggering 360 terabytes of data (equivalent to 75,000 DVDs) on a standard-sized disc

IV.CHALLENGES

Just like a coin poses both head and tail similarly 5D storages also pose wide variety of challenges besides disadvantages. It is not suitable for writing technology, however – there needs to be a significant breakthrough before we could be saving our personal music and photograph collections to memory crystal. National labs, cloud-computing clusters and other large data-generating enterprises, on the other hand, are obvious immediate candidates for early adoption.

Endeavors are undertaken to combine with industry partners to develop a higher-powered laser but, ahead of that, they plan to switch the SLM for another on the market that should increase their writing speed from kilobytes-per-second to megabytes-per-second, and are keeping a keen eye on the current development of an even better version that should offer them speeds of gigabytes-per-second, which is a time consuming and indefinite process.

V.CONCLUSION

In conclusion, we experimentally demonstrated the recording and read-out processes of 5D optical data by femtosecond laser writing. The data recording was significantly simplified by replacing the conventional control of the writing beam energy and polarization with a spatial light modulator and a specially designed laser imprinted half-wave plate matrix. Thisdemonstration is a crucial step towards commercialization of ultrafast laser based optical data storage

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