PROSPECTS OF DEVELOPMENT OF OPTICAL MEMORY SYSTEMS

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Optical information carriers were the basis for the creation of systems of mass distribution of information in computer and electronic archives and libraries. In the period of 80s - 90s of the last century optical discs than other types of media having high recording density and the reliability of data storage that has led to their widespread use. Now, however, the optical storage media with microrelief representation of the data in the form of pits and lands on the surface of a disc media (2D media), can not fully meet the requirements for the storage of large amounts of data (big data) and playback data at speeds of several hundred million bits per second. It is therefore necessary to determine the possibility of creating optical media capacity in the tens of terabytes and their use in modern information systems

Need to identify technologies that can significantly increase the recording density and capacity of optical media and reach values that are tens of times higher than those of carriers, recording information which is diffraction limited optical systems (the size of the imprint on the surface of the carrier is approximately equal to half the wavelength of the radiation records).

Increasing the density of recording information in a 2D optical media can be achieved by the use of photosensitive materials with non-linear exposure response (thermolithography recording). The use of such materials allows to increase the recording density 5-6 times [1]. This technology was first used for the disc-originals in BD format. More effective may be a two-layer photosensitive materials exhibit nonlinear characteristics of each layer. The exposure of the upper layer creates a region, the geometrical dimensions of which are smaller in size, defined by the resolution focusonline system. The exposure of the lower photosensitive layer by radiation with a different wavelength, which is created when recording region in the upper layer is transparent. This recording method allows to increase the capacity of optical media compared to media type BD 4-5 times [2]. The recorded data can be carried out by nearfield reading systems. A significant increase in recording density can be achieved with the use of multiphoton processes [3]. Recording optical media are created on the basis of photoluminescent materials. In the recording process uses the technology of optical super resolution microscopy (STED – stimulated emission depletion microscopy), which is based on suppression of spontaneous emission photoluminescence. The dye molecules in the first recording area excite femtosecond laser pulses that are focused into a spot size as small as possible. Then on the edges of the spot of the excitation of the molecules and even specially stewed, causing them to emit photons under the influence of an additional laser pulse of circular shape that is configured to wavelength luminescence (laser recording often has a wavelength of 800 nm, and the wavelength of the laser, which quenches the luminescence – 378 nm). And only after these two pulses are registering a photochemical process in the center of the spot. Overcoming the diffraction boundaries described in the write method is based on the generation time interval between the optical pulses, which are focused in a specific area of the photosensitive material. On a specially developed two-component resists after selective etching were obtained experimentally elements with a minimum size of $\lambda/20$. This method allows almost two orders of magnitude to increase the density of recording on optical media. Proposed and implemented several technologies superdens optical recording and optical nanolithography (RAPID – resolution augmentation through photo-induced deactivation, PINSR – photoinhibited super-resolution lithography, etc.) that use the method STED. They are different types of photoluminescent photoresists and wavelengths of radiation account for resolution enhancement in new development use the UV range, such as for recording and quenching of photoluminescence.

The creation of optical media for storing large amounts of data (big data) is only possible when using technology records data [4,5]. Multilayer optical recording improved to increase recording density by the use of additional encoding data with polarization and wavelength of the

reflected laser radiation. Implementation of multivariate volumetric optical recording requires the development of special photosensitive materials. Promising photochallenge materials for native mode are written only once photopolymer materials with dorotennis absorption. The quadratic dependence of the photochemical changes on the intensity recording radiation allows recording in any of the selected layers without damage to adjacent information layers. Suggested usage in multidimensional bulk nanostructured optical media recording media in the form of oriented gold nanorod. Under the influence of pulses of focused optical radiation changes the orientation nanorod and, as a result, the reflectance in the recording area [5]. It is important that the reflectance in the recording area depends both on the wavelength and polarization of the radiation for recording and reading, this allows you to increase the recording density(actually added two more coordinates in the data storage system and can be considered as 5D-memory. The implementation of the optical recording and reproducing data using technology far-field high-resolution microscopy (e.g. STED technology) in the multilayer recording will allow to achieve capacity optical disc with a diameter of 120 mm tens of terabytes. The data recording by the focused optical radiation with different wavelengths and polarization in the form microholograms also allows to create optical media capacity in the tens of terabytes. The advantage of optical media recording data in the form microholograms there is the possibility of parallel playback data at speeds of several hundred million bits per second. Actively discussed and analyzed the issue of creating a 6D-optical media for storing large amounts of data (big data) [4,5].

The use of strong nonlinear effects and multiphoton processes when recording information. it is possible to increase the recording density, compared with carriers of the type BD, nearly 100 times. Playback of recorded data from such media should be near-field reading systems. To reach indigenous increase the capacity of optical media is possible through the creation of a multilayer optical disc with a multi-level representation of the data. Promising is the creation of 5D-memory data encoding with frequency and polarization of the radiation reading. Such carriers can compete with hard magnetic disks when you create the data store.

1. Kryuchyn A. A. Perspectives for using technology of thermolithography / A. A. Kryuchyn , A. S. Lapchuk, Bryts'ky, S. O. Kostyukevych // Semicond. Phys., Quant. Electron. & Optoelectron.. 2012. – 15 (3). – P. 325-332.

2. Farhana Masid, Trisha L. Andrew, Rajesh Menon and Optical patterning of features with spacing below the far-field diffraction limit using absorbance modulation// OPTICS EXPRESS.– 2013– 21(4) – P. 5209 – 5214

3. Min Gu, Xiangping Li and Yaoyu Cao Optical storage arrays: a perspective for the future of big data storage// Light: Science & Applications -2014,- 3,- e177 - P. 1-11; doi:10.1038/lsa.2014.58

4. Watabe KazuoNext-Generation Optical Disc Technologies// Electronic resource]. – http://toshiba.semicon-storage.com/product/storage/pdf/ToshibaReview_vol66n8_06.pdf– the Ingestion. screen

5. Peter Zijlstra. Five-dimensional optical recording also been other idea: where by surface plasmons in gold nanorods/ Peter Zijlstra, James W. M. Chon & Min Gu //NATURE.-2009 - 459-p. 410-413.