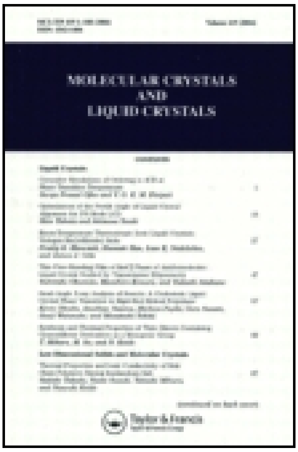

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Multi-Layered Optical Storage Media Using Arranged Nano Particles

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Recently, general optical-storage-media's capacity reached a limiting point due to shorter wavelengths and higher numerical apertures. Therefore, we need to develop novel optical storage system. In this research, a multi-layered high-density optical storage media has been proposed. The media has nanostructures composed of 200-nm-diameter photosensitive particles. Each particle is used for digital recordable pits. Its optical shape signal is picked up with a polarization-interferometric nonlinear confocal microscope equipped with a high numerical aperture objective. In the disk proposed, no electronically produced reference signal is necessary for clock data recovery. So, no jitter occurs in the recovery through nonperiodic clock signal.

Keywords nano-particle; storage media; jitter-free; confocal microscope; Michelson interferometer.

1. Introduction

Our laboratory is currently investigating several techniques to perform a mass storage using nano particles as recordable pit strings [1]. In this paper, we propose a new idea for a mass storage disk in order to increase the capacity. To this goal, we have adopted some approaches: for one thing, three-dimensional stacking of particles, which are downsized to 200 nm in diameter; what is more, S/N improvement with buffer ring, which is non-photosensitive area around the particles; one final point is image contrast enhancement with a novel high resolution microscope, which is equipped with a polarization interferometer in a confocal microscope. Therefore, particles can be measured, even though the particles size is under its spatial resolutions.

2. Experimental Procedure

2.1 Sample Preparetion

Figure 1 illustrates a process to prepare a multi-layer stacked three-dimensional particles disk. In order to alignment 200-nm nanoparticles with buffer rings, we prepared 4.0-wt% polymethl-methacrylate (PMMA) solution in cyclohexanone, as a transparent buffer layer

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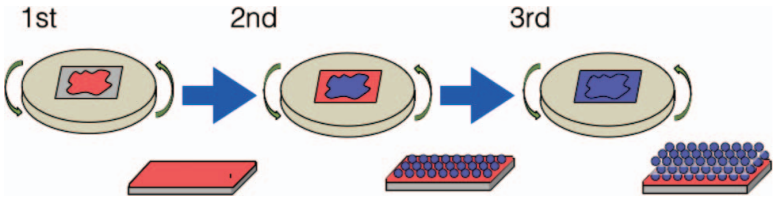

Figure 1. The process of making multi-layered optical storage media.

[2]. The 1st step is to prepare the buffer layer by spin-coating on a 26 mm x 38 mm glass plate at a spin rate of 1st: 500 rpm for 5 sec, 2nd: 2000 rpm for 30 sec. 2nd step is to arrange the photosensitive nanoparticles on the transparent buffer layer by spin-coating its suspension mixed with 10-mM sodium dodecyl sulfate (SDS) solution as a surface-active agent. The particles solution to SDS solution mass ratio was 1:1. A spin rate is 1st: 500 rpm for 5 sec, 2nd: 2000 rpm for 30 sec. 3rd step is to reitere the whole proces for multi-layer stacking. Figure 2 shows the photographic image of arranged nanoparticles. This figure reveals that the particles are successfully arranged with a small clearance gap (=30 nm), or buffer ring.

These nanoparticles can be recorded because these are stained with a photosensitive agent. With high-power laser beam, it could transition to the triplet excited state. Then the index of refraction of the nanoparticles is changed, and it is measured with a following laser microscope as a digital recorded bit.

2.2 Experimental Setup

Figure 3 shows a schematic of the optical setup for the nano-particles optical storage system [3]. The data recording and read-out apparatus with a reflection-type confocal scanning microscope including a polarization interferometer has laser light sources: a NdYAG laser ($\lambda = 532$ nm) for recording and a semiconductor laser ($\lambda = 635$ nm) for read-out. The expanded beams on the measurement arm beam are focused onto the disk sample surface through an objective lens (N.A. = 0.8). The confocal reflection signal from the sample surface is measured through a pinhole ($\Phi = 15\ \mu$m) with a photo detector. An approximate

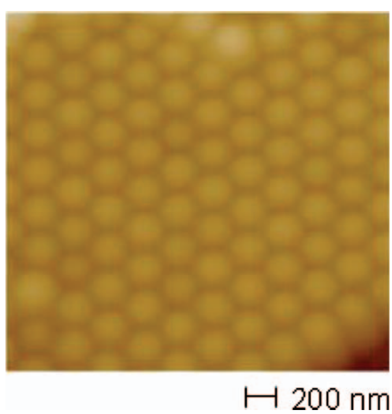

Figure 2. AFM image of the part of arranged nano-particles with buffer ring.

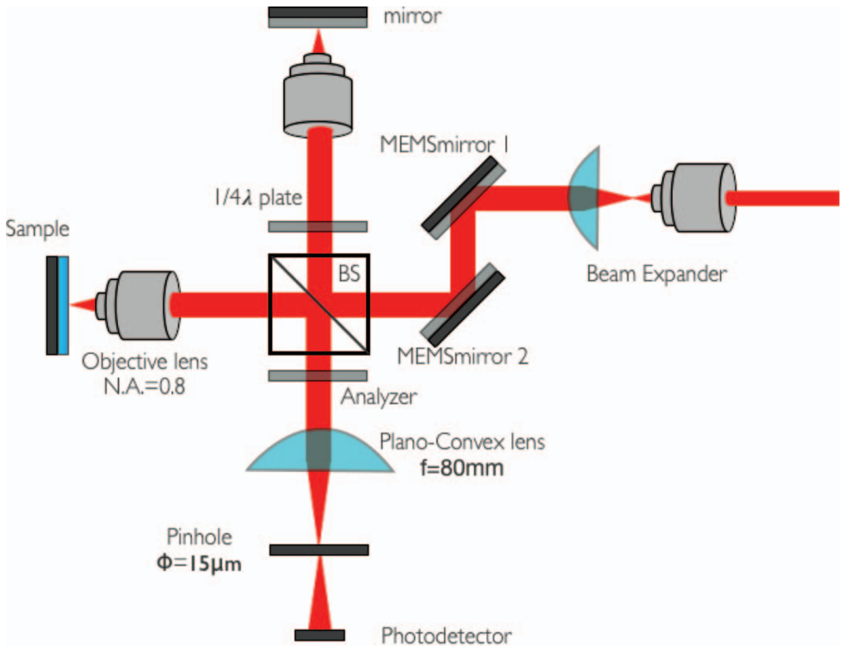

Figure 3. Reflection-type confocal scanning microscope including polarization interferometer.

particles position is checked with a transmission-type Koehler-illumination and a CCD image sensor. The focused beam generates a nonlinear dielectric polarization, which provides backscattering from it. Polarization analysis with an analyzer of the scattered signal with the polarization interferometer on the reference arm beam observes the nonlinear dielectric polarization induced in the particles. In order to get high contrast transfer function (CTF), the interference signal is set to minimum while scanning the background of nanoparticles.

3. Experimental Results

Figure 4 shows the negative type interferometric signal for clock signal recovery is generated from the nano particles storage medium by means of the reflection-type nonlinear confocal laser scanning microscope equipped with polarization interferometer. Figure 5 shows the

Figure 4. The polarization interferometric shape signal from two nano particles.

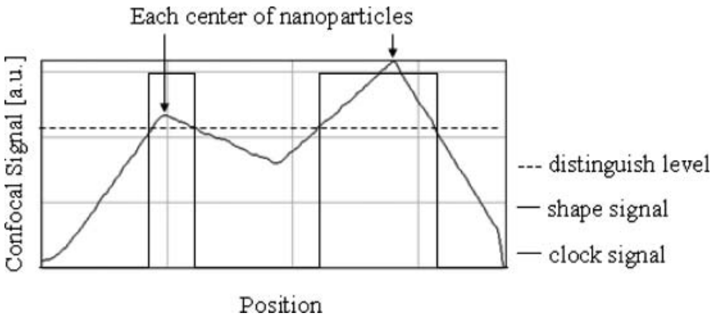

Figure 5. The optical shape signal and clock signal on the top of the nanoparticles.

clock signal generated from fig. 4. We have succeed in measuring not only the optical shape signal for clock signal generation but also accurate position of the signal nano particle. The lateral spatial resolution measured about 20 nm.

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