Error Rate Reduction of Super-RENS Disc (Invited)

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Abstract: We report the error rate improvement result of super-resolution near field structure (Super-RENS) read only memory (ROM) and write-once read-many (WORM) discs at a blue laser optical system: laser wavelength (λ) 405nm, numerical aperture (NA) 0.85.

1. Introduction

The signal characteristics (CNR above 40dB) of the super-RENS disk has been achieved from 300nm mark to 37.5nm signals by using a Sb type to a PtOx type during the last 6 years.[1-4] The technical issue of super-RENS has been changed from CNR of single frequency pattern to signal characteristics of random pattern.[5-6] The random signal error rate of Super-RENS ROM and WORM disc at a blue laser optical system (λ =405nm, NA=0.85) will be reported. The minimum mark size (2T signal) of the sample discs was 75nm. We controlled the equalization (EQ) condition, and used the adaptive write strategy and adaptive partial-response maximum likelihood (PRML) technology. We obtained bit error rate (bER) of 10^-4 level by using these new signal processing technology.

2. Experimental Procedure

We prepared a super-RENS ROM and WORM disc using phase change readout material. The thicknesses of substrate and cover layer are 1.1mm and 0.1mm, respectively. The ROM stamper (2T=75nm) was fabricated by an electron beam lithography technology (fabrication: OBDUCAT, Sweden). The experimental conditions are depicted in Table 1. To examine recording and readout characteristics, an optical disk drive tester (a Pulstec ALD-3000) was used and RLL(1,7) code was adopted for random pattern. We controlled EQ gain profile and used an adaptive write strategy and an adaptive PRML technology in order to improve the error rate.

3. Results and discussion

The sample structures of super-RENS ROM and WORM discs are shown in Fig.1. Phase change materials (ROM: GeSbTe, WORM: SbTe) were used for super-RENS readout. Figure 2 shows the 75nm ROM pit SEM images. The pit shape is much wider than that of conventional ROM. The RF signal of 2T (75nm) monotone pits is shown in Fig.2. The CNR and LFN (low frequency noise) was 48dB and below 18dB, respectively. MTF (Modulation Transfer Function) characteristics of super-RENS WORM disk were shown in Fig.3. Below resolution limit, approximately 5% modulation was achieved by super-RENS effect. The 2T and 3T shows the similar modulation. The MTF characteristics were controlled through a specially designed gain controllable EQ process. Figure 5 shows the effect of the write-strategy. For small size writing below resolution limit, newly designed 5 symbol write-strategy technology was used for the final writing condition control. The bER results (10^-4 level) of ROM and WORM discs were depicted in Fig.6 and Fig7, respectively.

4. Conclusion

The 10^-4 level bERs at both ROM and WORM (2T:75nm) super-RENS signal have been achieved using gain controllable EQ, advanced PRML techniques and 5-symbol write strategy. The ROM random signal below the resolution limit was enhanced by the super-RENS effect and error rate was greatly improved by the pit shape and EQ conditions. The WORM random signal was enhanced by optimizing the writing condition: error analysis and 5-symbol write-strategy process. These results show the feasibility of super-RENS technology for practical use.

References

Table 1. Experimental conditions.

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
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<tbody>
<tr>
<td>Wavelength</td>
<td>405 nm</td>
</tr>
<tr>
<td>Numerical aperture</td>
<td>0.85</td>
</tr>
<tr>
<td>Linear velocity</td>
<td>2.5~5 m/s</td>
</tr>
<tr>
<td>Modulation code</td>
<td>RLL (1,7)</td>
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<tr>
<td>Minimum mark length</td>
<td>75nm (Track Pitch: ROM 0.32 μm, WORM 0.60 μm)</td>
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Fig. 1 Sample structure of ROM and WORM super-RENS discs.

(a) ROM
(b) WORM

Fig. 2 SEM images of super-RENS ROM wide pits (track pitch 0.32μm).

Fig. 3 2T (75nm) RF waveform of super-RENS ROM Disc.

Fig. 4 Modulation characteristics of super-RENS WORM disk.

Fig. 5 Error improvement by write strategy in super-RENS WORM disk.

Fig. 6 bER result of 75nm super-RENS ROM disc as a function of disc linear velocity.

Fig. 7 bER result of 75nm super-RENS WORM disc as a function of readout power.