Stability Enhancement of Super-RENS Readout Signal

Jooho Kim †, Yongwoon Lee*, Wook Yeon Hwang*
Takayuki Shima** and Chongsam Chung*

ABSTRACT

We report the readout stability improvement results of super-resolution near field structure (Super-RENS) write-once read-many (WORM) disk at a blue laser optical system. (Laser wavelength 405nm, numerical aperture 0.85) By using diffusion barrier structure (GeSbTe sandwiched by GeN) and high transition temperature recording material ($BaTiO_3$), material diffusion of phase change layer and recording mark degradation were greatly improved during high power (Pr=2.0mW) readout process up to $1X10^5$ times.

1. Introduction

The issue of super-RENS has been changed from CNR [1-4] of single frequency pattern to signal characteristics of random pattern [5-6]. The bER characteristics of super-RENS were recently reported in both ROM and WORM type media [7-11]. Remaining important problem of super-RENS is the readout stability caused by high temperature super resolution readout process. We thought the signal degradation has two different origins, GeSbTe and ZnS-SiO2 inter-diffusion and PtOx rigid bubble gas (O2) leakage. In this study, we will report the improvement results of above two degradation origins by using new media structure and materials.

2. Experimental Procedure

We used a super-RENS WORM disk using PtOx, BaTiO3 recording material and phase change super resolution material. The thicknesses of substrate and cover layer are 1.1mm and 0.1mm, respectively. The experiment conditions are depicted in Table 1. In order to examine recording and readout characteristics, an optical disk drive tester (a Pulstec ODU-1000, a laser wavelength (λ) = 405 nm and a lens numerical aperture (N.A.) = 0.85) was used. We used the specially designed pattern signal [2T(20ea)-3T(20ea)]+ [2T(20ea) - 4T(20ea)]+...+[2T(20ea)-8T(20ea)]+[2T(20ea)-9T(20ea)] in order to evaluate the readout stability status like dc level and 2T amplitude change. The pattern signal stability is more severe condition than that of random signal and was, thus, used for evaluation of the signal stability.

† 삼성전자㈜ 디지털미디어연구소
E-mail : jooho1.kim@samsung.com
TEL : (031)200-4249 FAX : (031)200-3160
* 삼성전자㈜ 디지털미디어연구소
** Center for Applied Near-Field Optics Research National Institute of Advanced Industrial Science and Technology (AIST), 305-8563, Japan

3. Results and discussion

The writing and readout conditions of each T (2T~9T) were controlled to obtain both high CNR and good symmetry condition by using the pattern signal as shown in Table 1. Figure 1 shows the previous conventional sample disk structure consisting of dielectric, super resolution and recording layers. Readout stability at the previous disk structure (no diffusion barrier and no P/C protective layer) using pattern signal is shown in Fig. 2. The DC level was decreased from 1.6 V to 1.4 V (12.5% down) after 10,000 times reading as shown in Fig. 2 (a). The 2T amplitude was also deteriorated from 50mV to 10mV (80% down) as depicted in Fig. 2(b).

Table. 1 Experimental conditions

Item	Value
Wavelength (λ) /Numerical aperture (NA)	405 nm / 0.85
Recording power (Pw) / Readout power (Pr)	~6.0 mW / ~2.0 mW
Linear velocity (CLV)	2.5 m/s
Minimum mark length (2T) / Track Pitch	75 nm / 0.32 um
Pattern Signal (2T ~ 9T)	[2T(20ea)-T(20ea)]+ [2T(20ea) -4T(20ea)]+...+[2T(20ea) -8T(20ea)]+[2T(20ea)- 9T(20ea)]

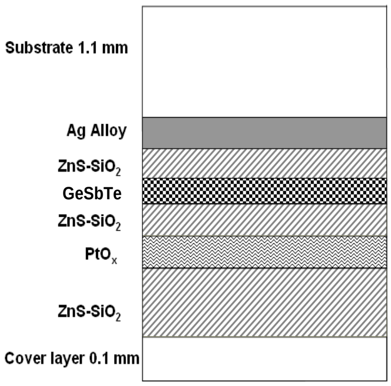

Fig.1 Previous conventional sample disk structure

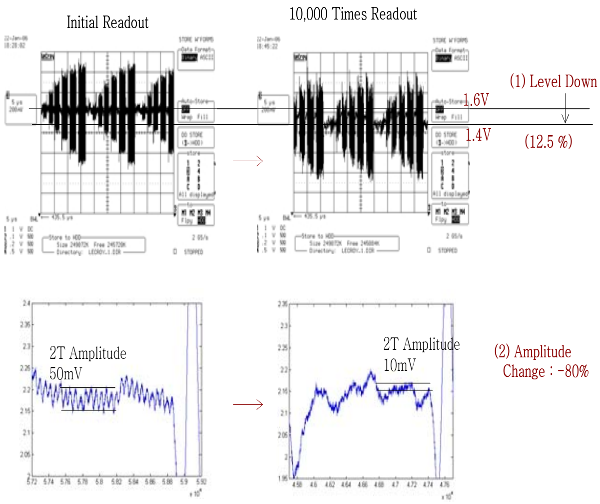

Fig.2 Readout stability without diffusion barrier in PtOx-GeSbTe super-RENS disk showing 12.5% DC level change (down) and 80% 2T amplitude change (down).

In the case of monotone 2T (75nm) signal, stability was kept up to around 50,000 times without signal degradation [12]. In the case of pattern signal, however, readout stability is rapidly deteriorated. We do not know the exact reason for this phenomenon at the moment. It is thought that the high temperature cause the inter-diffusion between GeSbTe and ZnS-SiO2 layer and the partial material flow inside the GeSbTe layer and this will lead to the rapid signal deterioration of the pattern signal. In this view point, the diffusion barriers between GeSbTe and ZnS-SiO2 layers were introduced to the layer structure.

Figure 3 shows the sample disk structure for readout stability improvement consisting of polycarbonate (P/C) protective layer, upper and lower diffusion barrier, dielectric layers, super resolution layer and recording layer. The results of the GeN diffusion barrier addition are depicted in Fig. 4 (a). The degradation of the pattern signal was greatly improved although there still remains 8.3% DC level down and 16.7% 2T amplitude down. For the additional improvement, we also used the P/C protective layer for preventing the P/C damage during high temperature readout. Figure 4 (b) shows the improved results of 0% DC level change and 10% 2T amplitude down by using of both the GeN diffusion barrier layers and the P/C protective layer, simultaneously.

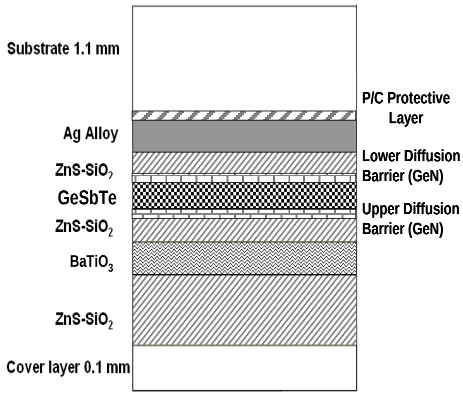

Fig.3 Sample disk structure for readout stability improvement.

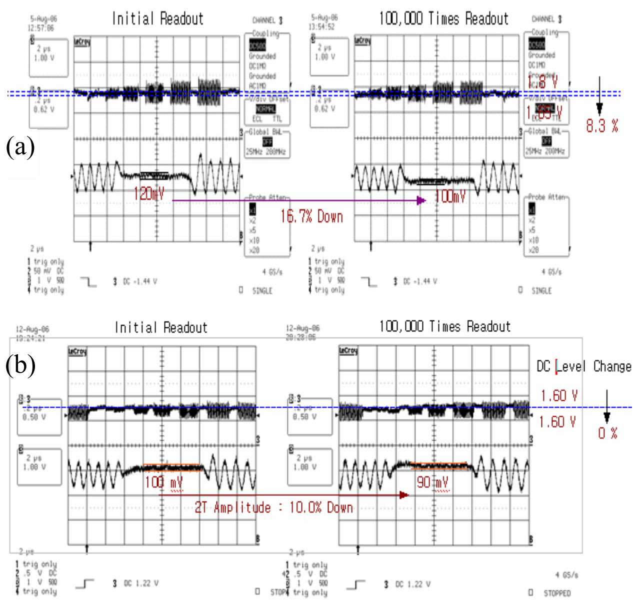

Fig.4 Readout stability in the case of (a) using GeN diffusion barrier showing 8.3% DC level change and 16.7% 2T amplitude change (b) using GeN diffusion barrier and P/C protective layer showing 0% DC level change and 10% 2T amplitude change.

However, the 2T amplitude deterioration still remains after 10^5 readout process. It is thought that the reason of 2T amplitude decrease may be the degradation of the PtOx rigid bubble recording mark due to the high temperature readout power. The decomposition (recording) temperature of PtOx starts around 500~550℃ and the readout temperature is very similar to the recording temperature. This temperature similarity will be related to the 2T amplitude down. Figure 5 (a), (b) show the PtOx rigid bubble recorded state and the BaTiO3 recording state. The melting (decomposition) temperature of BaTiO3 is approximately above 1500℃ and is much higher than that of the readout temperature. Another merit of BaTiO3 is the non gas-generation type recording material because the origin of deterioration of the PtOx recording mark would be also strongly related with the gas diffusion during high temperature readout. Both DC level change and 2T amplitude down were completely improved up to 10^5 readout times by using of BaTiO3 recording material as shown in Fig. 6. The DC level was kept at the 2.23V and the 2T amplitude was also maintained at 100mV after 10^5 readouts.

(a)

(b)

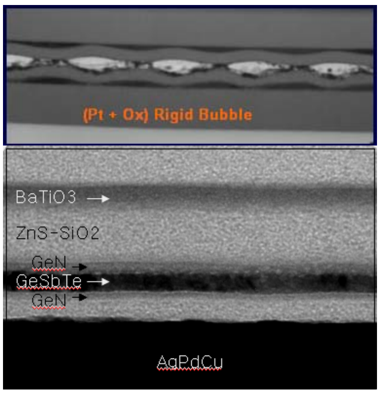

Fig. 5 Recording materials (a) PtOx layer showing rigid bubble and gas generation (b) $BaTiO_3$ layer showing no volume change and high transition temperature.

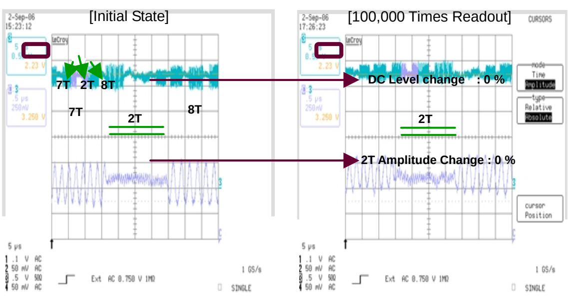

Fig. 6 Readout stability in the case of using GeN diffusion barrier, P/C protective and $BaTiO_3$ recoding layer showing 0% DC level change and 0% 2T amplitude change.

4. Conclusion

The 10^5 times readout stability of super-RENS pattern signal has been achieved by using GeSbTe diffusion barrier structure (GeSbTe sandwiched by GeN layers) and non-gas-generation type recording material ($BaTiO_3$) having high temperature transition and no-gas generation characteristics. This result reveals another progress in super-RENS feasibility for practical use.

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