Coverlayer Fabrication of Small Form Factor Optical Disks

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Abstract

Two different coverlayers which is useful for an optical buffer and a mechanical protection made of not only UV resin but also polycarbonate coversheet were prepared on small form factor optical disks. Thin coverlayer of 10 μm and thick coverlayer of 80 μm were fabricated. 10 μm -thick coverlayer was coated using UV resin material by spin coating method for the flying optical head application. On the other hand, 80 μm -thick coverlayer using coversheet with the resin bonding material was prepared for the non-flying optical head application. Both cases, the thickness uniformity seem to be the primary prerequisite factor, and it was analyzed. Thickness of 10 μm -thick UV resin coverlayer could be controlled within ±0.2 m range and 80 μm -thick coversheet could be controlled within ±3 μm range. However, the yield of such thickness tolerance was not good. New design of metal housing holder and polycarbonate outer ring was adopted to diminish the ski-jump phenomenon. Specifically, the polycarbonate outer ring was very effective to reduce the ski-jump. However, it should be careful to maintain uniform edge between disk and ring for the perfect coverlayer.

Key Words : small form factor optical disk, coverlayer, ski-jump, outer ring

1. Introduction

Two principle streams in optical data storage can be described as the increase of recording density and the miniaturization of drive and disk. The former can be realized by reducing wavelength of laser and enlarge the numerical aperture. The later is mainly for the mobile application such as cellular phone, PDA, sub-notebook, etc. Eventually, these two directions should be coupled as a small form factor high density optical storage.

Two types of small form factor optical disks are being proposed, one is using a flying optical head and the other is using a non-flying optical head.[1],[2] In an ideal case of the flying optical head system, a focusing actuation function can be removed since the gap distance between the head and disk surface is constant. In an actual case, it is very difficult to coincide between the focal plane of an objective lens and the recording layer in the media. Therefore, the thickness control of the coverlayer is critical not only for the focusing function but also for the aberration. Thin coverlayers from several micrometers to a few of tens micrometers are recommended in general. On the other hand, the non-flying optical head system adopts relatively thicker coverlayer like Blu-ray Disc. 10 μm and 80 μm-thick coverlayers were investigated for the flying and non-flying optical head application, respectively.

The thickness uniformity and the edge bead (ski-jump) phenomenon seem to be the most important two issues in coverlayer investigation.[3] Therefore, we have investigated to get uniform and ski-jump free coverlayer for small form factor disks. Additionally, the head-disk-interface (HDI) issue is also very important especially for the flying optical head system. A protective later was coated and the mechanical properties of it were investigated. In this report, we will present the uniformity and ski-jump properties of coverlayer and the hardness of the protective layer.

2. Sample Preparation

Figs.1 show two structures of small form factor optical disks. One of the common features of both structures is an adoption of the coverlayer but the thickness and preparation of the coverlyers are different. Specifically, 10 μm-thick coverlayer for the flying optical head was made of a UV resin shown in Fig. 1 (a) and 80 μm-thick coverlayer for the non-flying optical head was a coversheet shown in Fig. 1 (b). Moreover, DLC protective and lubricant film is added

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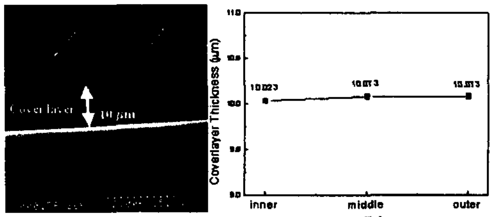
on the top of 10 μm-thick coverlayer to avoid the head-disk-interface problem for the flying optical head application. 10 μm-thick coverlayer was fabricated by using multi-step spin coating process to achieve a precise thickness control by changing the spinning parameters. In order to meet the requirement of our flying optical head, the uniformity of coverlayer thickness had to be controlled within ±0.2 μm range. 80μm coverlayer was fabricated using 70 μm-thick coversheet with spin bonding method. The role and the fabrication condition for the coverlayer were similar to the Blu-ray Disc but, the thickness and tolerance range were somewhat different. The optics of our non-flying optical head want coverlayer of 80±3 μm. The thickness margin is different from Blu-ray Disc, so that the difficulty of coating small disks could be compensated by the wider marginal range.

Even though it is not depicted in the figure, protective films made of UV resin were coated on the coverlayers in Figs. 1 to avoid the damage after the collision between head and disk. The total thickness including protective layer should be maintained as the nominal thickness. DLC and lubricant film were discussed in the previous report in conjunction with the protective layer from the viewpoint of HDI.[2]

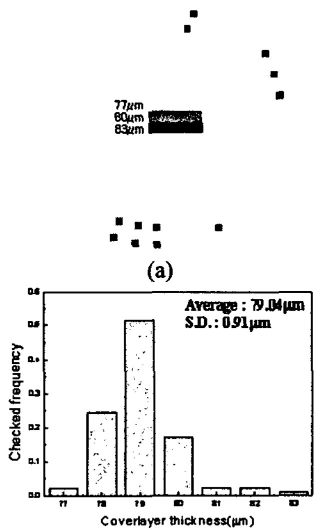
3. Results and Discussion

Thickness measurement of the coverlayer was carried out by the spectrophotometer using the interference effects especially, the dispersion of the refractive index on the wavelength could be considered for precious thickness measurement. Fig. 2 (a) shows SEM cross sectional image of the UV resin coverlayer and (b) the radial thickness distribution of it. Several over-coating processes were done for 10 μm since it was impossible to achieve 10 μm-thick coverlayer by single coating. However, if the viscosity of resin and spinning condition were controlled, single process could yield 10 m-thick coverlayer. Less than 1% of thickness uniformity could be obtained for whole area of 27.4 mm-diameter of the small form factor disk. Figs. 3 are measured thickness results of 80 μm-thick coverlayer, in which (a) is the thickness distribution for whole disk area and (b) is the diagram of overall distribution. Measurements were performed from 6 mm to 12 mm radius with 2 mm-step for every 10° of angles. The thickness deviation could be originated from both sources of uniformity of the coversheet and thickness of the bonding resin. The coverlayer thickness distributes mostly in 79±1.0 μm range, but longer tails could be measured. From an areal distribution of thickness, even though the total thickness distribution is satisfactory for the requirements of optics, more improvements in the uniformity should be carried



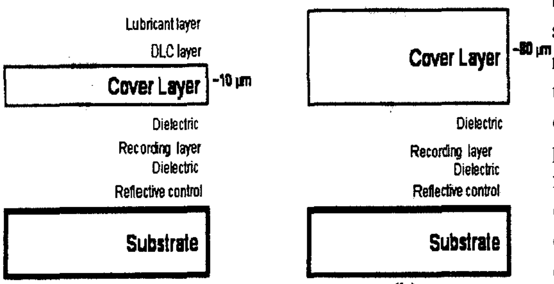
(a) (b)

Fig. 2 (a) SEM Image of 10 μm-thick coverlayer, and (b) thickness distribution



(a) (b)

Fig. 3 Thickness distribution of 80 μm-thick coverlayer, (a) is measured data, and (b) is statistical distribution



(a) (b)

Fig. 1 Disk structure of small form factor optical disks (a) for a flying optical head, and (b) for a non-flying optical head out. It could be mentioned that the thickness uniformity seems to be attributed to the coversheet since the distribution of the thickness is not symmetric.

For larger recording area in small form factor optical disks, the ski-jump must be minimized since it disturbs the stability of the flying optical head. The ski-jump is one of the most serious problems in spin coating process, it occurs due to the surface tension of the resin after the spinning. Our idea to remove the ski-jump phenomenon was to make a continuous surface at the edge of the disk. Results of two methods to reduce the ski-jump will be reported in a session, basically both are the same approaches which are shown in Figs. 4. New disk housing for coating is shown in Fig. 4 (a), which was designed to make a continuous surface during the spin coating process. On the other hand, an outer ring was implemented in Fig. 4(b) for the same mechanism as the new housing. The outer ring was fabricated using the same material and thickness of the substrate.

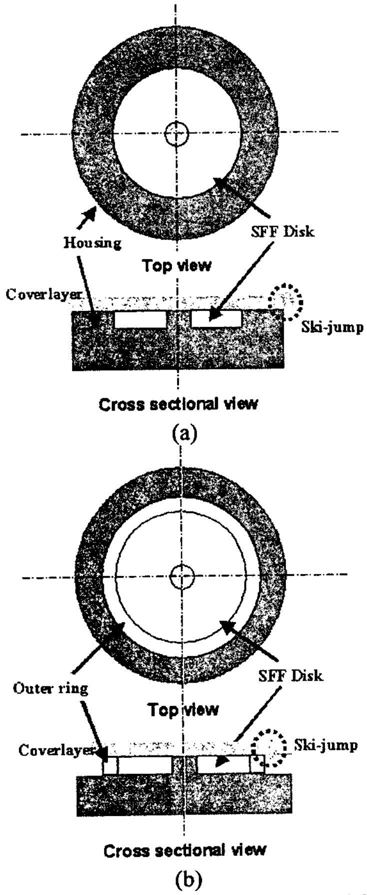


Fig. 4 Two designs to reduce ski-jump, (a) is using metal housing, and (b) is using outer ring

It was not easy to match the edge between the disk and the housing always. However we found that ski-jump area was almost disappeared in case of using outer ring. It is worthwhile to mention that to make a continuous surface is a good way to diminish the ski-jump when we make a sooth surface between the disk and its outer area.

Two pictures in Figs. 5 show the resultant coverlayers of the two cases of (a) with and (b) without outer ring. It is clear that large ski-jump is seen in figure (a) but no ski-jump in figure (b). This method seems to be effective for small form factor disk since it is relatively easy to fabricate an accurate housing or outer ring. Fig. 6 shows the hardness results by Micro-Vickers hardness for small form factor optical disks improved the surface properties by coating protective resins.

The size of dents was measured after loading of 1000 gf for 30 seconds. Compared with the bare polycarbonate substrate, it is clear that the hardness increases drastically by coating the protective layer. However, the thicker protective resin peeled off from the disk after UV irradiation because large stress was evolved during the curing.

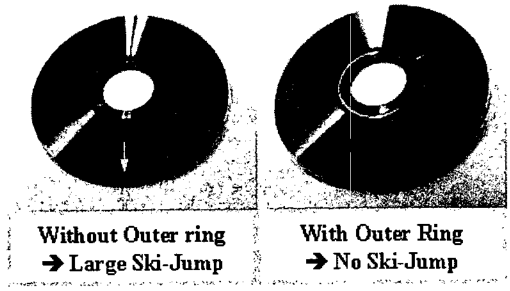
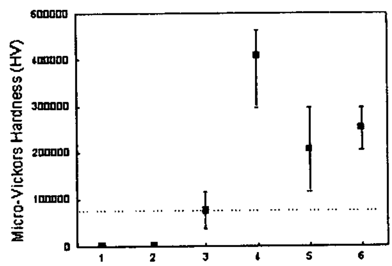


Fig. 5 Two coverlayers (a) without and (b) with outer ring



1. PC sub.
2. 70μm coversheet / PC sub.
3. 8μm hard resin / 2μm soft resin / PC sub.
4. 5μm protective resin / 3μm hard coat / 2μm soft resin / PC sub.
5. 15μm protective resin / 2μm soft resin / PC sub.
6. 10μm protective resin / 2μm soft resin / PC sub.

Fig. 6 Results of micro-vickers hardness test

4. Conclusion

Two types of coverlayers for small form factor optical disks were fabricated. 10 μm-thick UV resin coverlayer was coated for the flying optical head application, and the thickness uniformity was controlled within ±0.2 μm range. 80 μm-thick coverlayer using coversheet was prepared for the non-flying optical head application, and the thickness uniformity was within ±3 μm. New housing and outer ring were very useful to diminish the ski-jump phenomenon at the disk edge. Protective film using UV resin was coated on the coverlayer and the hardness was measured.

Reference

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