Thinner Glass Substrate designed for 10 platters 3.5 inch HDD and HAMR application

Shinji Eda[1] and Yoshinori Marumo[2]

1) HOYA MEMORY DISK TECHNOLOGIES LTD, eda@md.hoya.co.jp
2) HOYA MEMORY DISK TECHNOLOGIES LTD, marumo@md.hoya.co.jp

I. Abstract

In response to the exponentially growing demand for Cloud based storage capacity[1)], HDD development has concentrated on Areal Density improvement and disk platter count increases. As a Glass substrate maker for a long time, HOYA has continuously supported these development directions. In the course of the development we developed high modulus and high heat resistant glass substrate to support both increasing HDD platter count and HAMR technology. A new form factor of 3.5inch OD-0.5mm (20mil) thickness is now available and thinner thickness of 0.38mm (15mil) is under development. Developed glass N105Z has high modulus of 95GPa and high glass transition temperature (Tg) of 691 °C with CTE of 51 x10E^{-7}/K.

II. 3.5inch Thinner substrate

To increase platter count in one-inch height HDD thinner substrate is needed. The concern is of decreased stiffness which results in poor operation shock resistance and higher fluttering. HOYA developed a new glass N105Z with Young's modulus of 95Gpa that is much higher than former generation glass N105X.

Table 1 shows the thermal-mechanical properties of substrate materials. GD7S is exclusively used for PMR and N105X is designed for HAMR. These glasses have Young's modulus and specific modulus higher than AlMg by 118% and 120% respectively. However, in comparison with AlMg, N105Z has higher modulus (134%) and higher specific modulus (138%).

Fig.1 shows the Vickers and Knoop indentation test results of Glass (GD7S) and AlMg substrates. Glass shows less depression due to higher Vickers hardness of 620Kg/cm^2 than 128Kg/cm^2 of AlMg. A harder surface contributes to preventing scratches or surface damages by shock induced head slap during HDD operation.

Glass name			GD7S	N105X-T2	Al-Mg	N105Z
PMR , HAMR			PMR	HAMR,PMR	PMR	HAMR,PMR
Material properties	Tg	°C	483	676	(290)	691
	CTE(100/300 °C)	x10E^{-7}/K	95	68	242	51
	Young's Modulus (E)	GPa	83	84	71	95
	Density (d)	g/cm3	2.46	2.54	2.68	2.58
	Specific Modulus	–	33.7	32.9	26.5	36.6

Table 1 Property comparison (Glass vs AlMg)

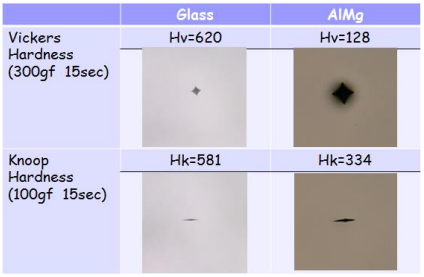

Fig.1 Hardness comparison

1) Operation Shock Test

Shock test was done by using a single platter shock tester (Lansmont Model 23D) shown in Fig.2. High speed camera captures the motion of disk with 10,000 frame/second while the shock of 100G through 200G with 2ms duration is applied.

Fig.3 shows the results of disk edge deformation of 3.5 inch OD-0.5mm thick (respectively, N105Z, GD7S and

HOYA MEMORY DISK TECHNOLOGIES LTD
E-mail: eda@md.hoya.co.jp
fax: +84 221-3-974-924
tel: +84 221-3-974-578
Plot A9, Thang Long Industrial Park II , Lieu Xa Commune, Yen My District, Hung Yen Province, Vietnam

AlMg). Disk edge deformation at 70G, which is maximum operation shock in specifications, is predicted by extrapolation. The space between ramp surface and disk surface is designed as 0.25mm in 10 platters HDD. At 70G shock, disk edge deformation of N105Z is below 0.25mm, which indicates that the ramp-media collision is not of concern. On the other hand AlMg shows much larger deformation than 0.25mm. GD7S is marginal. The results show that N105Z substrate is applicable to 10 platters HDD. GD7S is also applicable if thickness is increased up to 0.55mm.

Fig. 2 Test apparatus

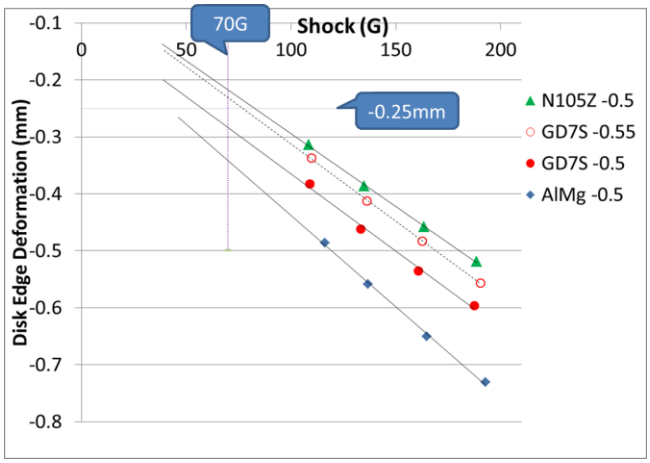

Fig.3 Result of Disk Edge Maximum Deformation

2) Anti-Shock Resistance

Table 2 shows anti-shock resistance of 3.5 inch OD-0.5mm thick N105Z at 600G. No breakage or chipping was observed in two times shock tests for 5 disks. This result verifies that the strength of 0.5mm thick N105Z is sufficient to meet the 3.5-inch HDD specification.

Test No.	1	2	3	4	5	6	7	8	9	10	Avg
Shock(G)	584.0	585.1	584.3	589.6	587.6	588.6	589.6	591.1	590.3	593.7	588.4
Duration time (msec)	1.98	1.98	1.97	1.94	1.95	1.97	1.96	1.94	1.95	1.94	1.96
Result	○	○	○	○	○	○	○	○	○	○	

Table 2 Anti-Shock test (600G) result

III. Summary

We have developed a new glass substrate N105Z of Young's modulus 95GPa for 3.5inch multi-platter HDD. With 0.5mm thick disks 10 platter HDD is realized. N105Z has also high heat resistance due to the high transition temperature of 691°C (Tg) as shown in table 1. This Tg is sufficient for the formation of ordered $L1_0$ structure of Fe-Pt binary alloys[2] for HAMR media. HOYA will continue the development of rather higher modulus glass substrate for thinner disk to realize larger capacity HDD with 12 platters or more.

REFERENCES

1) Eric Brewer, Lawrence Ying,Lawrence Greenfield, Robert Cypher, and Theodore Ts'o "Disks for Data Centers" web-site http://research.google.com/pubs/pub44830.html

2) Y.K.Takahashi "FePtAg-C granular films for thermally assisted magnetic recording media", web-site http://www.nims.go.jp/apfim/pdf/MORIS2011_YKT.pdf