

Reliability of Long-term Storage for Compact Disc Media

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ABSTRACT

In 1982, the history of the optical disk world started by CD-Audio. In this study, we have aimed to clarify long-term storage characteristics of CD media (CD-Audio, CD-R). Playback characteristics of commercial CD-Audio manufactured in around 1982 were evaluated and more the life expectancy of CD-R disks evaluate by using the Eyring acceleration test, experimentally. The experimental result demonstrated that lifetime of a CD media is deemed to be sufficiently long at general room condition.

KEYWORDS: Compact Disc, CD, reliability, archival data, Eyring acceleration model, life expectancy, optical disk

1. Introduction

Since 1982, CD media has been widely used in the internet-digital information world, and been expected the long-term and stability storage medium. A method of predicting the life expectancy of optical disks (CD-ROM, CD-R, DVD) has been established as the ISO or ISO/IEC standard.¹⁻³⁾

In this study, the playback characteristics of commercial CD-Audio media, that manufactured in around 1982 (after that a long-term storage under general room condition), were evaluated. Figure 1 showed the history of the reliability study (lifetime, standard test method etc.) for optical media. This paper presents discussion of long-term storage reliability for CD media and recent activity of estimating method for the archival life expectancy based on the ISO/IEC standard.

2. Measurement Results of reliability for 1982's CD-Audio media

Playback characteristics of commercial CD-Audio media manufactured in around 1982 were evaluated by using the newest commercial drive. The measurement item of the lifetime criteria used the block error rate (BLER) of the read-out digital signal, and the BLER averaged over any 10 seconds shall be less than 3×10^{-2} . At the standard data transfer rate, the total number of blocks per second entering the C1-decoder is 7 350. Thus, the number of C1 errors per second before error correction which is averaged over any 10 seconds shall not exceed 220.

Figure 2,3 shows experimental results of BLER measurements in archival (read-out) tests. A review of Fig. 2,

3 reveals that the BLER values of PC disks are very stable and not reach 220.

3. Estimating archival life expectancy of 48X CD-R media

The basic construction of our evaluation systems is shown in Fig. 4. The criterion used for determining a CD's failure time is the number of error of the BLER. The failure time is assumed to be the time at which the BLER reaches criterion value, 220. The relation between the median ranks of lifetime data obtained for measurement and the natural logarithm of the lifetime data are shown in Fig. 5. Verify that the plots for all stress conditions are reasonably parallel to one another.

As for the method of predicting the life expectancy of ISO/IEC standard, the Eyring acceleration test model is adopted. The Eyring model simplified equation in terms of temperature and relative humidity is

$$t = Ae^{\Delta H / kT} e^{B \times RH} \quad (1)$$

where t is the failure time data, T is the temperature in Kelvin, R is the relative humidity, k is the Boltzmann's constant, ΔH is the activation energy, and A and B are constants.

Constants A , B , and ΔH of eq. (1) were calculated using multiple linear regression analysis with failure time data and the respective stress conditions of temperature and relative humidity.

Now, we investigated a simple estimating method for the archival life expectancy of CD-R disks in order to apply a rough clarification of archival grade disks based on the ISO/IEC standard. Figure 6 shows the reliability function ($R(t) = 1 - F(t)$) under the 90% confidence interval. The life expectancy by the 95% confidence interval can be presumed, when reliability (survival probability) is assumed as 95% at 25°C/50%RH.

4. Conclusions

This study examined the playback characteristics of commercial CD-Audio media that manufactured in around 1982, and reported recent activity of estimating method for the archival life expectancy based on the ISO/IEC standard. The experimental result demonstrated that lifetime of a CD media is deemed to be sufficiently long at general room condition.

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References

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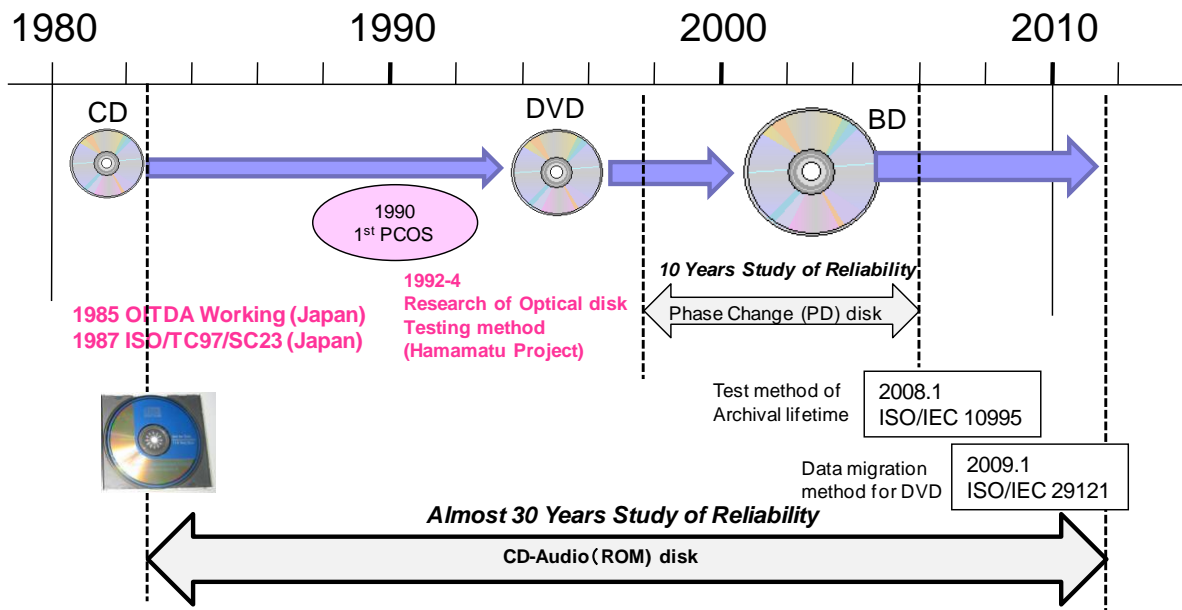


Figure 1 History of the reliability study for optical media.

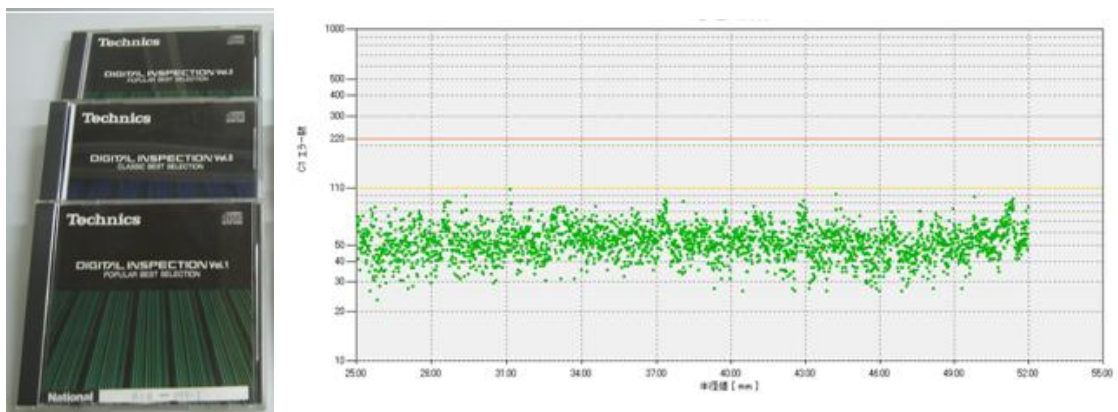


Figure 2 Experimental results of BLER measurements in 1983' CD-Audio (not for sale).

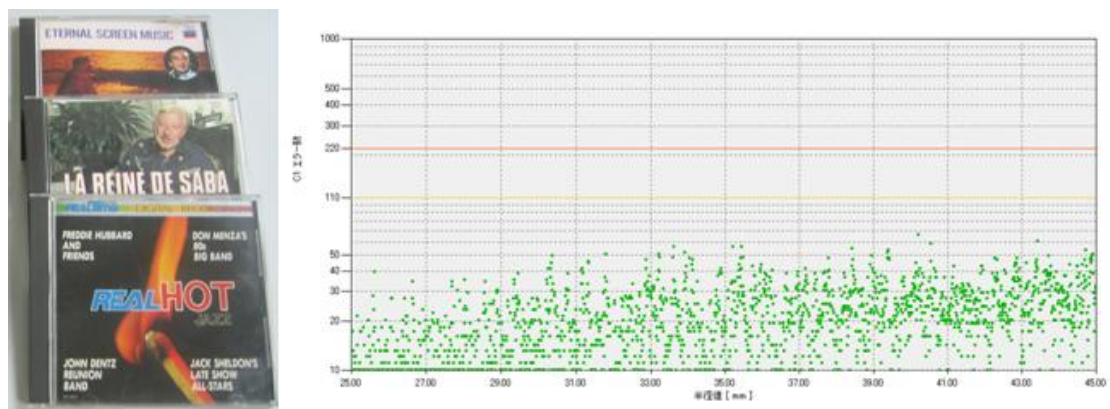


Figure 3 Experimental results of BLER measurements in 1982' CD-Audio.

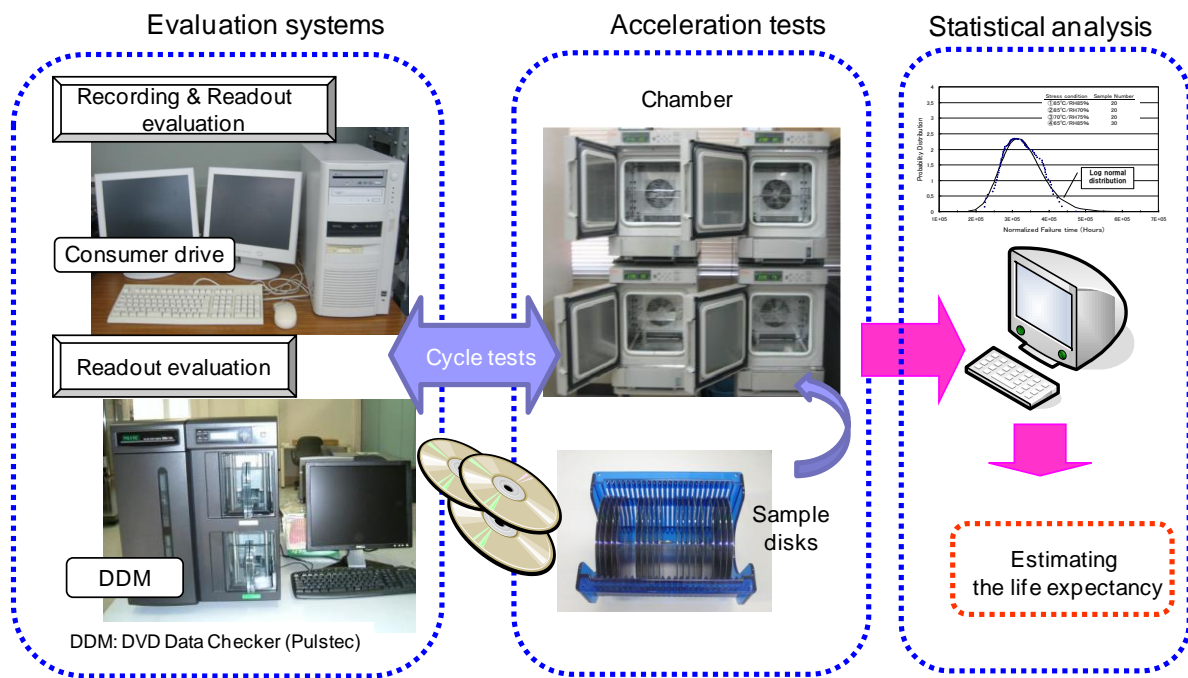


Figure 4 Basic constructions of evaluation systems.

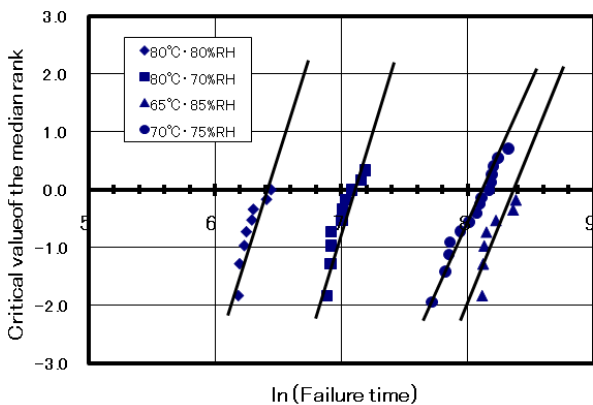


Figure 5. Relation between the median rank of lifetime data and the natural logarithm of the lifetime data .

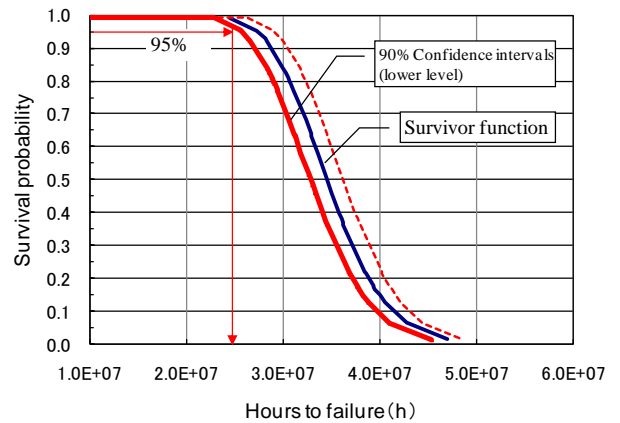


Figure 6. Survival Probability function at 25°C/50%RH .