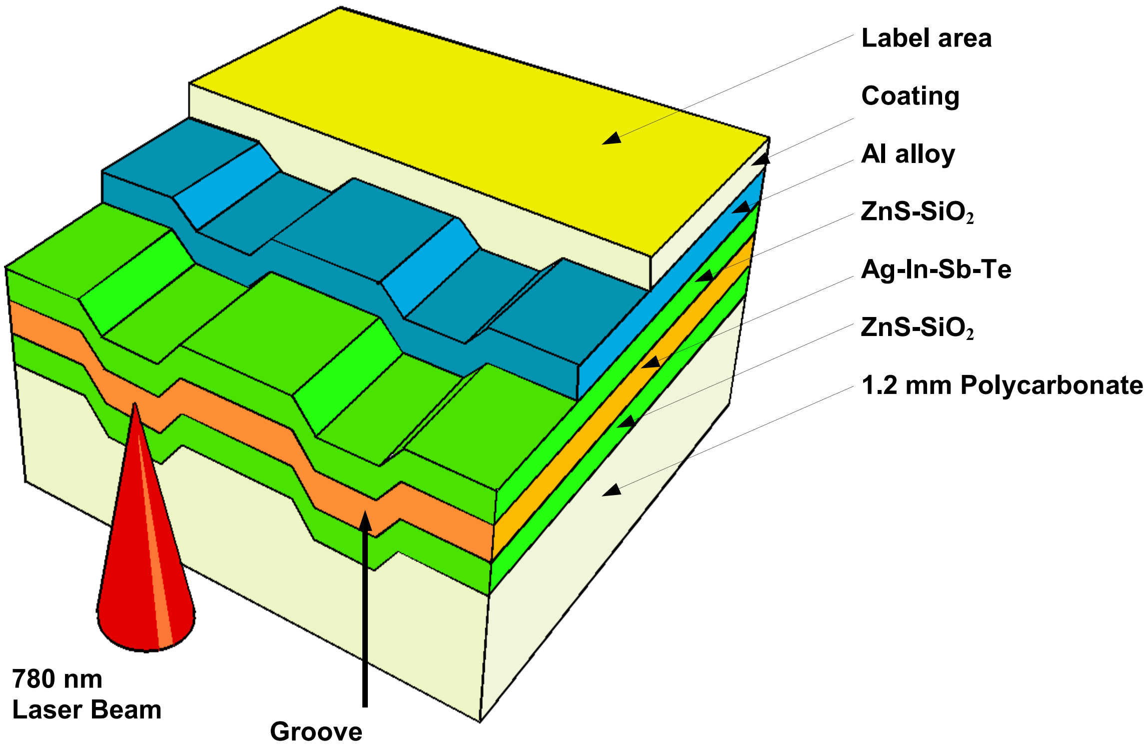
High Speed CD-RW



Introduction.

Recording on CD has grown rapidly in recent years. Practically all CD recorders are able to write on two media types: CD-R and CD-RW.

The best known media are the CD-R media, based on dye technology. The advantage of CD-R is the low media cost and the compatibility with conventional CD readers; the limitation is write-once which could be explained as a feature in case of backup applications. The major application is archiving and data interchange of large files: the corresponding write method is downloading on disc at constant bit rate.

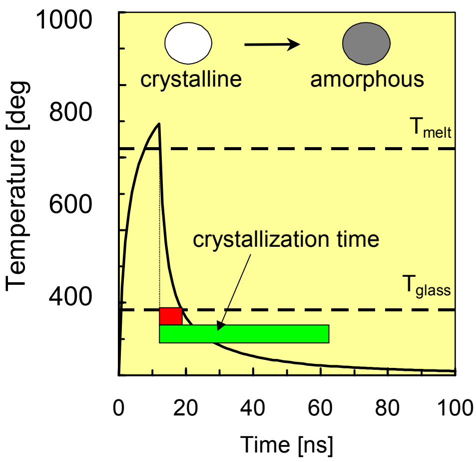
Because of the still higher high cost and compatibility (readable on Multi-read compliant devices), CD-RW media are less often used until now. CD-RW media are based on phase-change technology. The advantage of CD-RW media is the direct overwrite capability, opening a new application field for CD recording: temporary storage and data interchange.

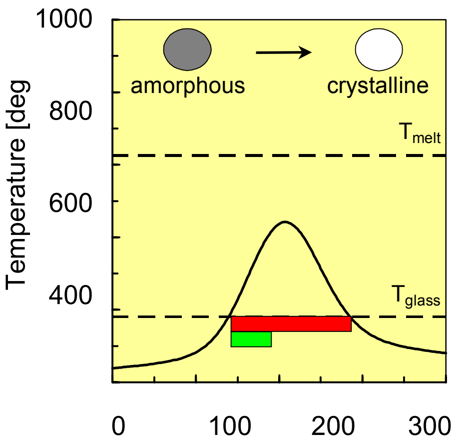
This so-called floppy use sets new performance criteria on CD-RW: the throughput of PC peripherals is not only determined by the media write speed itself, but also by the average access time to a specified address on the disc.

The latter requirement leads to CAV use of the disc, in stead of the conventional CLV use (Constant Angular Velocity in stead of Constant Linear Velocity). In CAV mode, seek times and power consumption are kept low by avoiding spinning up and spinning down while accessing different data files, randomly distributed on the disc.
This paper describes a new performance standard for CD-RW, not only by more than doubling the media write speed, but also by including CAV read-and-write performance.

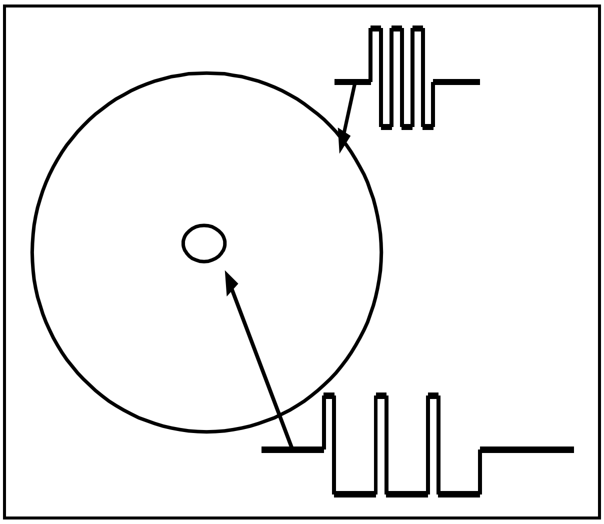
Principles of Phase Change recording at CAV.

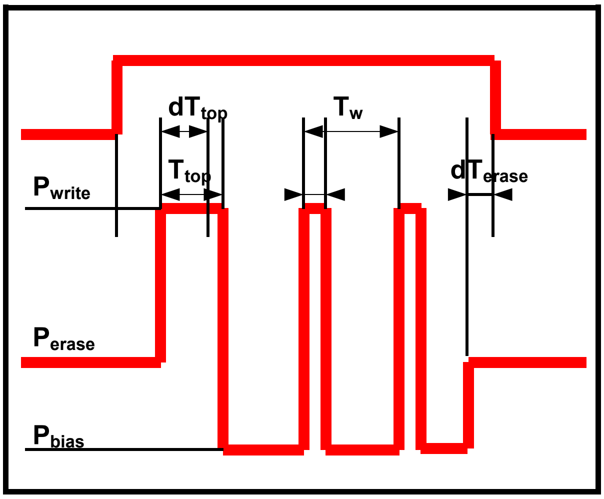
In contrast to write-once dye media like CD-R, in re-writeable Phase-Change media a critical balance in the time constants for cooling down and for (re) crystallisation determines the possibility of direct overwriting at a given speed. If the material is cooled off before crystallisation can take place the amorphous mark is frozen in: so-called melt-quenching The amorphous marks reflect less light, so appear dark in a CD player.





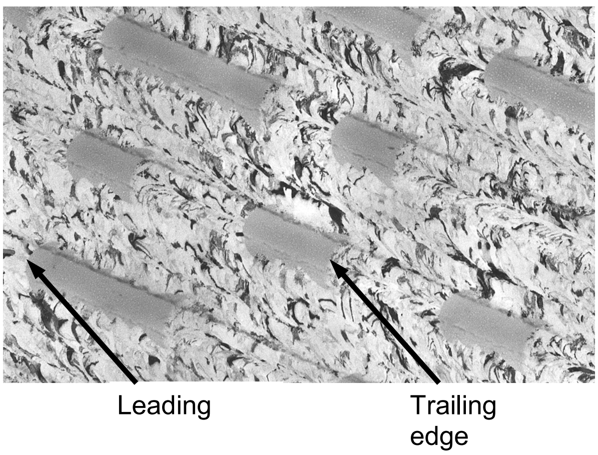
As is seen from the TEM photograph, the leading edge is round, corresponding to the shape of the write spot while the trailing edge looks truncated. This effect is due to the slow cooling of the phase-change layer at the trailing edge after the write spot has been switched up again from temporary bias power to erase power.

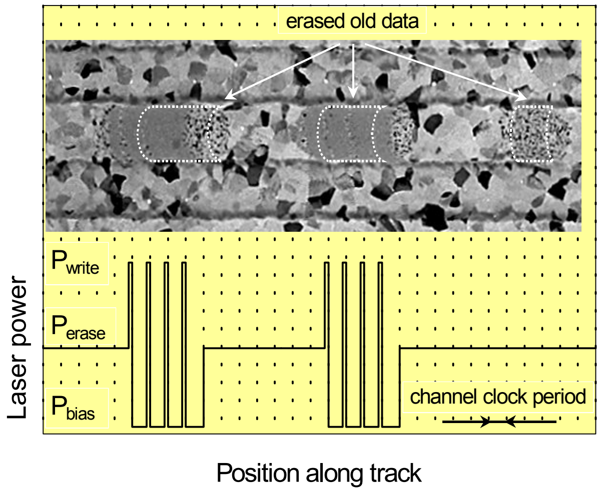




The multi-pulse shape of the power of the write laser.

An example is shown of a write multi-pulse. In this case, the multi-peaked write pulse is shown for an amorphous effect of 4T length (please, note that CD data is encoded on the disc by discrete effect lengths from 3T to 11T, with T the





The remaining crystal structure in the phase-change layer after direct overwrite of an

channel clock length in m). The figure shows that a 4T effect is written by a 3-fold pulse consisting of one T_{top}-wide single pulse and two T_{mp}-wide single pulses, with repetition times of T_w (with T_w the clock frequency at the write data rate).
In general: an effect of length nT is written by a multi-pulse consisting of n-1 single pulses.

As is indicated by the figures shown, direct overwriting on optical media is a very time critical process. It was logical therefore that CD-RW started with CLV recording, i.e. with recording at a constant disc speed.
Initially, CD-RW could only be written at 2x speed. Last year, we extended the speed range of CD-RW media to include also 1x and 4x.
Now, the improved phase-change technology, allow new high-speed media, suitable for linear recording at any speed between 4x and 10x, as well as for CAV recording at 32 revolutions per second.
Such high recording speeds require proportionally short cooling and crystallisation times of the media: for 10x media the optimum T_{mp} value will be 40% of the T_{mp} of current 4x media.
In CAV writing, the actual write speed increases with increasing value of the disc radius where writing takes place. As a result, the transfer rate increases linearly, and the write pulses must adapt accordingly. In high-speed CD-RW the rite multi-pulse adaptation is achieved by keeping single-pulse height P_{write} and single-pulse width T_{mp} constant while adapting the repetition time T_w to the changing clock frequency. At the outer diameter the linear speed is maximum and the single pulse duty cycle is 50%.

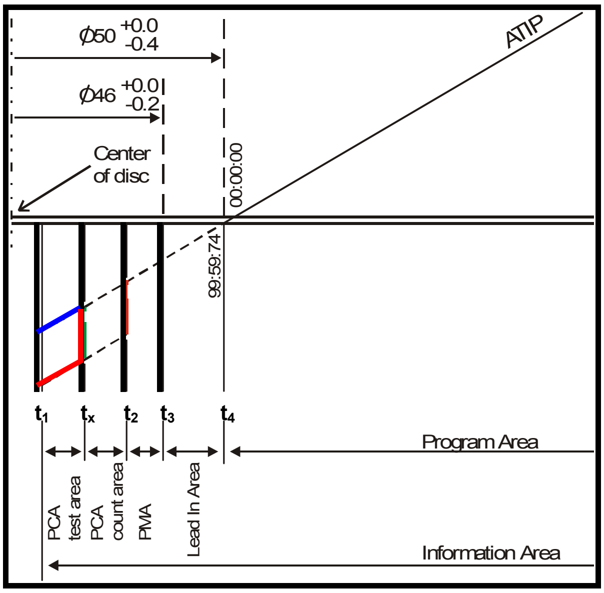
Compatibility Discussion

Problem description

Because of the time constants involved in phase-change recording, the new CD-RW media designed for high-speed recording need write strategies that are different from those prescribed for current low-speed discs. Consequently, the new high-speed CD-RW discs cannot be written correctly by the current 1x~4x drives.
A new subtype setting has been defined to identify the new discs. Some of the current drives do not recognise these subtype settings as special high-speed media and as a consequence will select their default speed setting (mostly 2x) with the related write strategy for writing on them. These recordings in general will create unreadable signals, thereby possibly overwriting and damaging previously recorded information. For instance, if these recordings would include file system structures on the disc, the accessibility of all information on the disc would get lost. To prevent such serious problems, measures have been taken to force "write-incompatibility" of high-speed CD-RW discs with existing recorders. In many cases, a firmware upgrade is sufficient to make the current drives recognise the new, high-speed discs and to write them at 4x with an adapted write strategy.

Problem solution: Hiding the PCA Test Area

During the search for a solution that could force write-incompatibility, the following requirements



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media standard	**part III, vol 1, v1.0**	**part III, vol 1, v2.0**	**part III, vol 2, v1.1**
media speed	2x-only	1x, 2x & 4x	4x – 10x
2x drive	2x	2x	Rejects writing
Current 4x drive	2x	1x, 2x, or 4x	Rejects writing
Upgraded 4x drive	2x	1x, 2x, or 4x	Writes 4x only
8x CLV drive	2x	1x, 2x, or 4x	Writes at any linear speed
10x CAV drive	2x	1x, 2x, or 4x	between 2x and 8x 10x CAV » 32 Hz
all-speed-modes drive	2x	1x, 2x, or 4x	10x CAV + any speed 4x – 10x

were seen as essential:

- Current CD-recorders shall not be able to write on high-speed CD-RW discs. However, upgrading should be possible.
- Current CD-recorders shall be able to read recorded high-speed CD-RW discs. Moreover, also CD-ROM drives should not be hindered by the measures.

Because a recorder starts with a power calibration procedure before actual recordings can be made, a solution has been found in "hiding" the PCA (Power Calibration Area). By applying a jump in the ATIP time code between the PCA Test Area and the PCA Count Area, the time code of the PCA Test Area is offset by 30 seconds. At t_x, ATIP jumps from t_3 – 00:45:26 to t_3 – 00:15:25, with t_3 the time of the start of the lead-in area.

Therefore unmodified existing drives cannot locate the PCA Test Area on high-speed discs and hence they cannot perform a power calibration procedure. As a result, they will reject writing the disc. The ATIP jump has no effect on the read out behaviour: a drive seeks no access to the power calibration area before or during read out.

Newly designed or upgraded drives can identify high-speed discs by means of the subtype; they can correct for the jump in the ATIP time code and they are able to write the new media as well.

In this document reference is made to the following standards:

- Orange book : Part III CD-RW, Volume 1. Version 2.0 describing the recording speeds 1x, 2x and 4x nominal recording speed
- Orange book : Part III CD-RW, Volume 2 High Speed Version 1.1, defining linear recording speeds between 4x and 10x nominal CD speed, which includes the capability to use the disc at a constant angular recording speed of about 32 revolutions/second

The logo to identify the High Speed CD-RW products

For further information, please contact:
Philips Intellectual Property & Standards
Business Support, Building SFF-8, P.O. Box 80002,
5600 JB Eindhoven, The Netherlands.
Fax. : +31-40-2732113
E-mail: info.licensing@philips.com
Or check our web site:
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