

DOUBLE LAYER DVD+R MEDIA WHITE PAPER

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Introduction

Although Double Layer 8.5GB DVD-ROM and DVD video discs have been available for some time as part of the DVD read-only standard, it was thought impossible or at least improbable that a similar technology could be developed for personal DVD recording. However, Mitsubishi Kagaku Media (MKM), parent company of Verbatim Corporation, and Philips have recently proven that a Double Layer DVD recording system is feasible utilizing the DVD+R (write-once) format. This technology is named Double Layer DVD+R, or DVD+R DL. DVD+R DL hardware and media products will enable consumers to store up to 4 hours of DVD-quality video, 16 hours of VHS video quality or 8.5GB of data on a single disc -- without having to stop and turn the disc.

The development of reliable DVD+R DL media materials and manufacturing processes is the key technology enabler for Double Layer DVD+R recording. This white paper discusses each component of the DVD+R DL media structure and the challenges involved in producing compatible DVD+R DL media.

Double Layer Disc Structure

The basic challenge was to develop materials and manufacturing processes for multi-layer DVD+R DL discs that allow the properties of two unique layers, once recorded, to meet the DVD read-only specifications for DVD-ROM drives and DVD video players. During recording (and reading), each layer can be targeted without disrupting data on the other layer (see Figure 1). The first recording layer (L0) of the Verbatim DVD+R DL disc is semi-transparent, providing enough reflectivity for writing/reading data on the first layer, yet transmitting enough laser power to read/write on the second layer (L1) by refocusing the laser. In addition to optimizing layer reflectivity, new Metal Azo recording dyes were developed by MKM for each layer to optimize parameters such as signal amplitudes and power margins and ensure compatibility with current DVD standards.

Note: Due to the loss of light at the L0 interface, a high-power laser is needed to transmit enough light to L1. Higher-power (30 mW) lasers, sufficient for Double Layer recording, have recently been implemented in 8X speed single-layer DVD+R recorders.

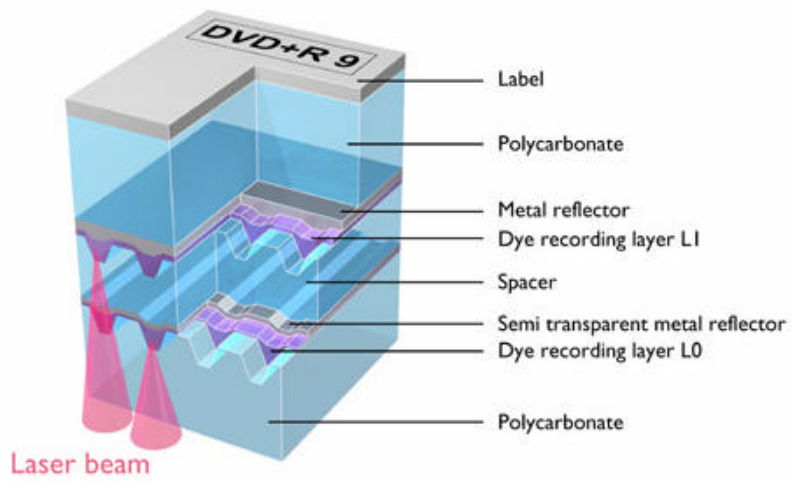


Figure 1

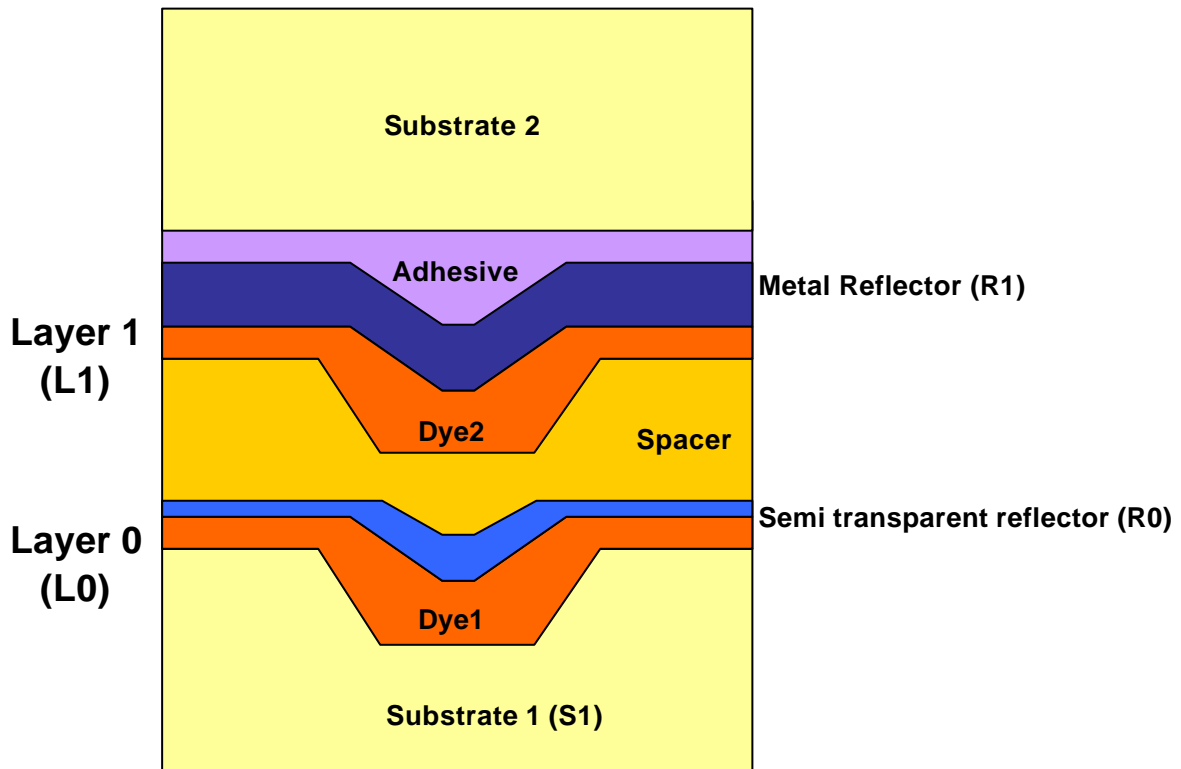


Figure 2

Substrate 1

The write/read laser passes through Substrate 1 (S1) while accessing Layer 0 and Layer 1. The groove shape that is molded into S1 must be very accurate to properly guide recording on L0. In addition, the thickness of S1 must be uniform throughout the disc. Due to the addition of the spacer material between L0 and L1, the thickness of S1 is thinner than single-layer 4.7GB DVD media. Under this condition, it is difficult to form accurate groove shapes while maintaining the proper thickness uniformity.

Verbatim/MKM have overcome this difficulty by applying very precise substrate molding technology and developing stampers. The quality of S1 cannot be optimized without internal mastering and stamper-making capabilities and expertise.

First Dye Recording Layer (L0)

L0 should function as a high-quality recording layer and should also transmit enough light to L1. For high-quality recording, L0 must exhibit high sensitivity, a wide power margin, low jitter and high durability. However, due to the transmittance requirement to enable recording on L1, L0 must also exhibit “low absorbency of light.” These requirements are difficult to achieve because, in general, high sensitivity and low light absorbance have a trade-off relationship.

The only way to solve this issue is to develop and fine-tune a new recording dye. Verbatim/MKM are pioneers in dye development and manufacturing for CD and DVD recording. Verbatim/MKM's R&D capabilities and years of experience made it possible to develop a new Metal Azo dye for L0 that can achieve high-quality recording, excellent transmissivity, and a long datalife.

Semi-transparent Metal Reflector (R0)

This layer plays the important role of reflective layer for L0 – but must transmit enough light to read/write on L1. To provide stable reflective and transmitted light, the thickness of R1 must be precisely controlled.

As a leading manufacturer of optical media which require thin metal film stacks like MO (magneto-optical) and DVD+RW, Verbatim/MKM have developed a special silver alloy

material for semi-transparent properties and have tightly controlled thin-film uniformity by optimizing the metal sputtering process.

Spacer

The optically transparent layer between R0 and L1 is called the spacer. The groove for L1 recording is formed in the spacer layer and it is very important to minimize any noise caused by the spacer. Spacer thickness uniformity must be tightly controlled for clear recording on L1.

Drawing on its experience as one of the largest material developers for optical discs, Verbatim/MKM applied a suitable material for the spacer and successfully developed a noiseless, uniform and transparent layer. Verbatim/MKM also developed a manufacturing process for application and stamping of the spacer layer.

Again, internal stamper development is required.

Second Dye Recording Layer (L1)

L1 is recorded via light transmitted through S1, L0, R0, and the spacer. Although each of these layers is designed to have excellent transmission performance, the light energy reaching L1 will be reduced. Thus, high sensitivity is the most critical requirement for L1.

A newly developed, highly sensitive Metal Azo dye has been implemented for L1 to realize a well-defined data mark recorded with the relatively low level of transmitted laser power.

Metal Reflector (R1)

The metal reflector for L1 must be designed for high reflectivity to maximize the light returned to the DVD recorder for proper signal detection.

The R1 material and thin film sputtering processes have been optimized to create a highly reflective and uniform R1.

Read/Write performance

The most important objective for DVD+R DL media is to maintain read compatibility with existing DVD-ROM drives and DVD video players. As a result, a recorded DVD+R DL disc must meet the specifications for dual-layer DVD-ROM media. Table 1 shows electrical signal test results from a DVD+R DL disc manufactured by Verbatim/MKM.

At the rated recording speed, the sample showed superior performance, well within the DVD read only specification. The recording power of less than 24 mW allows current 8X speed DVD+R/+RW drive lasers to record layers L0 and L1. Reflectivity exceeding 18 percent for both layers indicates that we can expect good read compatibility with the installed base of DVD read-only devices. Figure 3 shows wide power margins (low jitter for a wide range of write powers) for Layers L0 and L1 from the Verbatim/MKM DVD+R DL media.

Table 1. At rated recording speed

Recording Layer	L0	L1	DVD-ROM
Power (mW)	23.5	23.4	NA
Jitter (%)	6.9	6.8	< 8
Modulation I14/I14H	0.66	0.63	> 0.6
Resolution I3/I14	0.36	0.37	> 0.3
Asymmetry	0.04	0.06	+/- 0.1
Reflectivity (%)	18.5	19	> 18

Power margin sample

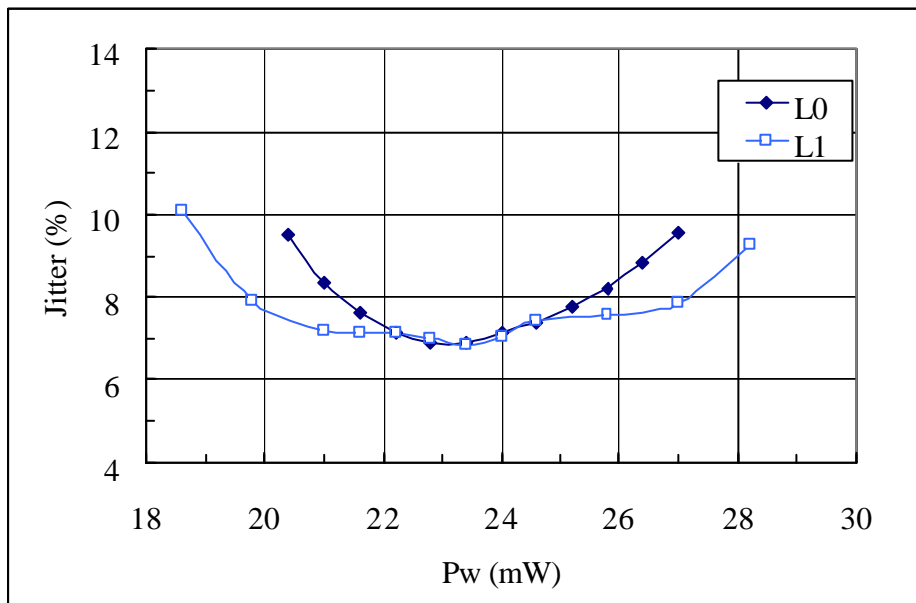


Figure 3. At rated recording speed:

Conclusion

The construction of a Double Layer DVD+R disc is complicated. Reflectivity, transmission and absorption of both recording layers must be balanced. Verbatim/MKM have used their extensive R&D capabilities and optical disc manufacturing experience to develop appropriate materials, optimize each layer structure and produce functioning 8.5GB single-sided DVD+R DL media. The Verbatim DL media is the first to have undergone exhaustive testing and be certified by the Philips Format Verification Laboratory.

Certification provides drive manufacturers and end users with the assurance that Verbatim's DVD+R DL media delivers broad compatibility with new DVD+R DL drives and as well as DVD playback devices that read DVD9 media and have fully compliant and supporting firmware and software.