REFERENCE GUIDE FOR BLUE LASER MEDIA

Content Links

FAQs about Blue Laser Media

There is a great deal of misinformation, hype, and misunderstanding in the field of optical media. Memorex wants to help customers make educated choices about the media and formats they choose; so we have assembled a list of Frequently Asked Questions and the Memorex Reference Guide for Blue Laser Media covering the subject in detail. Click on the blue text to get to the answer to the questions. Some answers will include additional links to the Memorex Reference Guide for Blue Laser Media for even more information.

High Definition Video

1) What is high definition video?
2) How do I get high definition programs?
3) I've heard that blue lasers are coming. What does that mean?
4) Why are there two different high definition discs?
5) Which disc is better, HD DVD or Blu-ray?
6) Can I play high definition DVDs in my DVD player?
7) Will the new high definition DVD players be able to play my old DVDs and CDs?
8) Will Blu-ray and HD DVD be compatible with each other?

The answers to the questions follow below. Click on the link to the Memorex Blue Laser Media Guide to get more detailed information, including pictures and charts. If you have a question not listed in our FAQs, E-mail the question to us; and we will add answers to the most frequently asked questions.

High Definition Video

1) High Definition video generally means a video signal with either 720 or 1,080 horizontal lines of video information instead of the 525 lines our NTSC television standard uses. (Of the 525 NTSC lines, only about 480 actually display picture information. The rest are used for synchronizing signals for the TV circuitry and only appear in the black bands above and below the picture.) Some DVD players use special circuitry to repeat lines the way computer monitors do. That means that instead of showing 30 frames of picture each second, each frame composed of two fields interlaced together, these DVD players send a signal to high definition displays as both fields simultaneously composing a frame. This is referred to as "progressive scanning" instead of interlacing. Although more detail appears in a progressively scanned DVD display, it is not true high definition. True high definition signals must have 720 lines of progressively scanned video ("720p") or 1,080 lines of lines of information either interlaced ("1080i") or progressively scanned (1080p). DVDs using their MPEG-2 compression do not have the capacity for carrying all the data needed for HDTV. There are two ways to add high definition information to DVD discs: a) use different compression methods to pack more information on a disc, or b) use a laser with a smaller wavelength to pack more MPEG-2 data on the disc. The first method retains the standard red laser and uses new firmware in the DVD player to distinguish regular DVDs from HD DVDs. The second method uses a blue-violet laser diode capable of much smaller wavelengths. There are two different versions of the second, blue laser method that are capable of carrying true

HDTV video signals in the MPEG-2 compression scheme: a “Blu-ray” version and an “HD DVD” version. See Reference Guide.

2) There are several ways to see high definition programs: a) use a high definition tuner with a high definition monitor to receive “over-the-air” broadcasts; b) use a high definition cable box for cable reception; c) play D-VHS cassettes that have high definition programs recorded on special VHS tape (requires a D-VHS player, which is hard to find); d) or use one of the two new high definition discs that are being introduced now.
3) The lasers used in CD players and drives and in CD-R/-RW burners are infrared lasers that produce laser light at a wavelength of 780 nanometers (billionths of a meter). DVD players, drives, and burners all use ruby-red lasers with wavelengths tuned to 650 nanometers. In order to create DVDs capable of high definition video, engineers have had to shrink disc pit sizes below the wavelengths of red light; so to read the pits, a new laser had to be developed with a smaller wavelength. The laser is a blue-violet laser with a wavelength of 405 nm. Reference Guide.
4) High definition programming requires far more data than DVD video. One way to increase the data would be to use a different data compression scheme to pack more information on a DVD, but developers chose to use blue lasers rather than red lasers used in DVDs. Blue lasers have smaller wavelength than red lasers (Red is at the bottom of the color spectrum and the blue lasers are closer to the upper ultra-violet—think of a rainbow!) and can read and write smaller data pits. Smaller data pits mean more information can be packed onto a disc the same size as a DVD. Unfortunately, the developers disagreed on how to use the blue lasers. One group decided to use greater data compression and fit all the HD programming on a less expensive disc much like a regular DVD. This was the HD DVD camp with its 15GB disc. A second group decided to push existing technology to its practical limits and use standard DVD compression on a totally new type of disc. Getting all the HD information at lesser compression on a single disc required more capacity; so this group—the Blu-ray camp—designed a disc with 25GB capacity.
5) Both discs will play high definition programming equally well. In fact, unless one is watching on a true HD screen larger than about 32 inches, high definition will be difficult to distinguish from standard DVD. Larger screen sizes begin to show the inter-line flaws and artifacts of standard video, and that is where the improvement in high definition resolution will be noticeable. As for superiority of format, that is debatable. HD DVD discs will be less expensive to manufacture because they are so similar to regular DVDs, and the recorders/players can use a plastic lens to read/write discs. Blu-ray discs have greater data capacity; and that capacity can be used with the standard DVD compression or the same compression used for HD DVD. The recording surface for Blu-ray, however, is on the bottom of the disc and more prone to scratches and physical damage. The disc will initially be more expensive to produce, and the recorders/players require a more expensive glass lens to read/write discs. The “better” format will be the one more consumers choose to adopt, and that will take time to decide.
6) In some cases it may be possible. The HD DVD Consortium has developed a special 'hybrid disc' that contains 2 distinct sets of information: one is the high definition information that will need a true HD DVD player to read it, and other is the standard definition information that can be played back on today's DVD players. This is relatively easy to do since both the standard DVD and the HD DVD use two pieces of plastic with the video data sandwiched between them. Blu-ray discs use a single-piece design with the data on the bottom of the disc. It is possible for such discs to have a double-layer design that includes a standard DVD program within the disc and the high definition information in its bottom position.
7) Yes. Read heads can include multiple read lasers or multiple lenses so that infra-red laser CDs, red laser DVDs, and blue laser high definition discs can all be read by the same device. Several leading consumer electronics companies (including Panasonic, Philips, Pioneer, Samsung, Sharp, Sony and LG) have already demonstrated products that can read/write CDs, DVDs and Blu-ray discs using a BD/DVD/CD compatible optical head; so you don't have to worry about your existing DVD collection becoming obsolete. It's up to each manufacturer

to decide to make its products backwards compatible, and most see the advantage in having players that can also read older optical disc formats.

9) No. A Blu-ray disc will not play in an HD DVD player and vice versa. However, it appears likely that some manufacturers will manufacture 'dual format' drives, players and recorders that could accommodate both formats in the same way that some manufacturers currently offer multi-format DVD players and recorders that can accommodate both DVD+R/RW and DVD-R/RW discs.

REFERENCE GUIDE FOR BLUE LASER MEDIA

Terence O'Kelly

BLUE LASERS—MORE FORMATS, MORE FORMAT BATTLES

The Digital Versatile Disc is a great medium for carrying a lot of data whether those data are used for video, super high-fidelity audio, games, information, or any combination of these programs. There are, however, limitations to the format. As great as 4.7 GB of capacity per side seems, it is not enough for more than twenty minutes or so of high-definition video in the MPEG-2 compression format. DVD movies look wonderful in comparison to VHS cassette recordings, but they are merely the best our present TV standards can show. They are not HDTV, and HDTV is the new quality standard of the future.[1] In order to be capable of carrying high-definition video, DVDs need either more capacity or greater data compression.

The other limitation is, of course, that there are three competing, incompatible recording formats that are sometimes not playable on regular DVD players. In order to resolve both limitations at the same time, DVD developers have proposed a new, future DVD standard for both players and recorders based on a different laser diode—a blue-violet laser rather than the red lasers used for CDs, CD-Rs, DVDs, and all three recordable DVDs. The original intent was to have these new players and recorders able to play today's DVDs, DVD-Rs, and DVD-RWs in addition to future HD DVD discs and allow a single standard to end the confusion over DVD recording and playback. A single standard was such a good idea that several other groups proposed their own competing, incompatible "single standards" to end the confusion even further!

Just as DVDs used smaller pits and more tracks to pack more information on a disc the same size as a CD-R, HD DVD will again shrink the pit sizes and pack more tracks on the same sized disc. The pits will have to be so small, however, that they will be smaller than the wavelength of a red laser beam; and the beam will be unable to track the disc. The laser reader/writer will have to use a smaller wavelength of light to read the edges of the pits, and a smaller wavelength means a beam of a different color.

Light is merely energy that is visible to the human eye. We first begin to see light energy as it passes from below visibility, the infrared range, to the red range. Hot coals, for example, glow "red-hot" as their heat increases to visibility. Light energy remains visible through the color spectrum until it passes beyond violet to the ultra-violet range and beyond. White light is the combination of all the visible wavelengths together. If white light passes through a prism and bounces off an interior prism wall, it spreads out according to the wavelengths of the energy components in a "rainbow" effect. In a real rainbow, sunlight passes through billions of water droplets acting as prisms to divide the light.

[1] In terms of digital photography, high definition video is not so impressive. Standard TV's 720x480 interlaced picture resolution is equivalent to 0.3 megapixels. High definition 1280x720p resolution improves to a 0.9 megapixel equivalent, and 1920x1080i is equivalent to two 1.0 megapixel interlaced fields.

Rainbow Colors Spread According to Their Wavelengths:

(nanometer=1 billionth of a meter)

- Red 780-622 nm
- Orange 622-597 nm
- Yellow 597-577 nm

Green 577-492 nm

- Blue 492-455 nm
- Violet 455-390 nm

Infrared for CD=780nm; ruby-red for DVD= 650 nm

Blue-violet laser for DVD HD = 405 nm

Figure 1

Figure 1 shows that the range of wavelengths for each color in the visible spectrum is different. Red has the widest range and the longest wavelengths. The laser diodes used in CD players and CD-R/-RW burners are infrared lasers with a wavelength of 780 nm. A different red laser diode produces the beam needed for the smaller pit sizes of DVDs. A beam of 650 nm reads DVD information and a high-power version utilizing 70 milliwatts or more records at the same wavelength onto DVD-R, DVD-RAM, and DVD-RW discs. DVD-R authoring discs require a 635-nm burning laser.

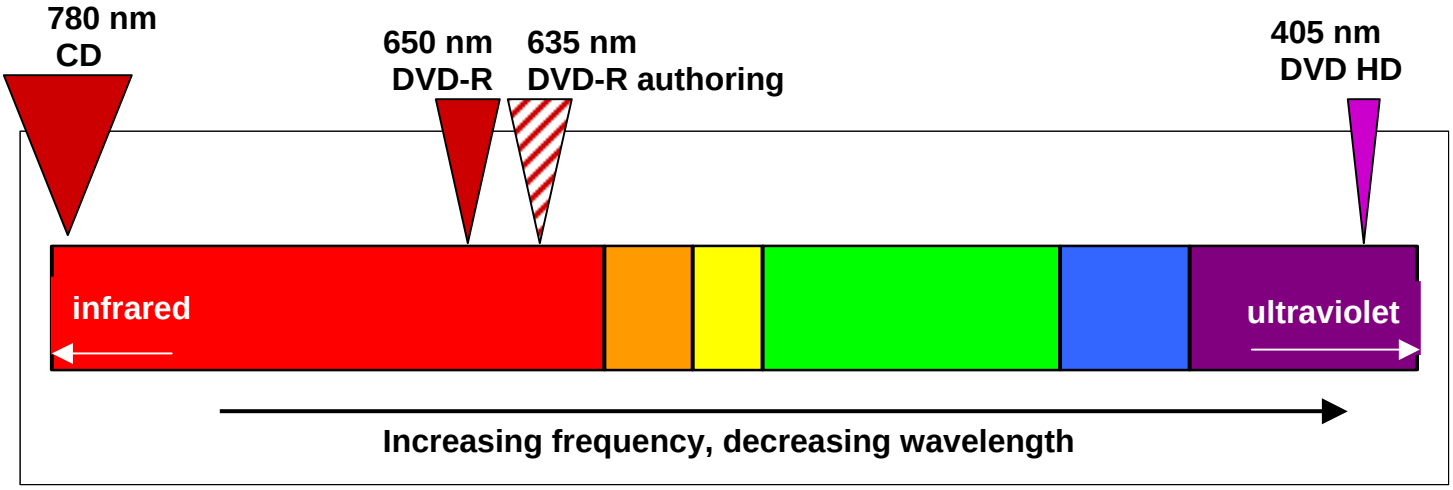


Figure 2

In order to decrease pit sizes further to pack more information on a disc, engineers have to move beyond red lasers. Plans for the new high definition discs are based on blue-violet laser diodes with a wavelength of 405 nm, approaching the ultra-violet range. This wavelength is slightly more than half that of the infrared CD wavelength of 780 nm. See Figures 3 and 4 below.

Blue-violet lasers are more expensive and difficult to build than red lasers and may have a shorter lifetime. Manufacturers, however, now feel confident that they can produce enough of them with a significantly long enough life to make them practical as a replacement for the common red laser found in CD and DVD players and drives.

Figure 3

CD pit size

HD DVD pit size

CD laser spot of 1.6 microns (µm) from 780-nanometer laser. Tracks are 1.6 µm apart.

DVD laser spot of 1.1 µm from 650-nanometer laser. Tracks are 0.74 µm apart.

Blue laser has wavelength of 405 nanometers:
HD DVD spot = 0.62 µm
Tracks = 0.4 µm apart
Blu-ray spot = 0.48 µm
Tracks = 0.32 µm apart

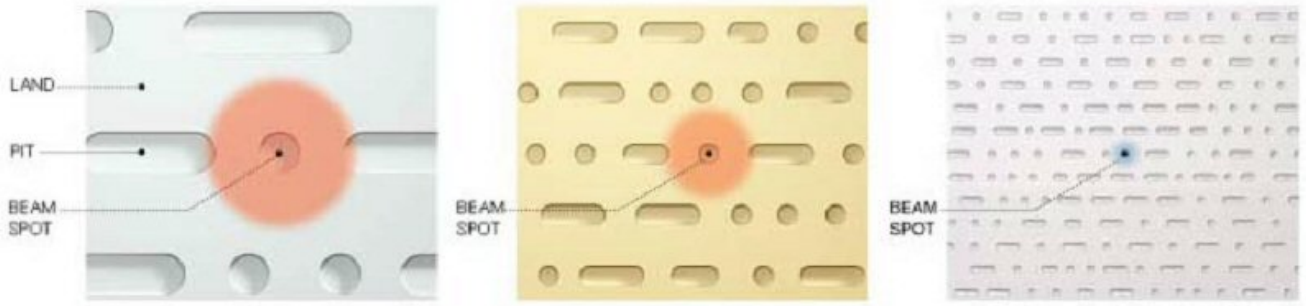


Figure 4

Courtesy of Sony and Cinram

The first blue laser system on the market is Sony's Blu-ray format. The early Blu-ray versions use the same MPEG-2 encoding used in today's DVDs, but the disc is very different from today's two-piece DVD sandwich because it uses a single substrate with a very thin recording layer. The substrate itself does not even need to be translucent because the recording and reading lasers do not need to penetrate it. The initial versions of these discs are contained in a cartridge, but that will change in time when scratch-resistant coatings are applied to the bottom recording surface. Other changes to the format will include more advanced video encode/decode systems than MPEG-2. Specifications and comparison for the Blu-ray format appear in Figure 5.

Specifications for Blue Laser DVD

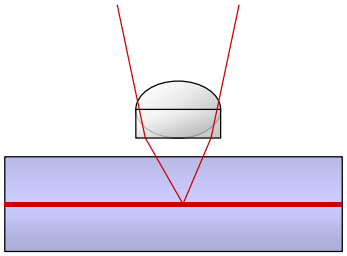
	HD DVD	Blu-ray DVD	DVD	CD
Disc thickness:	1.2 mm	1.2 mm	1.2 mm	1.2 mm
Disc diameter:	120 mm	120 mm	120 mm	120 mm
Data capacity:				
Single layer--	15 GB/side	25 GB/side	4.7 GB/side	0.74 GB
Double layer--	30 GB	50 GB	8.5 GB	
Laser wavelength:	405 nm	405 nm	650 nm	780 nm
Laser type:	blue-violet	blue-violet	ruby-red	infrared
Track pitch:	0.4 μ	0.32 μ	0.74 μ	1.6 μ
Width of laser spot:	0.62 μ	0.48 μ	1.1 μ	1.6 μ
Minimum pit length:	0.204 μ	0.15 μ	0.4 μ	0.83 μ
Pit width:	0.25 μ	0.25 μ	0.35 μ	0.5 μ
Distance from disc surface to data surface:	0.6 μ	0.1 μ	0.6 μ	1.1 μ
Standard transfer rate	36Mbits/sec	36Mbits/sec	11.08Mbits/sec	1.38Mbits/sec

Figure 5

BLU-RAY

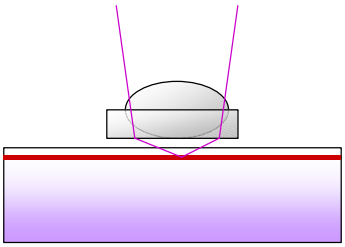
Sony is the first manufacturer to introduce blue laser recorders and media intended for professional use. The discs themselves are quite a bit different from DVD recordable discs and DVDs in their structure. They are composed of a single polycarbonate substrate instead of two halves. The laser

Sony's Blu-ray Disc



DVD-RW/+RW

- Requires a 650 nm. red laser
- Blank disc made of two 0.6 mm disc halves
- Total Thickness is 1.2 mm.
- Phase change recording layer in middle of disc
- Laser lens is millimeters above surface of disc.
- Capacity = 4.7 GB



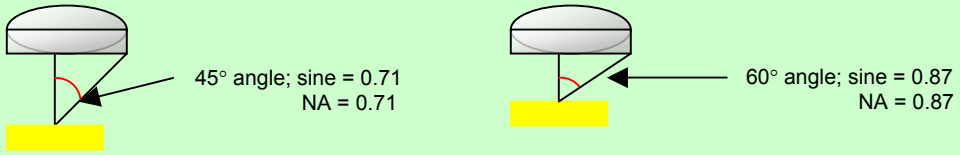
Sony Blu-ray DVD

- Requires a 405 nm. blue-violet laser
- Cartridge holds disc with a 0.1 spacing layer covering a polycarbonate substrate
- Total Thickness is 1.2 mm.
- Phase change recording layer near surface of disc
- Laser lens is microns above surface of disc.
- Capacity = 25GB for single layer, 50GB for dual layer

Figure 6

lens is positioned very closely the disc in a form of “near-field recording.” The numerical aperture* of the lens is 0.85 rather than the 0.65 of lenses used in regular DVDs. The complexity of the lens requires that it be made of glass rather than the less expensive plastic used for all other types of optical recorders and or players, including the competing HD DVD version. See Figure 6.

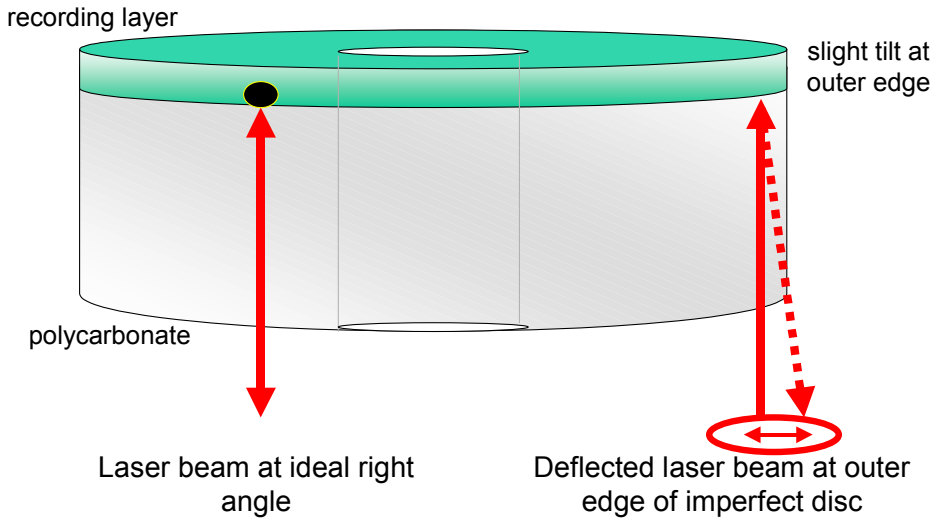
*The numerical aperture is a measure of a lens’s ability to gather or disperse light and its ability to resolve fine detail. The expression of numerical aperture (NA) is a mathematical number derived from the sine of an angle of light passing through a lens. For example, a lens with a numerical aperture of 0.7 would form a 45° angle from the point of focus at a fixed focal length to the center of the lens.



The most distinctive aspect of the Blu-ray is its application of “near-field” recording and playback. The read/write Blu-Ray laser is much closer to the data surface than it is in CDs, DVDs, or in the HD-DVD. The advantage of getting the laser closer to the data is in the reduction of deflection errors if the medium is not perfectly flat. A non-flat disc will have “tilt” errors toward its outside circumference that will deflect the reflected laser beam from its intended optical sensor. This tilt error becomes more critical as pit sizes and laser spots shrink to smaller dimensions in order to pack more data on a disc, and the whole point of moving to blue lasers is to shrink the light wavelengths and pits to the smallest practical size. The CD-R has a relatively large pit size and laser spot; so a disc’s tilt would have to be severe to cause a significant deflection error.

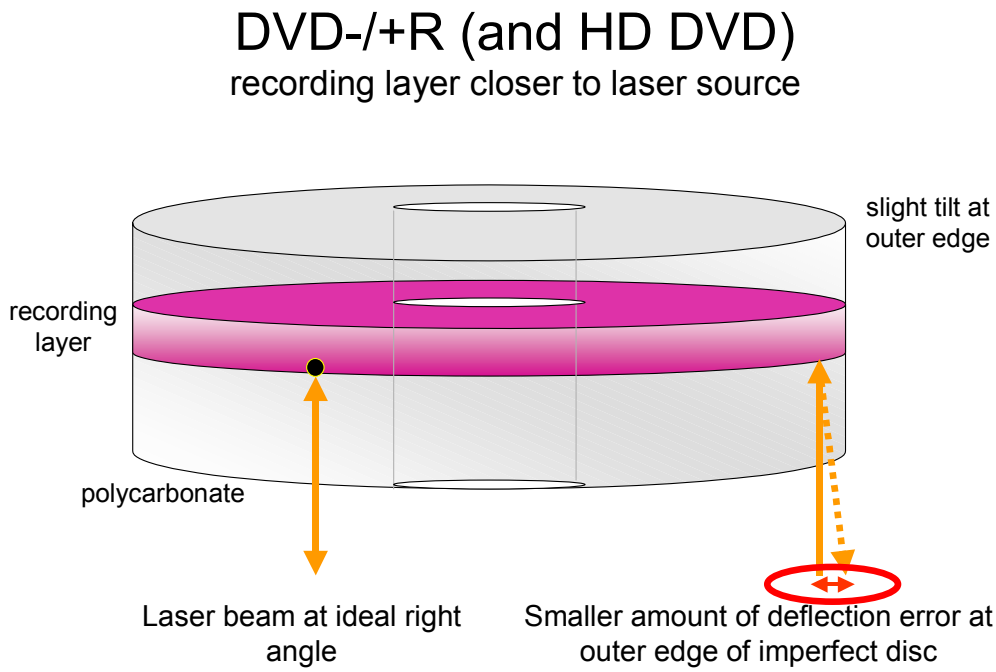
CD-R

recording layer at distance from laser source



The DVD, however, packs more data on a disc the same size and thickness as a CD by using a smaller beam size as well as smaller pits and narrower tracks. In order to reduce the effect of deflection errors due to tilt of a disc, the data area is moved closer to the laser by sandwiching it between halves of a disc that are bonded together. The HD DVD uses this same design for its blue laser disc, and this approach offers HD DVD its greatest advantage: HD DVD discs can use the

same manufacturing equipment as that used for DVDs and recordable DVDs because the disc design is identical. Manufacturers have gained great experience in making flatter and more uniform discs as the speed ratings of recordable bonded discs have increased from 2X to 16X. Flatness is essential to keep the recording/reading laser properly focused on at the outermost edge of a pit one-twentieth the size of the finest human hair as the disc spins at a speed of 200kph/125mph. And that DVD pit is twice as big as the one for HD DVD!



The Blu-ray engineers chose to maximize the amount of data to be recorded to a high definition disc by making pits and tracks even smaller than those for HD DVD. The Blu-ray design has taken a "near-field" approach to recording by bringing a 0.1-micron data surface as close to the read/write laser as possible. This allows a capacity of 25GB per layer with a minimum amount of tilt deflection error. A secondary advantage is that the substrate (or "superstrate" at this point) does not need to be of optical grade polycarbonate because the laser does not pass through it all. Some manufacturers have made experimental samples of Blu-ray discs made from recycled paper or other materials that are relatively durable and can be made uniformly flat. The actual write-once recording layer is a combination of aluminum/copper alloy and silicon; recording marks are spots where the laser has melted the two to form a light-blocking alloy. Organic dyes are an option for Blu-ray recording.

With every advantage comes some disadvantage, and Blu-ray discs are no exception. Because the data field is so close to the read/write laser, the surface of the disc has to be kept free as possible from scratches, damage, and fingerprints. These flaws are less critical for CDs and DVDs because the laser is focused on the data layer deeper in the disc, and many superficial flaws on the disc surface are simply too out of focus to affect the laser's ability to resolve the pit edges. The "in-your-face" near-field design of Blu-ray discs has the laser focusing just below the disc surface with little allowance to ignore surface flaws. A cartridge for Blu-ray was the first solution to the problem, but consumers prefer discs to be free of such protection (as the DVD-RAM has learned). Manufacturers now cover the bottom of Blu-ray discs with protective coatings using a combination of micro-silica particles for hardness and scratch resistance and fluorine-loaded resins that prevent the absorption of water and oils. The laser lens for Blu-ray near-field recording is more expensive than that for DVDs or HD DVD, especially when it is combined with a red laser for reading CDs and DVDs in addition to high definition discs. Another disadvantage for Blu-ray is the same as that for any advanced technology: new production equipment to manufacture a disc quite a bit different from

those that have preceded it. While HD DVD requires little investment for manufacturing beyond mastering equipment, Blu-ray requires new production lines in order to produce a disc capable of 25GB per side.

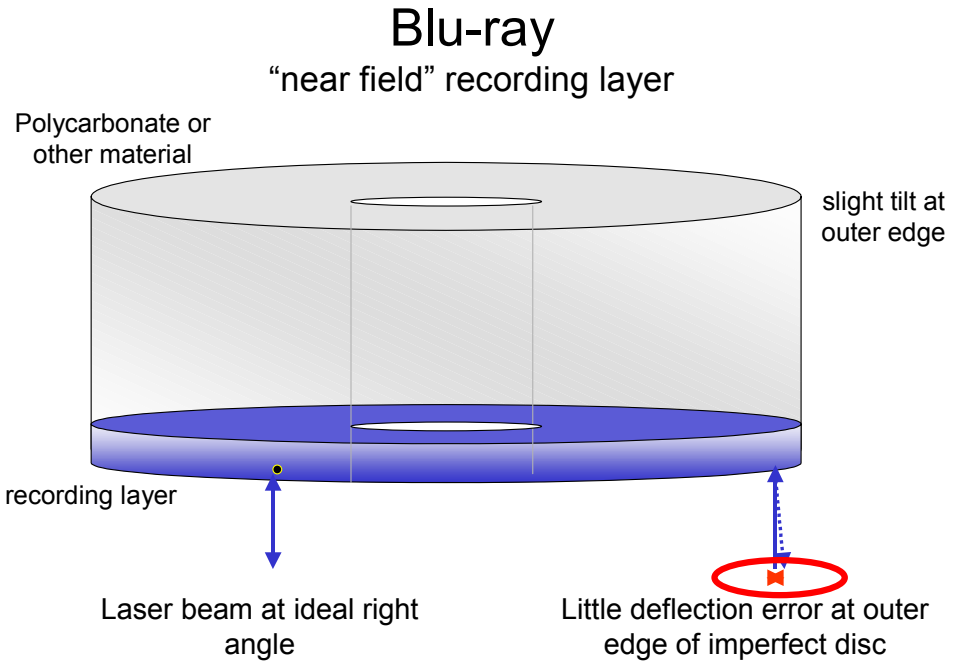


Figure 7

HD DVD

Blu-ray is just the first of several different solutions for High Definition video. Toshiba and NEC offer their own version of a blue-laser DVD that offers a capacity of up to 30GB, enough for three hours of HD video. Their format is known as HD DVD and uses a disc very similar in construction to today's DVD discs, which allows present DVD manufacturing equipment to be modified for production rather than have manufacturers invest in all new equipment. A single layer HD DVD version has a capacity of 15GB, and the dual-layer version holds twice that amount. A rewritable version also holds 15GB and the dual-layer version of the rewritable disc holds as much as 30GB of information. The format uses more advanced compression than MPEG-2 to shrink HD files to sizes that can easily fit on these blue-laser discs. Other cost-conscious attributes are a single plastic lens that can operate with both blue and red lasers than the more complex glass lens for a blue laser and a separate lens for a red laser required by the Blu-ray disc. Although the HD DVD disc has received the approval of the DVD Forum, that approval is for the disc as a DVD video carrier, not necessarily as a recording medium. The rewritable version of HDvDVD will use phase change alloys similar to those used in DVD rewritable discs, and the write once version will initially use an organic dye. Research continues on other methods, including the aluminum/copper and silicon recording layers used in Blu-ray discs.

High Definition Alternatives

A group from Taiwan, the AOSRA (Advanced Optical Storage Research Alliance), is working on another system physically similar to the Blu-ray disc but differs from it in terms of the encoding, error correction, and file structure. AOSRA believes there are two advantages for their proposal: 1) the format is less expensive because it avoids the onerous royalty payments that are beginning to burden optical media and encoding systems, and 2) it offers more than five hours of HD video.

There is a fourth solution called FVD (Forward Versatile Disc) offered by those who either do not want to have to upgrade all of their mastering facilities to press ever-smaller pits for a more expensive and, perhaps, shorter-lived laser diode, or who feel that the blue laser has too many shortcomings. This group uses a different compression scheme from MPEG-2 that can compress more video data without sacrificing video quality. Advances in algorithms have made such compression possible. HD-capable DVD players would retain the red laser diodes but include different circuitry to identify and decode HD signals while still being able to read today's DVD discs. The players would require only a single laser reader instead of both blue and red diodes, and prices would remain low for consumers. Prices for discs would also remain reasonable because only software upgrades would be required for the pressing facilities rather than all new mastering and test equipment and, perhaps, new molding presses. This group also argues that it is too early to introduce a new format for consumers while standard DVD is still in its growth period and has reached only half of US household penetration.

High Definition Video Formats

	Blu-ray	HD DVD	AOSRA	FVD
Rec. layer:	.1 mm thick	.6 mm thick	.1 mm thick	.6 mm thick
Laser:	blue	blue	blue	Red
Wavelength	405 nm	405 nm	405 nm	650 nm
N/A:	.85	.65	.85	.65
Lens(es):	2	1	2	1
Capacity: **Rewritable:**	25GB 25GB single layer 50GB double layer	15GB and 30GB 15GB single layer 30GB double layer	17GB and 27GB	6 and 11GB
Encoding:	MPEG-2 to start; MPEG-4	MPEG-4 AVC; VC-1; MPEG-2	AVC (proprietary)	WMV HD
Cartridge:	Only for earliest versions	no	no	no
Backers:	Hitachi, Matsushita, Pioneer, Sony, Philips, Sharp, Dell, Samsung, Columbia Pictures, Buena Vista	NEC, Toshiba, Warner Brothers, Paramount, New Line Cinema, HBO, Intel, Microsoft	29 Taiwanese companies	29 Taiwanese companies

Figure 8

Memorex has been a well-recognized and trusted supplier of high quality media for many years. We realize that the consumer will determine which medium or format to choose given enough accurate, honest information to see what fits his or her needs best. Memorex supplies, and will continue to supply, all the media types available to the market and takes pride in helping to inform the consumer so that he or she can choose what is best.