

# **BLUE RAY DISC**

## **INTRODUCTION**

Blu-ray Disc (BD), sometimes called "Blu-ray", is an optical disc storage medium designed to supersede the standard DVD format. Its main uses are for storing high-definition video, PlayStation 3 video games, and other data, with up to 25 GB per single layered, and 50 GB per dual layered disc. The disc has the same physical dimensions as standard DVDs and CDs.

The name Blu-ray Disc derives from the blue-violet laser used to read the disc. While a standard DVD uses a 650 nanometer red laser, Blu-ray uses a shorter wavelength, a 405 nm blue-violet laser, and allows for almost six times more data storage than a DVD.

During the format war over high-definition optical discs, Blu-ray competed with the HD DVD format. Toshiba, the main company supporting HD DVD, ceded in February 2008, and the format war ended; in July 2009, Toshiba announced plans to put out its own Blu-ray Disc device by the end of 2009.

Blu-ray Disc was developed by the Blu-ray Disc Association, a group representing makers of consumer electronics, computer hardware, and motion pictures. As of June 2009, more than 1500 Blu-ray disc titles are available in Australia, 2500 in Japan, 1500 in the United Kingdom, and 2500 in the United States and Canada.

Commercial HDTV sets began to appear in the consumer market around 1998, but there was no commonly accepted, inexpensive way to record or play HD content. In fact, there was no medium with the storage required to accommodate HD codecs, except for JVC's Digital VHS and Sony's HDCAM. Nevertheless, it was well-known that using lasers with shorter wavelengths would enable optical storage with higher density. Shuji Nakamura invented the practical blue laser diode; it was a sensation among the computer storage-medium community, although a lengthy patent lawsuit delayed commercial introduction.

## **Origin**

Sony started two projects applying the new diodes: UDO (Ultra Density Optical), and DVR Blue (together with Pioneer), a format of rewritable discs that would eventually become Blu-ray Disc (more specifically, BD-RE). The core technologies of the formats are essentially similar.

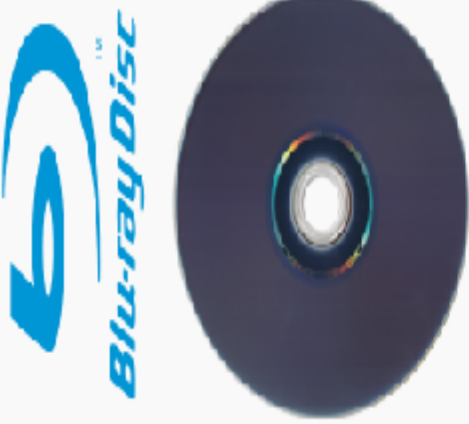
The first DVR Blue prototypes were unveiled at the CEATEC exhibition in October 2000.[9] On February 19, 2002, the project was officially announced as Blu-ray, and Blu-ray Disc Founders was founded by the nine initial members.

The first consumer device was in stores on April 10, 2003. This device was the Sony BDZ-S77, a BD-RE recorder that was made available only in Japan. The recommended price was US\$3800; however, there was no standard for prerecorded video, and no movies were released for this player. The Blu-ray Disc standard was still years away, as a newer, more secure DRM system was needed before Hollywood

studios would accept it—not wanting to repeat the failure of the Content Scramble System used on standard DVDs. On October 4, 2004, the Blu-ray Disc Founders was officially changed to the Blu-ray Disc Association (BDA), and 20th Century Fox joined the BDA's Board of Directors.

## Blu-ray Disc format finalized

The Blu-ray Disc physical specifications were completed in 2004. In January 2005, TDK announced that they had developed a hard coating polymer for Blu-ray Discs. The cartridges, no longer necessary, were scrapped. The BD-ROM specifications were finalized in early 2006. AACS LA, a consortium founded in 2004,[17] had been developing the DRM platform that could be used to securely distribute movies to consumers. However, the final AACS standard was delayed, and then delayed again when an important member of the Blu-ray Disc group voiced concerns. At the request of the initial hardware manufacturers, including Toshiba, Pioneer, and Samsung, an interim standard was published that did not include some features, such as managed copy.

<div>Blu-ray Disc</div> <div></div>	
Media type	High-density optical disc
Encoding	MPEG-2, H.264/MPEG-4 AVC, and VC-1
Capacity	25 GB (single-layer) 50 GB (dual-layer)
Block size	64kb ECC
Read mechanism	400 nm laser: 1× @ 36 Mbit/s (4.5 MByte/s) 2× @ 72 Mbit/s (9 MByte/s) 4× @ 144 Mbit/s (18 MByte/s) 6× @ 216 Mbit/s <sup>[1]</sup> (27 MByte/s) 8× @ 288 Mbit/s (36 MByte/s) 12× @ 432 Mbit/s (54 MByte/s)
Usage	Data storage High-definition video High-definition audio PlayStation 3 games

## Competition from HD DVD

The DVD Forum, chaired by Toshiba, was deeply split over whether to develop the more expensive blue laser technology or not. In March 2002, the forum voted to approve a proposal endorsed by Warner Bros. and other motion picture studios that involved compressing HD content onto dual-layer standard DVD-9 discs. In spite of this decision, however, the DVD Forum's Steering Committee announced in April that it was pursuing its own blue-laser high-definition solution. In August, Toshiba and NEC announced their competing standard, Advanced Optical Disc. It was finally adopted by the DVD Forum and renamed HD DVD the next year, after being voted down twice by DVD Forum members who were also Blu-ray Disc Association members—prompting the U.S. Department of Justice to make preliminary investigations into the situation.

HD DVD had a head start in the high definition video market, as Blu-ray Disc sales were slow to gain market share. The first Blu-ray Disc player was perceived as expensive and "buggy", and there were few titles available. This changed when the PlayStation 3 was launched, since every PS3 unit also functioned as a Blu-ray Disc player. At CES 2007, Warner proposed Total Hi Def—a hybrid disc containing Blu-ray on one side and HD DVD on the other—but it was never released. By January 2007, Blu-ray discs had outsold HD DVDs, and during the first three quarters of 2007, BD outsold HD DVDs by about two to one. In a June 28, 2007 press release, Twentieth Century Fox cited Blu-ray Disc's adoption of the BD+ anticopying system as a key factor in their decision to support the Blu-ray Disc format. In February 2008, Toshiba withdrew its support for the HD DVD format, leaving Blu-ray as the victor.

Some analysts believe that Sony's PlayStation 3 video game console played an important role in the format war, believing that it acted as a catalyst for Blu-ray Disc, as the PlayStation 3 used a Blu-ray Disc drive as its primary information storage medium. They also credited Sony's more thorough and influential marketing campaign.

## End of the format war and future prospects

On January 4, 2008, a day before CES 2008, Warner Bros. This effectively included other studios that came under the Warner umbrella, such as New Line Cinema and HBO—though in Europe, HBO distribution partner the BBC announced it would, while keeping an eye on market forces, continue to release product on both formats. This led to a chain reaction in the industry, with major U.S. retailers such as Best Buy, Wal-Mart, and Circuit City and Canadian chains such as Future Shop dropping HD DVD in their stores. A former major European retailer, Woolworths,, dropped HD DVD from its inventory. Netflix and Blockbuster—major DVD rental companies—said they would no longer carry HD DVDs. Following these new developments, on February 19, 2008, Toshiba announced it would end production of HD DVD devices, allowing Blu-ray Disc to become the industry standard for high-density optical disks. Universal Studios, the sole major movie studio to back HD DVD since its inception, said shortly after Toshiba's announcement, "While Universal values the close partnership we have shared with Toshiba, it is time to turn our focus to releasing new and catalog titles on Blu-ray Disc." Paramount Studios, which started releasing movies only in HD DVD format during late 2007, also said it would start releasing in

Blu-ray Disc. Both studios announced initial Blu-ray lineups in May 2008. With this, all major Hollywood studios now support Blu-ray.

According to Adams Media Research, high-definition software sales were slower in the first two years than standard DVD software sales. 16.3 million standard DVD software units were sold in the first two years (1997–98) compared to 8.3 million high-definition software units (2006–07). One reason given for this difference was the smaller marketplace (26.5 million HDTVs in 2007 compared to 100 million SDTVs in 1998). Former HD DVD supporter Microsoft has stated that they are not planning to make a Blu-ray Disc drive for the Xbox 360.

Blu-ray Disc began making serious strides as soon as the format war ended. Nielsen VideoScan sales numbers showed that with some titles, such as 20th Century Fox's *Hitman*, up to 14% of total disc sales were from Blu-ray, although the average for the first half of the year was around 5%. Shortly after the format war ended, a study by The NPD Group found that awareness of Blu-ray Disc had reached 60% of U.S. households. In December 2008, the Blu-ray Disc of *The Dark Knight* sold 600,000 copies on the first day of its launch in the United States, Canada, and the United Kingdom. A week after launch, *The Dark Knight* BD had sold over 1.7 million copies worldwide, making it the first Blu-ray Disc title to sell over a million copies in the first week of release.

According to Singulus Technologies AG, Blu-ray is being adopted faster than the DVD format was at a similar period in its development. This conclusion was based on the fact that Singulus Technologies has received orders for 21 Blu-ray dual-layer machines during the first quarter of 2008, while 17 DVD machines of this type were made in the same period in 1997. And the other key equipment supplier for optical disc Anwell Technologies Limited had shipped its Blu-ray disc production equipment to Frankfurt for the largest trade show in the world - MEDIA-TECH Expo in May 2008 and they received new order for the Blu-ray production line also. According to GfK Retail and Technology, in the first week of November 2008, sales of Blu-ray recorders surpassed DVD recorders in Japan. According to the Digital Entertainment Group, the total number of Blu-ray Disc playback devices (both set-top box and game console) had reached 9.6 million by the end of 2008. According to Swicker & Associates, Blu-ray Disc software sales in the United States and Canada were 1.2 million in 2006, 19.2 million in 2007, and 82.4 million in 2008. Some commentators have suggested that renting blu-ray will play a vital part in keeping the technology affordable while allowing it to move forward.

## Technical specifications

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Type	Physical size	Single layer capacity	Dual layer capacity
Standard disc size	12 cm	25 GB / 23866 MiB / 25025314816 B	50 GB / 47732 MiB / 50050629632 B
Mini disc size	8 cm	7.8 GB / 7430 MiB / 7791181824 B	15.6 GB / 14860 MiB / 15582363648 B

High-definition video may be stored on Blu-ray ROM discs with up to 1920×1080 pixel resolution at up to 60 frames per second [interlaced](#) or 24 frames per second [progressive](#)

Resolution	Frame rate	Aspect ratio	Codec
1920×1080	59.94-i, 50-i	16:9	
1920×1080	24-p, 23.976-p	16:9	
1440×1080	59.94-i, 50-i	16:9	MPEG-4 AVC / SMPTE VC-1 only
1440×1080	24-p, 23.976-p	16:9	MPEG-4 AVC / SMPTE VC-1 only
1280×720	59.94-p, 50-p	16:9	
1280×720	24-p, 23.976-p	16:9	
720×480	59.94-i	4:3/16:9	
720×576	50-i	4:3/16:9	

## Laser and optics

Blu-ray Disc uses a "blue" (technically violet) laser, operating at a wavelength of 405 nm, to read and write data. The diodes are InGaN lasers that produce 405nm photons directly, that is, without frequency doubling or other nonlinear optical mechanisms. Conventional DVDs and CDs use red and near-infrared lasers, at 650 nm and 780 nm, respectively.

The blue-violet laser's shorter wavelength makes it possible to store more information on a 12 cm CD/DVD-size disc. The minimum "spot size" on which a laser can be focused is limited by diffraction, and depends on the wavelength of the light and the numerical aperture of the lens used to focus it. By decreasing the wavelength, increasing the numerical aperture from 0.60 to 0.85, and making the cover layer thinner to avoid unwanted optical effects, the laser beam can be focused to a smaller spot. This allows more information to be stored in the same area. For Blu-ray Disc, the spot size is 580 nm. In addition to the optical improvements, Blu-ray Discs feature improvements in data encoding that further increase the capacity.

## Hard-coating technology

Since the Blu-ray Disc data layer is closer to the surface of the disc compared to the DVD standard, it was at first more vulnerable to scratches. The first discs were housed in cartridges for protection, resembling Professional Discs introduced by Sony in 2003.

Using a cartridge would increase price of already expensive media, so hard-coating of the pickup surface was chosen instead. TDK was the first company to develop a working scratch-protection coating for Blu-ray Discs. It was named Durabis. In addition, both Sony and Panasonic's replication methods include

proprietary hard-coat technologies. Sony's rewritable media are spin-coated, using a scratch-resistant and antistatic coating. Verbatim's recordable and rewritable Blu-ray Discs use their own proprietary hard-coat technology, called ScratchGuard.

All Blu-Ray Disc media is required to use hard-coating. DVD media is not required to be scratch-resistant, but since development of the technology some companies, such as Verbatim, implemented hard-coating for more expensive lineups of recordable DVDs.

## Recording speed

Drive speed	Data rate		Write time for Blu-ray Disc (minutes)	
	Mbit/s	MB/s	Single-Layer	Dual-Layer
1×	36	4.5	90	180
2×	72	9	45	90
4×	144	18	23	45
6×	216	27	15	30
8×	288	36	12	23
12× <sup>[54]</sup>	432	54	8	15

## Software standards

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### Codecs

The BD-ROM specification mandates certain codec compatibilities for both hardware decoders (players) and movie software (content).

#### Video

For video, all players are required to support MPEG-2 Part 2, H.264/MPEG-4 AVC, and SMPTE VC-1. MPEG-2 is the codec used on regular DVDs, which allows backwards compatibility. MPEG-4 AVC was developed by MPEG and VCEG. VC-1 is a codec that was mainly developed by Microsoft. BD-ROM titles with video must store video using one of the three mandatory codecs; multiple codecs on a single title are allowed.

The choice of codecs affects the producer's licensing/royalty costs as well as the title's maximum run time, due to differences in compression efficiency. Discs encoded in MPEG-2 video typically limit content producers to around two hours of high-definition content on a single-layer (25 GB) BD-ROM. The more-advanced video codecs (VC-1 and MPEG-4 AVC) typically achieve a video run time twice that of MPEG-2, with comparable quality.

MPEG-2 was used by many studios (including Paramount Pictures, which initially used the VC-1 codec for HD DVD releases) for the first series of Blu-ray discs, which were launched throughout

2006. Modern releases are now often encoded in either MPEG-4 AVC or VC-1, allowing film studios to place all content on one disc, reducing costs and improving ease of use. Using these codecs also frees a lot of space for storage of bonus content in HD (1080i/p), as opposed to the SD (480i/p) typically used for most titles. Some studios, such as Warner Bros., have released bonus content on discs encoded in a different codec than the main feature title. For example, the Blu-ray Disc release of Superman Returns uses VC-1 for the feature film and MPEG-2 for bonus content. Today, Warner and other studios typically provide bonus content in the video codec that matches the feature.