

# Our Dream

Aspirations in Light Sources for Visual Imaging

## Making use of different light sources, providing light that illuminates, projects, and attracts.

### Principal related products and fields of business

Projectors, illumination of general and commercial facilities, landscape lighting and display, stage & studio lighting, office automation equipment

### Ushio proudly presents illumination with "quality of light"

Ushio creates new markets for light by using it for both illumination and energy. In the field of electronics, it is light's energy that plays the leading role. With visual imaging, it is visible light. Ushio provides light for a broad range of applications: light for interior illumination, spotlights for lighting objects and spaces, lamps for cinema and data projectors that show video and images on screens, and light that creates visual appeal in illuminating displays and media façades\*.

From halogen lamps whose warm colors enhance the

visual appeal of food to metal halide lamps that present jewelry and clothing to best effect, xenon lamps that show objects as they would appear under natural sunlight, and long-life LEDs for a variety of applications... all, though based on different principles, are examples of "Ushio light" that share a common characteristic: the dedicated pursuit of quality.

### All sorts of light born of a rich technology and advanced production control

Ushio produces "exactly the light its customers need." This is not only true for the common notion of illumination. For

example, Ushio produces over 2,000 types of lamps each month for illumination of documents that are copied by copying machines made by various manufacturers. Lamps provided are not made according to a unified standard that encompasses all machines, but are optimized for the characteristics of individual models, to allow rapid reading at high resolution of a document's subtle tones. This ability to achieve quality that is not attainable through automation in the manufacture of finely tuned lamp varieties is one of the main strengths underlying Ushio's capability. Our superior technology accommodates a variety of shades of requirements. It is this cumulative performance that is the prime factor underscoring our customers' trust.

### Toward the creation of visual images to enrich the joy and excitement of life

The market for light has great potential for future growth. Some of Ushio's strengths lie in its advanced knowledge of the nature of light, its record of performance in various areas, and most importantly, its ability to "create light that is only

possible with Ushio." Taking this spirit in an unbroken chain of inheritance, Ushio has introduced numerous products that hold top market share throughout the world.

At present, light sources can be categorized according to three different emission principles. First are incandescent light sources, which produce light by passing current through a resistive body; second are discharge light sources, in which voltage across electrodes produces an arc, as with xenon lamps and metal halide lamps; and third are solid-state light sources, where light is produced by light emitting diodes.

Although LED lighting is coming into increasing use in a variety of areas, Ushio cannot fulfill its mission simply by switching from conventional light sources to LEDs. It will only be Ushio light when LEDs can reproduce the quality that customers have come to expect from conventional light sources.

\* Media façade: An outdoor structure which has light source modules attached to its surface, and which produces dynamic images, video and effects by changing the brightness and color of the modules or by moving the modules.

### Ushio's three major light sources

#### The principle of Edison Incandescent light sources

With incandescent light sources, electricity passing through in an internal filament (a resistance) heats the filament and produces light (thermal radiation) by emission. Featuring compact size and high brightness, incandescent lights provide excellent color rendering properties and are still widely used in a wide variety of applications.



#### Light emission by discharge in gas

#### Discharge lamp (HID lamp)

Lamps that produce light emissions by discharge between electrodes. This group includes a range of UV lamps, flash lamps, metal halide lamps and xenon lamps, and delivers light in a variety of wavelengths through use of different enclosed gases and metals.



#### Light emitting semiconductors

#### Solid-state light sources

With these sources, light is produced by passing electricity through specially doped semiconducting materials in layered structures. Said to be the most rapidly advancing type of light source, this group includes LEDs, semi-conductor lasers, and organic EL (electro-luminescence) devices.



# The trajectory of challenge

## ① Light sources

The field of Ushio's light is not limited to production processes for semiconductors and liquid crystal displays. We also literally throw a strong light on daily life. For example, this includes light sources in essential office automation equipment, in stage lighting and in movie theaters, and in lighting of public facilities, commercial establishments and amusement parks. Ushio light permeates the entire world, making each day brighter in many different ways. Let's listen to the voices of those who work behind the scenes to develop the Ushio light that has achieved a revolution in visual imaging in so many different fields.

### Light sources for office automation equipment

#### Supporting businesses with "light sources" and "optical systems"

One of the most familiar applications for Ushio light is in the office. When asked where so, one developer with many years of involvement in light sources for office automation equipment responded, "in the integrated copying machines that also function as scanners and printers. First is light that is used as a heat source. Second is light that is used to read documents. Since its founding, Ushio has provided light sources for both of these roles as it supports advances in office automation equipment. Yes, Ushio's lamps play a major role in making possible the beautiful color documents that we have come to take for granted."

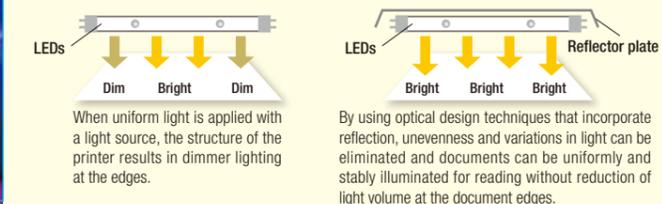
We asked him to tell us more about use of light as a heat source; that is, to talk about the halogen heater lamps that are used to melt toner on paper to bond it to the paper's surface. In addition to halogen heaters, heat sources used for this purpose have included ceramic heaters that produce heat by passing electricity through a resistance, and inductive heating devices that are used to head a metal belt. How do halogen heaters differ from such devices?

"One of the big advantages of halogen heaters over these other devices is that they can apply heat without direct contact. They also heat up quickly, eliminating warm-up delay and helping to minimize power consumption. Further, Ushio is able to convert better than 90% of input electricity into light. This efficiency is highly valued, as can be seen in Ushio's 90%\* share of the overall halogen heater market." He confidently continued, "For high-speed, high-volume printing, there really is no alternative to the halogen heater lamp."

Next we asked about the light sources that are used to illuminate documents in fine detail and the measurement of strength and color of reflected light. This also is a role that was first filled by halogen lamps, then by rare gas fluorescent lamps and, recently, by more durable and power-efficient LEDs.

"Looked at simplistically, wide areas can be illuminated by lining up enough LEDs to illuminate the same area as with conventional lamps. The problem is that the light produced by individual LEDs usually varies in subtle ways that are not visible to the naked eye. Another problem is variations in illumination that result due to varying rates of deterioration of individual LEDs. And even if the illumination produced by the LED array is even, the structure of devices such as printers is such that the center portion of the document is more brightly

#### Ushio "light distribution technology" used in light sources for reading documents



# How Light is Changing the Office and Entertainment

\* Per Ushio's own market survey as of March 31, 2014

illuminated than the edges. Ushio solved this problem by devising a new arrangement for the LED and its associated optical system.” This technology has been patented by Ushio, and cannot be imitated by its competitors. Such technology is enabled by Ushio’s thorough knowledge of the properties of light.

### Light sources used in cinema projectors

#### A tradition of craftsmanship produces light to decorate the screen

The sun is the ultimate factor that makes our lives possible. The light it produces is made up of many wavelengths, including the visible light that allows the human eye to perceive color in all of its variations. Truly, it gives color to our lives. Ever since its establishment, Ushio has sought to create lamps that produce light which replicates sunlight as closely as possible. The result is the xenon lamp, which is sometimes referred to as “the sun in miniature.”

A representative application for this lamp is as a light source in the cinema projectors that have contributed to advances in cinematography. Developed at about the time movies were moving from black and white to color, the xenon short arc lamp has won praise and delight for its unprecedented ability to project colors that are bright and beautiful. Since then, Ushio’s cinema projector lamps have entered service around the world, and now hold a large share of the overall market.

At the end of the 1990s, the wave of digitization reached the movie industry. With the introduction of DLP® (Digital Light Processing)\*, film began disappearing from movie theaters to be replaced with devices that use optical semiconductors to reflect light onto the movie screen. These are called Digital

Cinema Projectors, or DCP.

Digital cinema projectors not only occupy less space and use less power than conventional projectors, but require brighter light sources in which the lamp cathode and anode are more closely spaced than in lamps used with film projectors. This is in order to make them more point-like, which allows DCPs to produce images with brighter, more beautiful colors than is possible with film-based projectors.

“Achieving this was a truly challenging task. Increasing the brightness of gas-discharge devices such as xenon lamps by reducing the spacing of the electrodes requires increasing the pressure of the enclosed gas. However, increasing the gas pressure also makes the lamp more susceptible to rupturing. Solving this required a whole new approach to lamp design. Ultimately, we solved the problem through various research innovations, such as improved electrodes and glass strength, giving birth to highly reliable, long-life xenon lamps for use in digital cinema projectors.”

Our competitors also undertook such development efforts, but makers who only had lamp technology suitable for film projectors were not able to duplicate Ushio’s quality. The truth is that lamps for digital cinema projectors must fulfill requirements that differ greatly from those for the lamps used with film projectors. Our developer says, “The difference lies not only in the knowledge we’ve cultivated about the nature of light, but in the stance we take to building things.”

“Since xenon lamps are an industrial product, people think that they are produced on fully automated production lines, but the truth is that a great deal of craftsmanship is required in their manufacture. Such craftsmanship cannot be achieved by pushing buttons or reading a manual. Not even the production of a single piece of glass can be automated. Therefore, our technicians produce each piece individually while keeping

track of glass condition and heating temperature. In Ushio’s production workplaces, lamps of high reliability and competitiveness are achieved by passing on a legacy of highly detailed and precise skill and know how.”

As he speaks, the developer’s face is filled with pride and confidence. To make things and confirm their quality with your own eyes is a strength of Ushio’s technology that lies in the basic attitude and artisan skills that are handed down by its workers.

#### From xenon lamps to lasers: The quality of 3D movies takes a leap forward

3D movies have rapidly proliferated since the 2009 release of the 3D movie “Avatar.” 3D movies are made possible by showing different images to the left and right eyes to produce an appearance of depth. With conventional projectors, the problem is that this also reduces the amount of light that is delivered to each eye by half, making movies appear darker than when viewed in 2D. One approach to solving this problem is to use lasers as the light source.

“In simple terms, the only way to achieve the brightness of 2D images in 3D while using conventional projectors is to project images by two projectors simultaneously. With lasers, this sufficient brightness can be obtained with a single projector. This also provides increased image contrast, making it possible to give a feeling of depth even to the darkness of outer space. The difference is very pronounced, and readily apparent to anyone. However, laser projectors are still very expensive, and it will take time for them to come into widespread use. Also, the brightness of today’s xenon lamps is undergoing continuous improvement, so it will probably take

some time before projectors that use lamps are completely replaced by ones that use lasers.”

3D movies are becoming clearer and clearer, and more realistic as well. What new advances will movie technology bring? Perhaps we will see screens that provide a 360-degree field of view, or perhaps hologrammatic movies will become possible. One thing we can say for sure is that no matter how movies evolve, they will shine with Ushio light.

### Light sources for data projectors

#### Pride and satisfaction for the developer who overcame issues of ultra-high pressure and temperature

Until about ten years ago, people using data projectors would turn out the lights and close the curtains. However, today’s data projectors are so bright there’s no need to darken the room. The fact is that Ushio lamps have helped make such progress possible.

The two constant requirements for data projectors are brightness and compactness. In principle, achieving this only requires making the projector’s light source more point-like, the same as with movie projectors. But as with movie projectors, the required reduction in electrode spacing and increase in gas pressure present obstacles. Safety is also an issue. After much trial and error to identify the limits of lamp envelope integrity, the “NSH Lamp” was developed in 1998, a lamp based on the ultra-high pressure UV lamp.

“The NSH lamp operates at a pressure of 200 atmospheres. In terms of water pressure, this is equivalent to a depth of 2,000 meters. Further, the temperature at which the lamp begins working is in excess of 800 degrees Celsius,



1 LED module used for scanning documents in office automation equipment

Brightness equivalent to that of rare gas fluorescent lamps is achieved with just one or two LED chips.

2 Lamp for digital cinema projectors

DCP lamp optimized for use in digital cinema projectors provides high brightness with high reproducibility.

\*DLP®: A video display system developed by Texas Instruments. Uses optical semiconductors called digital micromirror devices to project images onto a screen.

and the lamp reaches a maximum temperature of 1,000 degrees Celsius during operation. Nothing else in our daily lives involves such high temperatures and pressures. Contaminants were the great enemy to the development of a lamp capable of withstanding such temperature and pressure extremes. For example, even the tiniest bit of moisture in the lamp will react with the tungsten or halogen that is used, rendering the lamp non-functional. To prevent this, Ushio has developed production processes that completely exclude moisture from the production environment." Further, systemization has been applied to management of materials and standards to the maximum extent possible, and layered improvements implemented in every possible area. "Certainly, development was an ongoing struggle, but the joy we felt in overcoming these obstacles was all the greater." The developer says this with an expression that is somewhat shy and humble, but none the less filled with an air of confidence.

### Entertainment

#### Technology and passion embodied in light give birth to richness in visual images

Finally, we move our focus from "light for copying and projecting" to "light for delighting and inspiring." Such light gives visual appeal to amusement parks, contributes to the passion of musical experiences in concert halls, and illuminates the significant moments of life in places like wedding halls. Here too, Ushio light plays an important role in making presentation of themes effective. For the xenon-lamp spotlights used for stage illumination, Ushio holds better than

90% of the domestic market.\* "Since spotlights, or followspots, are manually controlled by their operators, they must be as easy to handle as possible, but the way in which they illuminate depends on the skill of the operator. It is a process that requires both sensitivity on the part of the operator and a product that is sensitive to the operator's touch. Sometimes a single person has to operate two spotlights, and sometimes spotlights are needed that can easily be handled by people of shorter stature. So we sometimes build spotlights to order for special requirements." With major projects, it can take up to three years from development to delivery. Of course, advances are being made in using LEDs as light sources, but power deficiency and color variations make them difficult to use together with existing light sources. "As the entertainment industry reaches maturity, the demands placed on stage production can only increase. As a top maker of stage lighting, our mission is fulfilling such needs," says the manager with an air of purpose.

Now let's shift our attention from stage lighting to large-scale lighting for landscape illumination. Perhaps you've heard the term, "media façade." In a media façade, illumination is used to light up the surface of building walls or entire structures to produce a visually attractive, dynamic display. Whereas digital signage is an advertising medium, a media façade contains a strong element of ambient art.

"Actually, media façades are used very extensively in Korea," says a sales representative who formerly worked in Ushio's local company in that country. "Korea was quick to make extensive use of LEDs, and media façades can be seen everywhere." Making use of its unique optical technology for

lighting control, color representation and reproduction, Ushio has served as a collaborator with illumination designers and contractors on a wide variety of projects.

Contributing to the realization of work in the face of highly challenging requirements, Ushio is a partner in this area which requires both artistic sensitivity and experience. Working together with top artists, Ushio makes such works possible with light control technology that has been developed while working at art's frontiers. This makes it possible to provide a form of entertainment that has the added value of being attractive as well as illuminated. This is an Ushio strength that other companies do not have. Says the sales representative, "I'm sure that Ushio light will continue playing a role in providing people with wonder and entertainment in the form of optical art."

#### Ushio light: Continually evolving along with dreams for the future

Whether in the office or in the world of entertainment, Ushio light gives life to visual communications by providing color and beauty. Reflecting human emotions throughout the years, it projects images of excitement and joy. But this does not come without the behind-the-scenes efforts of many people. They also share in Ushio's hopes and dreams for the future. As long as dreams for the future are possible, Ushio light will continue to steadily evolve.

\* Per Ushio's own market survey as of March 31, 2014



**3 "Graphical Illusion," grand staircase in the Kyoto Station Building**  
Created by controlling 14,750 LEDs to represent the seasons, scenery and events of Kyoto. A new tourist attraction in Kyoto.

