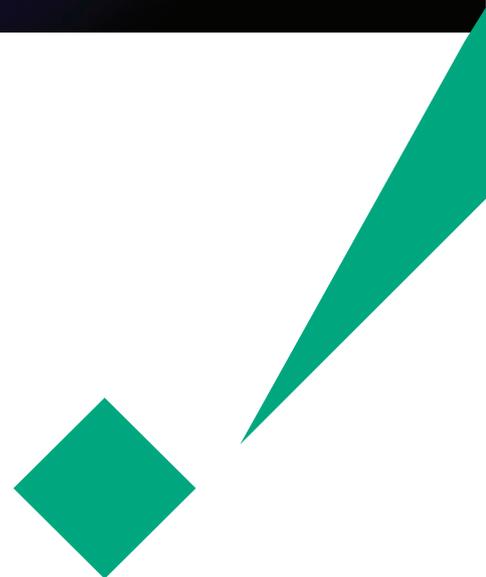


Ultraviolet Lamps

for diverse industrial applications



Defining Ultraviolet Radiation

What Is Ultraviolet?

Ultraviolet (UV) is electromagnetic radiation (EMR) occupying the wavelength range from approximately 10 - 400 nanometres (nm). UV radiation is invisible to the naked eye due to its short wavelength and high frequency which human brains are unable to perceive as an image.

UV can be divided into a number of subtypes in accordance with ISO-21348. At Ushio, our speciality UV lamps are placed into the following five partially overlapping categories:

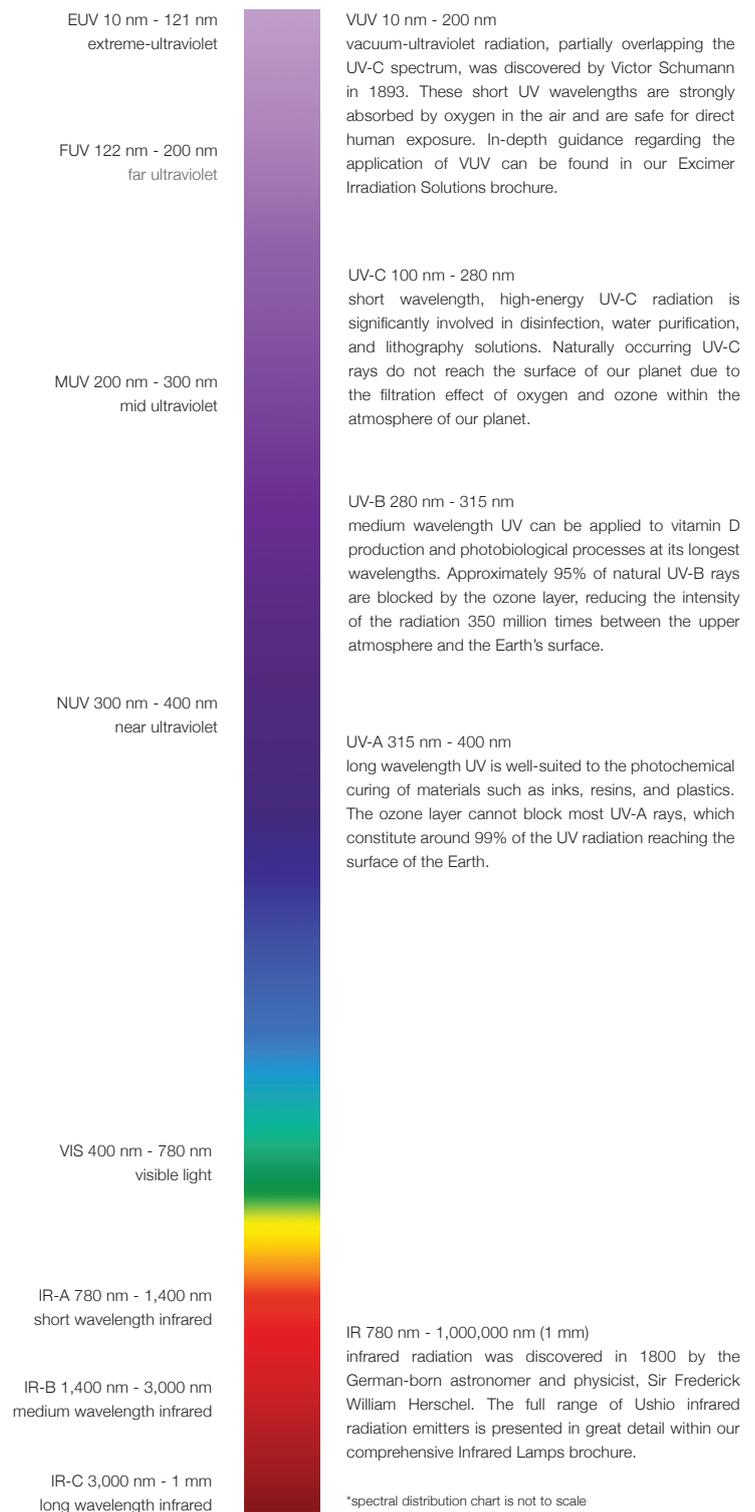
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|---------------------------|-----------------|
| Extreme-ultraviolet (EUV) | 10 nm - 121 nm |
| Vacuum-ultraviolet (VUV) | 10 nm - 200 nm |
| Ultraviolet C (UV-C) | 100 nm - 280 nm |
| Ultraviolet B (UV-B) | 280 nm - 315 nm |
| Ultraviolet A (UV-A) | 315 nm - 400 nm |

Beyond Violet: The Search For Polarity

The UV section of the electromagnetic radiation spectrum was discovered by a German physicist, Johann Wilhelm Ritter, in 1801. Following the discovery of infrared “heat rays” by Herschel the previous year, Ritter was convinced that there must be an opposite “cooling ray” at the opposite end of the spectrum.

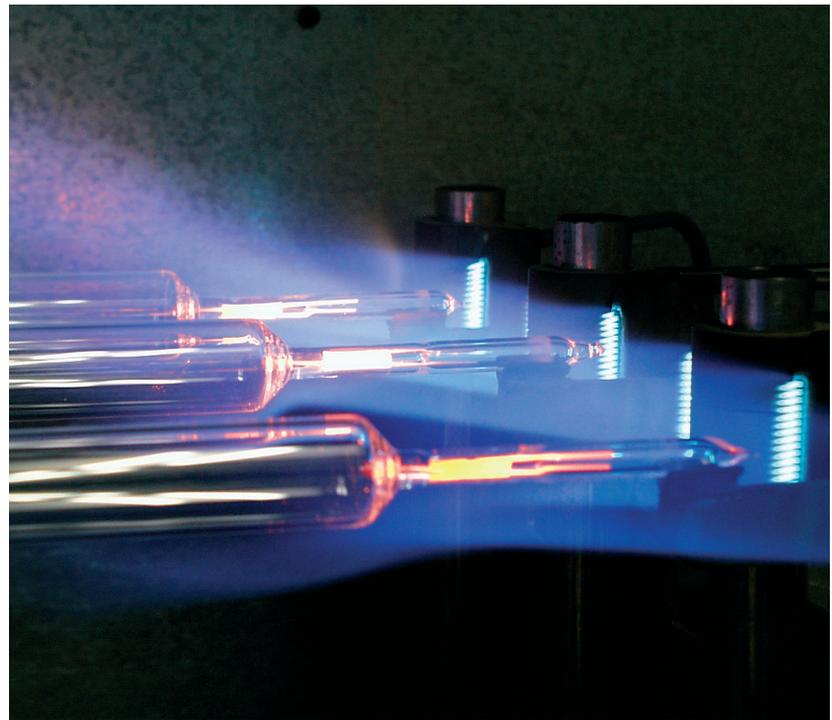
While his search for temperature polarity was slightly misguided, he eventually discovered that the transformation of silver chloride (AgCl), a light-sensitive compound, from white to black was expedited when placed in the dark region just beyond the visible violet light range. Ritter tentatively labelled this new chemically-reactive phenomenon “oxidising rays”. Later, as the sector expanded to include the neighbouring violet-blue rays, he coined the term “chemical rays” after witnessing the rays triggering certain other chemical reactions. These terms remained popular throughout the 19th century, but were eventually phased out in favour of a more restrictive and scientific term, “ultraviolet”. The Latin prefix *ultra-* means “beyond”.

UV Light On The Electromagnetic Radiation Spectrum



Expertly Applied To Your Field

- ◆ 3-D Printing
- ◆ Adhesives
- ◆ Analysis
- ◆ Air Purification
- ◆ Ballast Water Treatment
- ◆ Bilirubin Phototherapy
- ◆ Biochemistry
- ◆ CD, DVD, and Blu-Ray Production
- ◆ Chemical Processing
- ◆ Cold-Light Therapy
- ◆ Curing
- ◆ Dentistry and Orthodontics
- ◆ Dermatology
- ◆ Diazo Processing
- ◆ Disinfection
- ◆ Duct Relining
- ◆ Fluorescence
- ◆ Fresh Water Treatment
- ◆ Glazing
- ◆ Hardening
- ◆ Inactivation of Micro-Organisms
- ◆ Insect Baiting
- ◆ Inspection
- ◆ Ink Pinning
- ◆ Inkjet Printing
- ◆ Lamination
- ◆ Lithography
- ◆ Manicure and Pedicure Studios
- ◆ Medical Science
- ◆ Photochemistry
- ◆ Pollution Reduction
- ◆ Polymerisation
- ◆ PCB Protective Lacquer
- ◆ Printing
- ◆ Reprographics
- ◆ Resin Setting
- ◆ Spectrometry
- ◆ Surface Cleaning
- ◆ Tanning Salons
- ◆ Varnishing
- ◆ VOC Destruction
- ◆ Waste Water Treatment
- ◆ and many more...



Ushio is the premier manufacturer of customisable UV lamps. We have spent over 55 years developing our cutting edge technology and tailoring it to the needs of each unique client. With a legendary commitment to quality and flexibility, we have remained unsurpassed as the world leading manufacturer of specialist lighting solutions since our foundation in Tokyo, 1964.

In our experience, each application requires a varying degree of UV treatment, but a single solution may not necessarily maintain a high level of effectiveness in all environments. That is why Ushio does not simply ship out mass produced UV solutions.

Our specially trained engineers at Ushio's production facilities in Germany and Poland devise, build, and test each device with a unique design for each client. This ethos results in lamps which perfectly align with your requirements every time you place an order.

Alongside our proprietary lamps, we can provide you with complete industrial systems which can optionally include lamp housings, extra UV modules, power supplies, and electrics for different processes and applications.

Metal Halide Short Arc UV Lamps

Ushio's metal halide short arc lamps are high intensity discharge emitters which are deployed in numerous applications, such as the use of inks and the production of semiconductor materials.

Emitting a well-balanced visible light spectrum, these lamps are efficient and provide superb colour rendering to reproduce vivid images and natural colours.

Mercury and other metal halogens are excited by a high temperature arc discharge until they evaporate into separate atoms.

These metallic atoms release a substantially high level of luminance and the predetermined ultraviolet wavelengths.

Offering a wide and uniform light, Ushio's metal halide short arc lamps are highly efficient. In some cases, they consume less power and have a longer lifespan than incandescent light bulbs.

Applications

- ◆ CD, DVD, and Blu-Ray Disc Production
- ◆ Diazo Processing
- ◆ Inspection
- ◆ Polymerisation
- ◆ Spot and Search Lights
- ◆ Semiconductor (PCB)

Benefits

- ◆ High lumen output
- ◆ Vivid colour rendering
- ◆ Features a compact design
- ◆ Can be used in conjunction with parabolic or elliptical reflectors



Long Arc Medium Pressure UV Lamps

These long arc lamps have a medium operating pressure and are applicable for the curing of inks or lacquers and for triggering photochemical processes, such as disinfecting drinking water or ballast water treatment.

The versatility of these light sources is of particular note, with over 100 different models available, ranging from very short, up to 2.5 m in length.

With the precedent set for a vast array of options, Ushio's long arc medium pressure lamps provide the largest possible selection of wattages, from just 200 W, all the way to 40 kW!

Depending on the application, the UV-A, B, or C radiation output can be increased to achieve the desired result without any need for a lamp change.

Applications

- ◆ CD, DVD, and Blu-Ray Disc Production
- ◆ Chemical Processing
- ◆ Disinfection
- ◆ Duct Relining
- ◆ Curing of Inks, Lacquers, Resins, and Varnishes
- ◆ Decorative Glazing
- ◆ Fibre Optics
- ◆ Graphic Arts
- ◆ PCB Protective Lacquer
- ◆ Water Treatment

Benefits

- ◆ Highly adept in curing and other photopolymerisation applications
 - ◆ Wide-range of options accommodating customisation of size and power
 - ◆ Various geometrical designs and suitable connections available
 - ◆ Spectral adjustments possible through the introduction of doping materials
-



Our Lamp Technology Explained

Firing Up The Electrodes

Ultraviolet emitters, commonly referred to as UV lamps, are light sources which are mostly implemented in substrate treatment processes, rather than for typical illumination applications.

The UV emitters produced by Ushio belong to the discharge family. Unlike lamps which use a filament, discharge lamps usually contain mercury and an inert gas, such as argon, causing a reaction when two electrodes generate an electrical discharge arc between them.

The distance between these electrodes is known as the arc length. Varying the size of the gap between the electrodes will result in a longer or shorter arc length.

To emit a specific wavelength of UV light, further reactive substances such as metal halides can be added in a process described as “doping”. A UV lamp that has undergone this modification process is referred to as a “doped emitter”.

Only The Highest Quality Quartz Glass

All Ushio UV lamps are made using quartz glass for improved thermal shock resistance, high softening temperature, and crucially, its UV-permeable qualities.

Quartz is also resilient against the effects of solarisation which, due to the presence of internal defects in lesser types of glass, can cause discolouration and loss of transparency after exposure to high-energy electromagnetic radiation.

A significant characteristic of quartz glass is its transparency to UV radiation. Couple this with a resistance to thermal shock and very high softening temperature, and you have the perfect tube material for a UV lamp. Ushio offers several variants which allow different wavelengths to pass through.

The mechanical and electronic connection to the lamp base is located at the end of the glass chamber. Vacuum sealing is required to ensure the containment of the reactive substances within the lamp by means of a pinched or round sealed section at the ends of the quartz glass tube.

The Molybdenum Foil Bridge

Electricity is able to pass through the seal thanks to the implementation of a molybdenum (Mo) foil welded between the tungsten electrode and contact pin.

The Mo foil is required because tungsten (W) possesses a thermal coefficient ten times that of quartz glass, thereby prohibiting a direct bond between the two parts.

The introduction of the foil allows a thermally stable, vacuum sealed connection within the quartz glass which will remain intact for the duration of the lamp's operational lifetime.

Dispersing The Heat Load

The electrodes and the Mo foil transmit the current while simultaneously dispersing the heat produced by the emitter during operation.

The quartz tube can reach temperatures of 600°C to 900°C, and the persistent channelling of this heat load will raise the temperature of the foil and seal considerably. In order to prolong the operational lifetime of the emitter, the foil and seal must not exceed a temperature of 350°C.

However, depending on the application in question and various environmental factors, the end user must implement a suitable cooling system to ensure the maximum operational temperature is not exceeded.

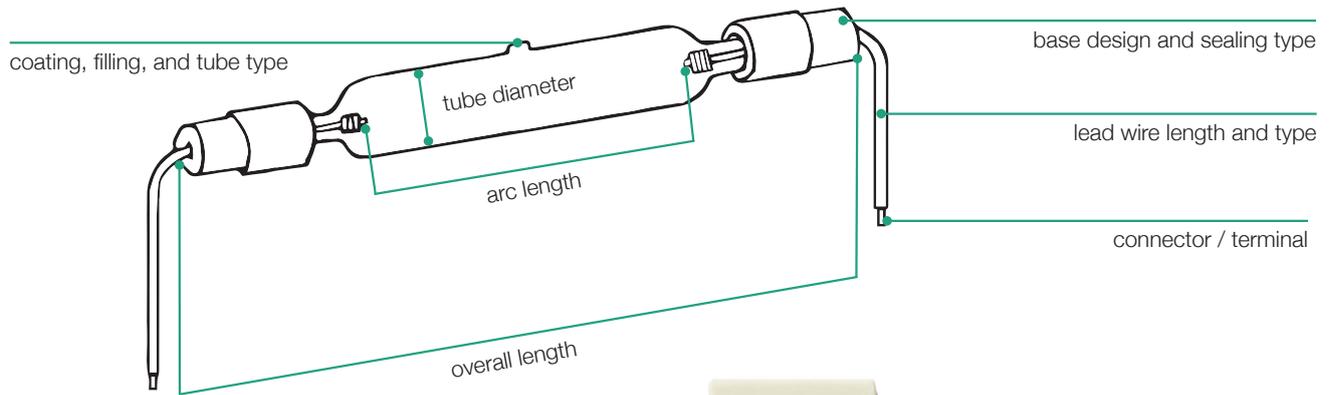
Ceramic Isolation

At the extremities of the lamp, an outer pin mostly shielded by a ceramic base facilitates the electrical connection. The ceramics used by Ushio have high heat capacity with a high level of heat conduction and, aside from mechanically integrating the lamp to the equipment and power supply, the corrosion-resistant base serves as an electrical isolator.

The Ushio UV Advantage

- ◆ High radiation intensity across the desired spectral range
- ◆ Short irradiation and exposure lengths required
- ◆ Different arc lengths available, both long and short
- ◆ Radiation efficiency optimised with high quality reflectors
- ◆ All lamps produced in compliance with DIN EN ISO 9001

Top Quality, Bespoke Design



Uniquely Attuned To Your Requirements

In order to attain a consistently high quality output for your application, there are several key factors which must be considered when designing and manufacturing an industrial UV lamp.

The diagram above illustrates a typical UV lamp and the design features which Ushio can customise in order to provide you with the most effective application solution.

Your Wish Is Our Command

- ◆ Plug-and-play for super-fast lamp exchange
- ◆ Reaches full power in 3 - 5 seconds (up to 1 kW)
- ◆ Simultaneous power connection and secure mounting
- ◆ Pinched seals reduce unit size; maintain arc length
- ◆ Standard, synthetic, or ozone-free quartz types
- ◆ Emitters doped with gallium, iron, etc. are available
- ◆ Standard flying leads, plug-in, rectangular, and axially mounted contact connections are available on request

Ushio UV Customisable Features

- ◆ Any lamp length available, up to 2,500 mm
- ◆ Arc lengths between 15 mm and 2,300 mm
- ◆ Quartz tube diameter variants from 13 mm to 45 mm
- ◆ Optional tube coatings incl. platinum, gold, zirconium
- ◆ Endless possibilities for customised base design

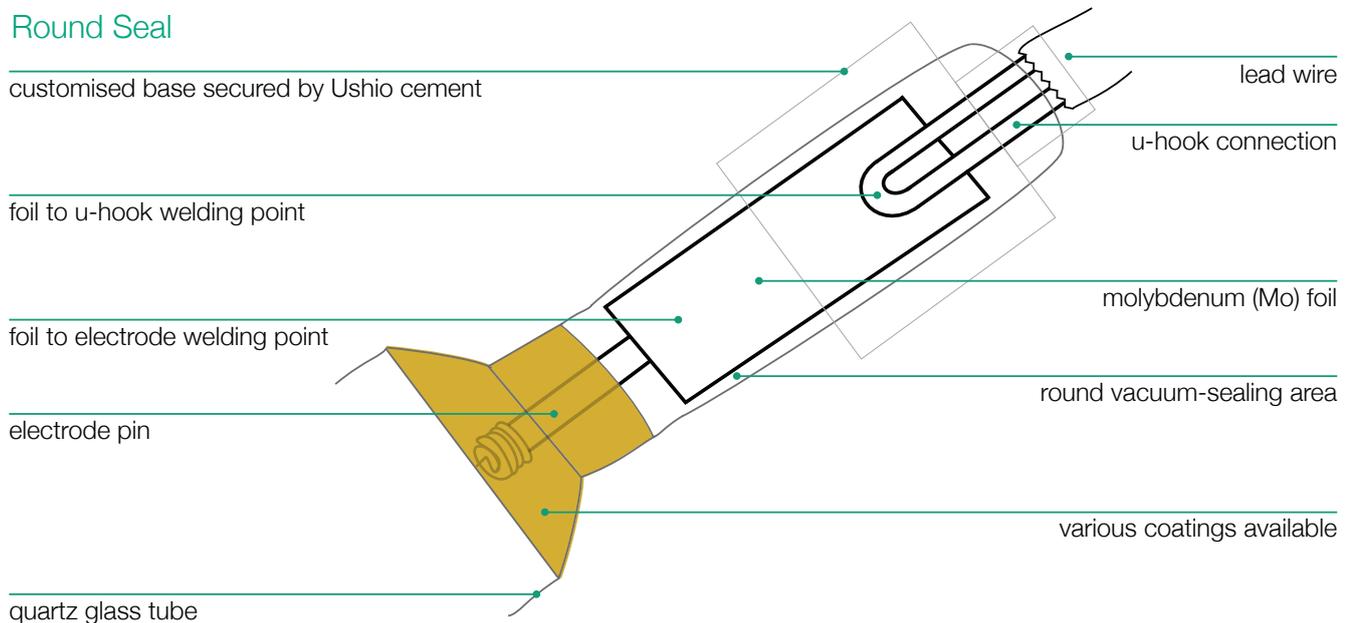


Special Sealing Techniques

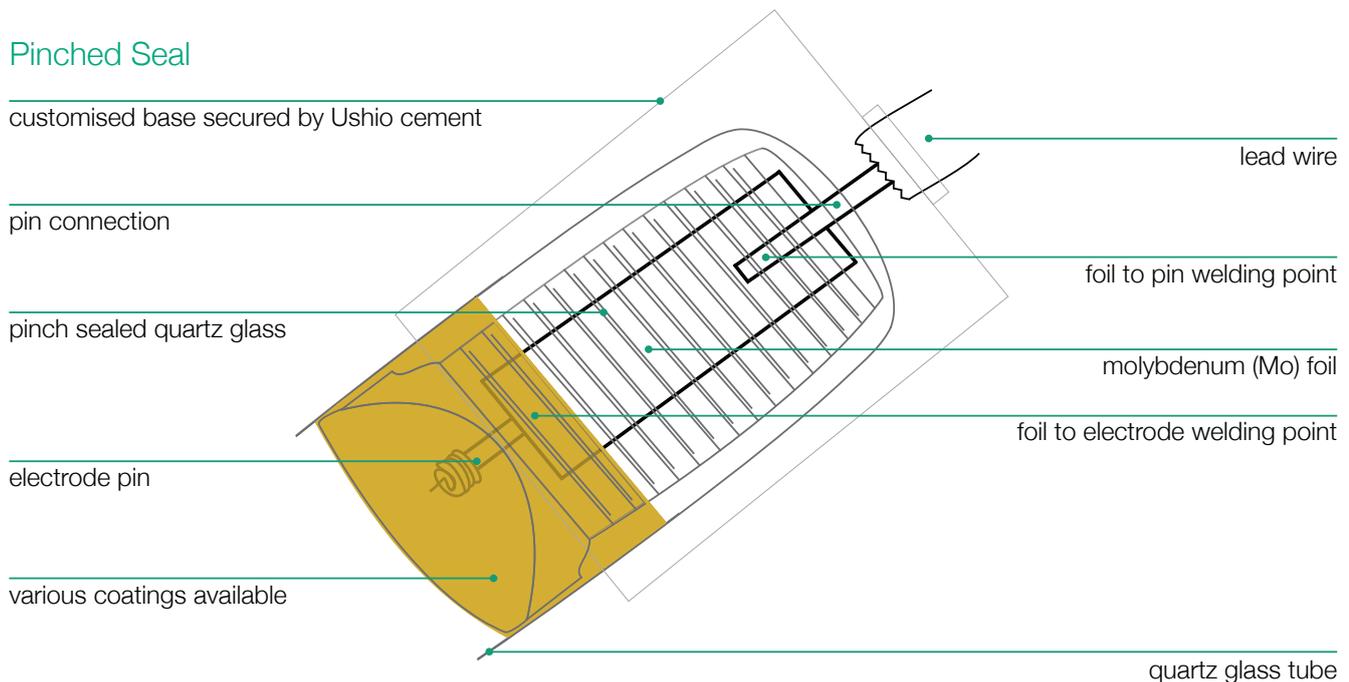
Choose Your Seal Wisely

Ushio's successful development of the optional pinched seal allows the dispersion of excess heat to take place over a much shorter distance. The subsequent reduction in overall unit length passes on the potential for cost and space saving to our clients, who include OEM's worldwide. If the lamp is only as long as it needs to be, the cost of housing the lamp within a machine can be reduced. In situations where the overall unit length is of less priority, some prefer our round sealing method instead.

Round Seal



Pinched Seal



Customised Lamp Construction

Bases

We offer a large variety of common lamp bases, however Ushio's UV technical development team is on standby to design bases on request for seamless integration into your existing or newly designed systems. The majority of Ushio lamp bases are formed from ceramic due to its excellent corrosion resistance, although metal bases are available should they fit your requirements.

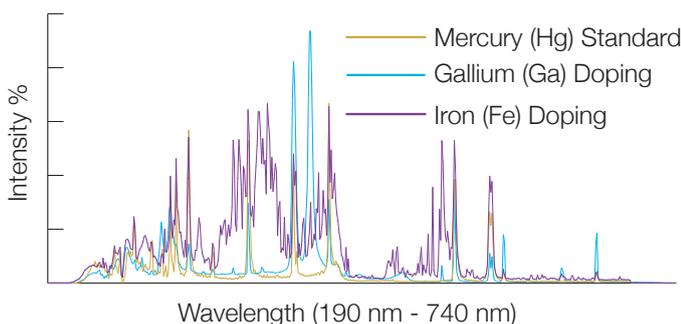
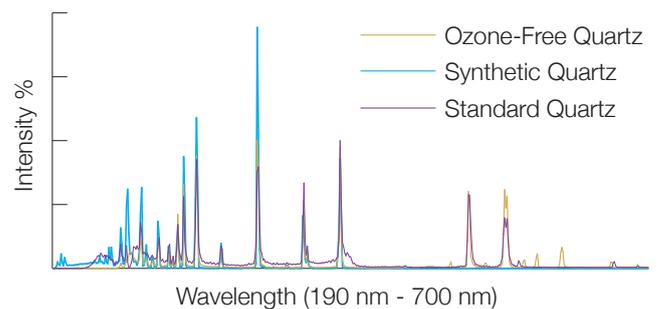


Connections

Depending on the power rating and size of the machine housing your UV emitter, you may select from our range of connections to suit all situations. Alongside our standard (b) and axially mounted ceramic connections featuring flying leads, Ushio produces various types of plug-in and axially mounted contact pins which can be selected to ensure the optimal power feed for your lamp. These include our rectangular pin plug (a) for pinch sealed lamps, and axially mounted contact pins (c). If required, our engineers can even design a tailor-made connection for you.

Glass Tube

- ◆ Standard Quartz - Produces ozone, useful for surface activation but requires an exhaust system. Reaching $\geq 80\%$ transmission down to approximately 210 nm.
- ◆ Synthetic Quartz - Implemented to achieve the highest possible UV-C output, UV lamps fitted with synthetic quartz can reach 60% transmission at approximately 160 nm.
- ◆ Ozone-Free Quartz - Popular in germicidal applications, this type of tubing filters out ozone-producing wavelengths at ≤ 235 nm, while allowing the transmission of UV-A and UV-B.



Doping

With a broad range of applications occupying different areas of the ultraviolet spectrum, it is possible to enhance certain wavelengths with the introduction of a doping element. Once your chosen wavelength is agreed upon, our experts may recommend a UV lamp imbued with additional metal halides to achieve the optimal output. The most common substances added to our lamps are iron (Fe) and gallium (Ga).

Handling & Operation tips for ultraviolet lamps

Our bespoke UV lamps are only permitted to leave the factory floor after being benchmarked by Ushio's rigorous standards - the true zenith of technological excellence and efficiency. However, this diligence must persist once the finished product leaves Ushio. It is of paramount importance that the operation, handling, and care of such emitters is carefully managed.

The following stipulations must be adhered to by all personnel operating in close proximity to a UV radiation emitting device.

- ◆ **WARNING: Ultraviolet Radiation!** Protect skin and eyes against unfiltered, direct, or indirect radiation. If people are within close proximity of the lamp during operation, adequate shielding and/or other safety precautions must be implemented.
 - ◆ **WARNING: The quartz glass lamp presents a severe danger of breakage!**
 - ◆ **WARNING: Contains Mercury and/or other harmful substances!**
 - ◆ Occurrences of lamp bursts increase with lamp age, temperature, incorrect operation, and improper handling.
 - ◆ Never operate lamps with any traces of cracks, defects, scratches, or physical damage.
 - ◆ Be aware of high lamp temperatures during operation and up to ten (10) minutes after deactivation.
 - ◆ Do not operate lamps in close proximity to paper, cloth, or any other combustible materials.
 - ◆ Ushio lamps should only be used with compatible fixtures and power supplies.
 - ◆ Dirt or other physical contaminants must be cleaned from the lamp before operation.
 - ◆ Ensure electrical power has been deactivated before inserting, removing, or cleaning the lamp.
 - ◆ Presence of foreign elements will affect lamp radiation output, may cause overheating, and/or decrease the lifetime of the lamp.
 - ◆ Lamps should never be operated beyond their designated lifetime.
 - ◆ Improper installation will result in electrical arcing, overheating, and reduced operational lifetime.
 - ◆ Electrical connections should be kept clean and in good condition.
-

Ushio Technical Engineering: research as a joint enterprise

With a steadfast commitment to offering every client a unique solution to their needs, Ushio Europe has pledged to involve each customer in the R&D process. Catering for the plethora of requests received at Ushio, our experts have constructed several facilities for the development and testing of vacuum-ultraviolet (VUV), ultraviolet (UV), visible (VIS), and infrared (IR) lamps.

The construction of the Ushio Application Laboratory in Germany allows every client the opportunity to test our solutions on their own materials under strictly controlled conditions. Located in Steinhöring, Germany, prospective clients are welcome to experiment with industrial UV processes like never before.

The UV lamp engineers at Ushio undertake intensive in-house research, conceptualisation, and design while keeping you in the loop during each phase. Whether your interest lies in curing paints onto your final product, or you are searching for molecular-level defects on your substrate surface, Ushio can lend you its knowledge and experience during the investigatory stages.

Once this crucial exploratory phase has found the best solution to your application, the testing is relocated and repeated at your own production facility. Here the final adjustments can be made in a 'real world' scenario by taking your actual efficiency, environmental conditions, and production intensity into account.

Let Ushio know which industrial or laboratory solution you wish to perfect, and the best product development team in the business will experiment with all manner of lamps, doses, and speeds to present you with the perfect UV solution to take your process to the next level.

The Ushio Solution Development Procedure follows a simple set of important steps to implement and maintain your Ushio ultra-violet equipment to the highest possible standard.

Before

- ◆ Application research and experienced comparison
- ◆ Co-operative conceptualisation
- ◆ In-house design and recommendations
- ◆ Extensive comparative testing simulations

During

- ◆ 55+ years of speciality lighting expertise
- ◆ One-stop-shop for adjustments and advisements
- ◆ Uncompromisingly focused on impeccable quality

After

- ◆ Controlled reassessment of solution output results
- ◆ Continued focus on improvement
- ◆ Post-sale performance analysis and alterations

Developing Solutions Together

Ushio is a partner which listens to your ideas and requirements. Let us optimise your processes according to your specifications and expectations. Use our expertise to develop a tailor-made solution which matches your needs.

USHIO

Applying Light to Life

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