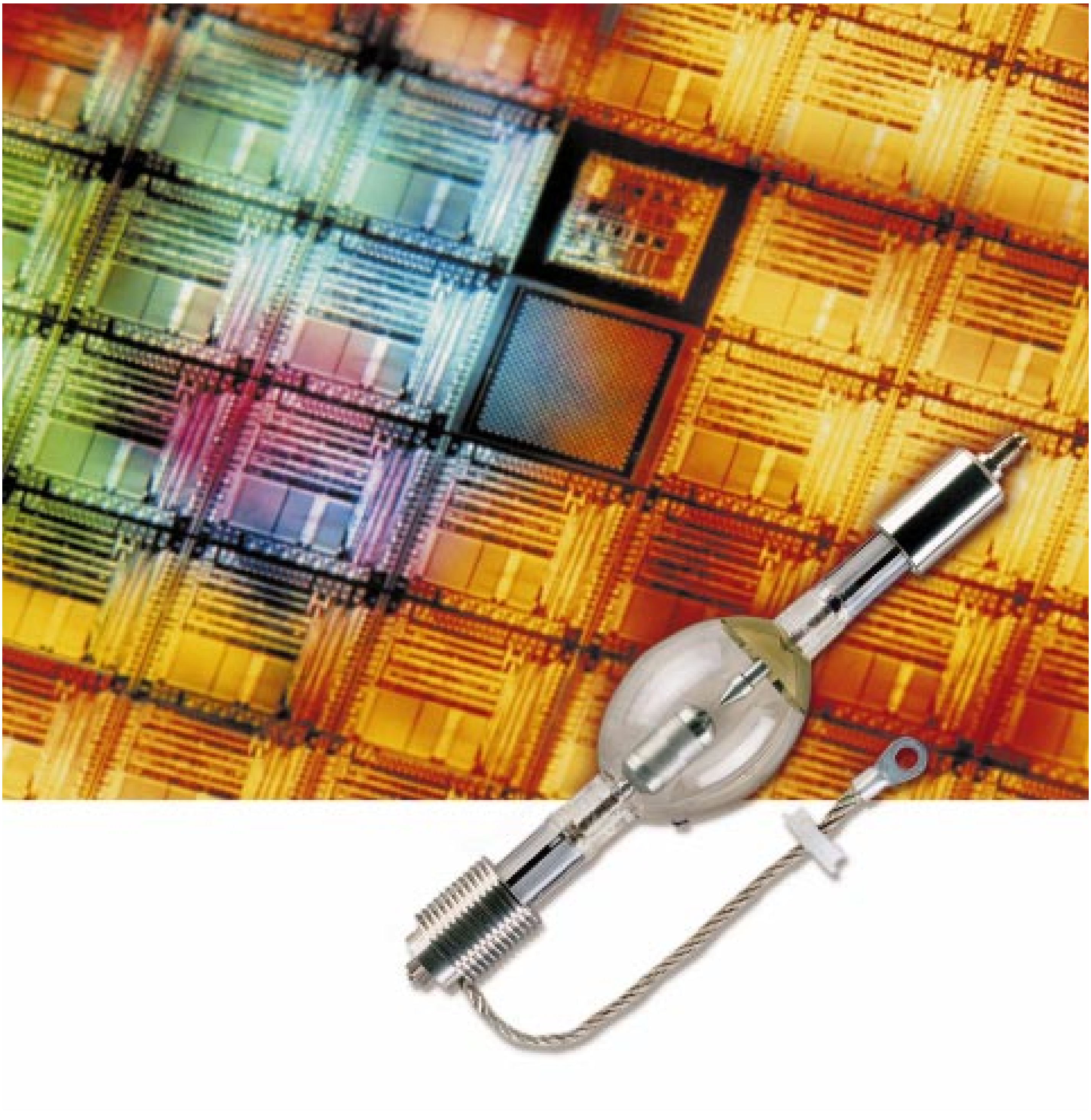
TECHNOLOGY AND APPLICATION – EDITION 1999/2000

MERCURY SHORT ARC LAMPS HBO® FOR MICROLITHOGRAPHY



THERE IS LIGHT. AND THERE IS OSRAM.

OSRAM

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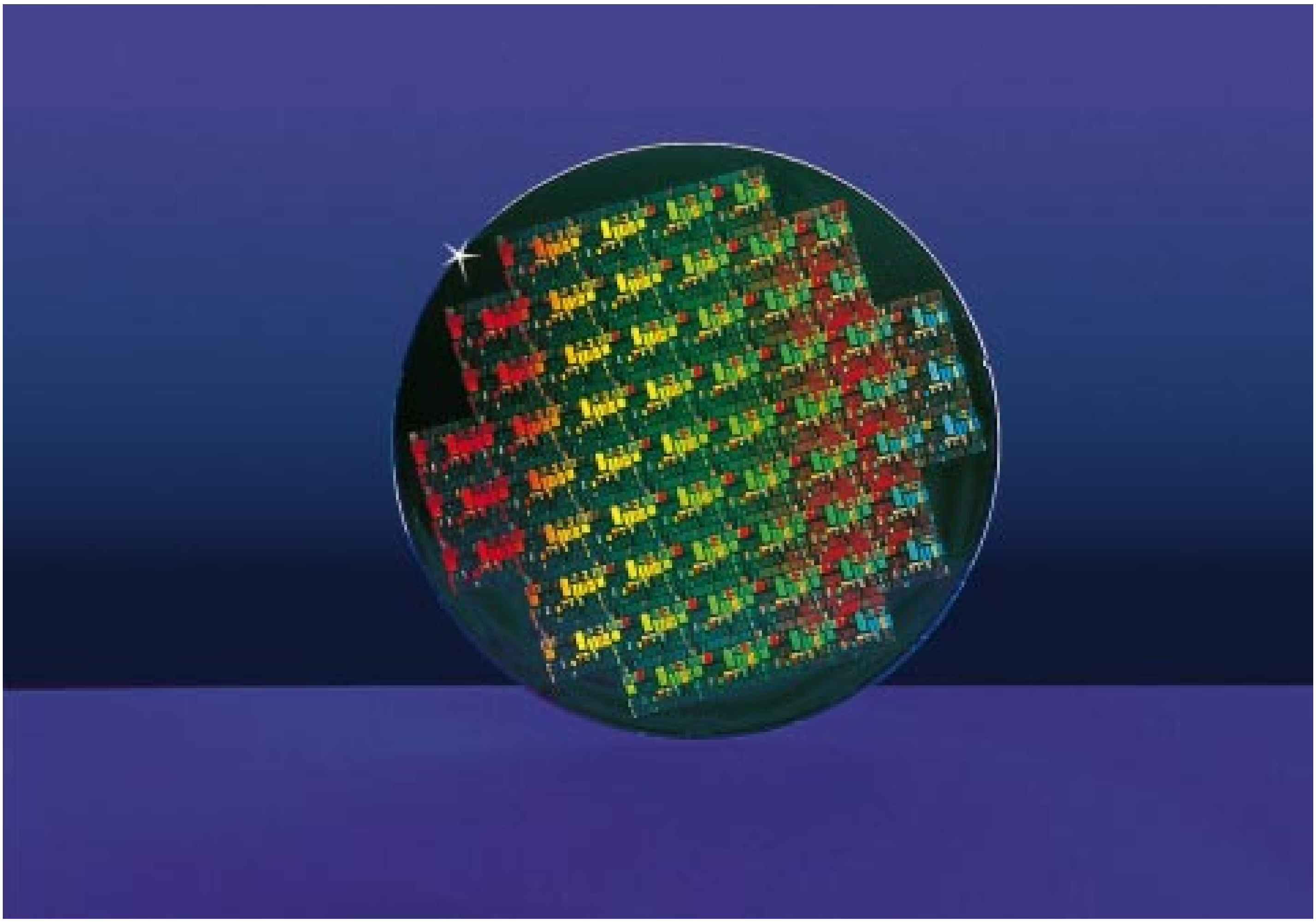


8-inch wafer with test structure for the development of a 256-Megabit DRAM. This memory chip is based on a 0.25 µm design guideline ("Quarter Micron"). Photo: Siemens AG

Mercury short arc lamps are used as light sources in microlithography because of their violet and ultraviolet radiation and their high luminance. OSRAM, as the world market leader in special-purpose discharge lamps, has been developing, manufacturing and marketing HBO® short-arc mercury lamps for more than 65 years. Our certification for DIN EN ISO 9001 guarantees the highest possible levels of quality and regulated procedures in all areas.

QUESTIONS?

The major technological innovations for OSRAM HBO® lamps for micro-lithography are

– the development of lamps with higher and higher wattages
– the optimization of g-line and i-line emission
– the development of pulse-mode lamps
– the introduction of longlife and extended longlife lamps
– the introduction of IOFR (improved Ozone-free) quartz technology for i-line lamps to reduce undesirable low UV radiation furtheron.

The goal for the future is to emphasize on innovations in HBO® lamp technology. Included in this is the continued development of higher lamp wattages as well as increases in service life and maintenance.

By using electrode material from our own production facilities, we are able to achieve extremely high arc stability in our OSRAM HBO® lamps. In conjunction with quartz of the highest optical purity, this guarantees extremely homogeneous and stable radiation properties and excellent maintenance of the lamps. In addition to using the right materials, we carefully optimized the geometry of the lamp and the electrodes to ensure an efficient conversion of electrical power into radiant power.

REG. NO. 19 496-01
OSRAM GmbH

A quality audit carried out by the German Society for the Certification of Quality Management Systems (DQS) demonstrated that the quality assurance system operated by OSRAM GmbH meets the requirements of

DIN EN ISO 9001


CERTIFICATE

DQS Deutsche Gesellschaft zur Zertifizierung von Managementsystemen mbH

OSRAM GmbH

quality system

DIN EN ISO 9001

1. INTRODUCTION

Mercury short arc lamps (also referred to by their abbreviation HBO®) with a power consumption of between 200 W and 8,000 W are used primarily as a light source in the manufacture of microchips, Liquid Crystal Displays (LCDs) and Printed Circuit Boards (PCBs).

As one of the three large lamp manufacturers in the world, OSRAM feels obligated towards its customers not only to produce high quality products, but also to render information as comprehensive as possible.

By presenting this publication we want to satisfy this demand for information. An overview as comprehensively as possible is to be rendered on all questions which may arise in conjunction with the use and the operation of HBO® lamps with a power consumption of between 200 W and 8,000 W. HBO® lamps with a power consumption of more than 200 W are used almost exclusively in microlithography for the production of electronic semiconductors, LCD's (Liquid Crystal Displays) and PCBs (Printed Circuit Boards). Depending on the respective production, various types of equipment (stepper, scanner, mask aligner, et cetera) are used, whereby the common feature is that they are all used for exposure. For this reason, they will be referred to as "exposure units" in the chapters below.

This brochure addresses primarily users of lamps for exposure systems. As the lamps are used for specific exposure equipment of various manufacturers as a rule, we dispensed with a detailed description of the igniter devices and control gear required for the operation. These units are described in detail in the brochure titled "HBO® Mercury Short Arc Lamps: Technology and Application".

Apart from the physical and lighting fundamentals, which the emission-generating process of the mercury short arc lamps (HBO®) is based upon, the practical requirements, which have to be met for a safe and beneficial operation of the lamps, shall have priority here.

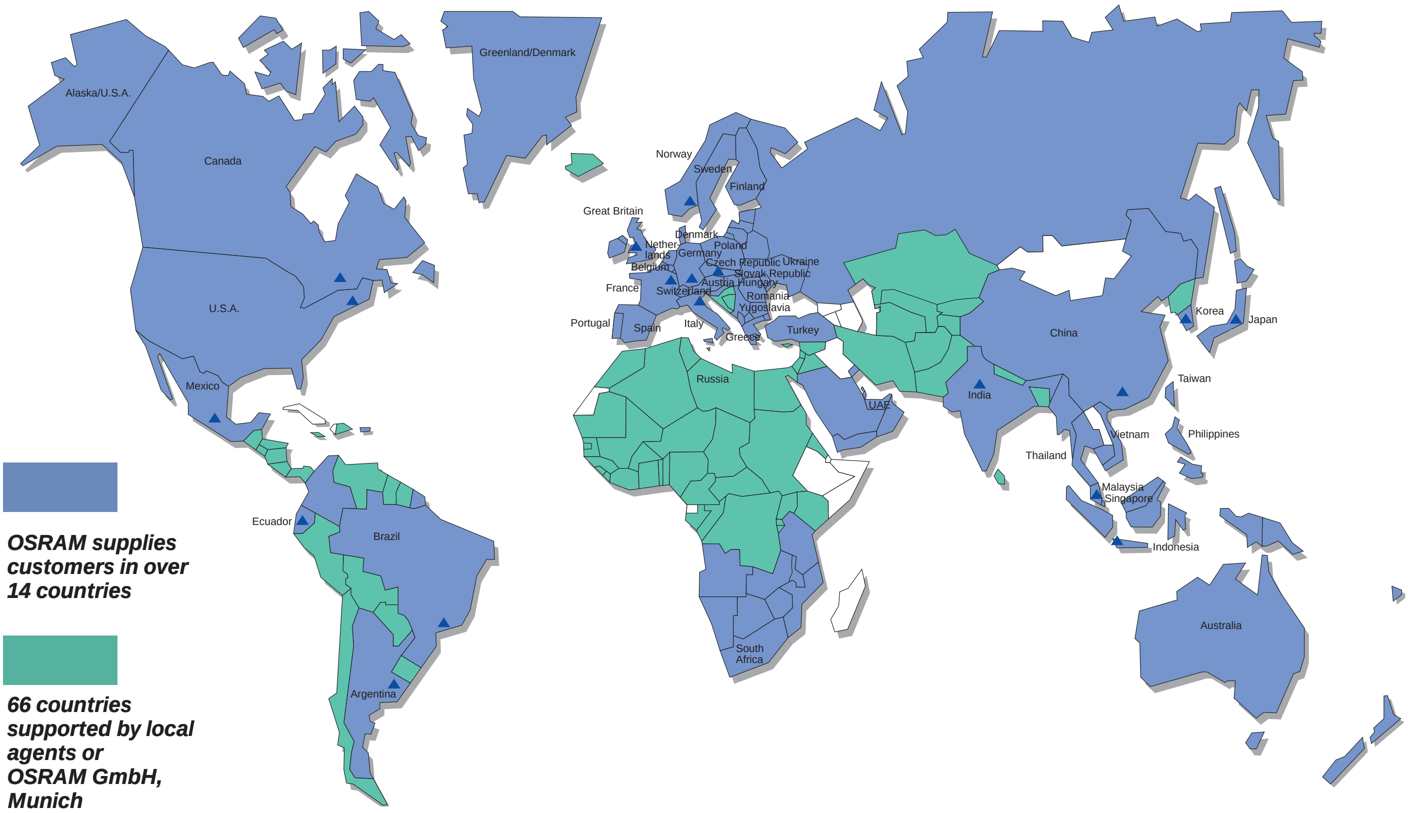
1.1 Historical overview

The mercury short arc lamps are direct-current short-arc gas discharge lamps, in which the electric arc of the discharge takes place in a high-pressure mercury atmosphere.

The first HBO® lamps were developed by OSRAM as early as in the 1930s. The first useful application followed immediately. In the following years the lamps were continuously further developed. Whilst the short-arc lamps were used for ultraviolet light pens primarily at the beginning, more and more new applications like fluorescent microscopy were added in the years to follow. Apart from the use as a light source for UV-curing (photo polymerization), the high power lamps have been used increasingly in the production of semiconductor structures since the 1980s. At the beginning, lamps with a power consumption of 200 W and 350 W were used whereby, depending on the application, either a large share of the emission spectrum or selected lines were employed for the exposure. With the increasing miniaturization of the structures, lamps up to a power consumption of

1,000 W optimized to the g-line (436 nm) of the mercury and then lamps optimized to the i-line (365 nm) were used, the power of which may amount to 3,500 W and more nowadays. Some devices use lamps, the emission spectrum of which is optimized in the deep ultraviolet (DUV) region. Lamps with a power consumption of over 3,500 W are employed primarily in the production of LCDs and PCBs. In these applications, the feature in the foreground is not the illumination of very small structures on a small surface, but rather the fast exposure of large surfaces. The reliability and the life-time behavior of the mercury short arc lamps has been improved continuously by further developments in the lamp components and the production processes. For this reason, a range of high-quality products can be offered today divided up into a multitude of power ranges and variants so that each of the numerous applications is catered for.

OSRAM is represented by local agents in all countries in the world, in which semiconductors, LCDs or PCBs are manufactured. Thus, OSRAM offers its customers the best possible consultation and ideal support. An optimized customer services system ensures the support of the customer in his high-tech applications as fast as possible.



OSRAM supplies customers in over 14 countries

66 countries supported by local agents or OSRAM GmbH, Munich

52 production plants in 18 countries

1.2 Quality and the environment

OSRAM is banking on quality and environmental protection.

The high quality demand of OSRAM is reflected not least in the corporate principle of “Total Quality Management” (TQM), which defines the quality principles applicable in the world-wide active company. These quality principles represent the basic attitude and concrete way of action of all employees.

OSRAM was the first manufacturer of lamps for microlithography to be awarded certification in compliance with standard DIN EN ISO 9001 by the Deutsche Gesellschaft zur Zertifizierung von Managementsystemen mbH (DQS) in 1994. This certification, which has been confirmed continuously since 1994, has ensured a continuous improvement of our products and especially our customer services.

OSRAM emphatically stands up for its responsibility. We want to act environmentally responsibly. The impact on the environment caused by the operation of our production plants, by the sales operations as well as by our products is to be kept as low as possible at all times.

Our guiding principle in all actions therefore is to prevent entirely, if possible, or to reduce to a minimum at least all environmental loads, even beyond the legal stipulations by means of a continuous improvement process, and the use of the latest technology.

This is ensured by our environmental management system validated since 1995 in compliance with standard DIN EN ISO 14.001 and the European EU eco-audit regulations (EU Directive No. 1836/93).

Fig. 1: Certificates - quality management system and environment management system

2. GENERAL DESCRIPTION OF HBO® LAMPS

2.1 HBO® technology

The mercury short arc lamps (HBO®) belong to the big family of the gas-discharge lamps. These lamps contain a ground gas (such as argon, xenon, et cetera) and liquid mercury which changes into gaseous state under high pressure by the temperature produced when the discharge is switched on. The light (the radiation) is produced by the discharge arc freely occurring between two electrodes in the mercury vapor atmosphere. By collision with the electrons and the ground gas atoms, the mercury atoms gain energy; they enter into an "excited" state. Based on the physical laws, this higher energy level can be quit by liberating a quantum of radiation and the atom returns into a lower state. The wavelength of the emitted quantum of radiation depends on the previously difference of energy levels involved. As discreet energy conditions only are possible, a spectrum is produced which consists primarily of the widened lines of the mercury (depending on the pressure) (cf. chapter 4.6). The arc gap, i.e. the spacing between the two electrodes during the operation of the lamp, is only a few millimeters. Thus, the lamps come very close to the ideal of a point-source lamp.

2.2 Fields of application

The various applications also make different demands on the light source employed. In a constant co-operation between OSRAM in its capacity as the manufacturer of lamps and the device manufacturers or the local users, respectively, a wealth of mercury short arc lamps and variants thereof have been developed, which generate the right radiation for virtually any application. The fields of application are versatile:

– microlithography
– production of LCDs
– production of PCBs
– microstructure, nanotechnology
– printing technology
– and many fields more

3. LAMP CONSTRUCTION

3.1. Terminology

“A rose by any other name would smell as sweet” - Shakespeare’s words apply for OSRAM lamps as well. Below, we want to try and give the reader a brief insight into the background and the significance of the names we use.

The three letters preceding the power data refer to the lamp family. In the case of the mercury short arc lamps these are the letter HBO, in which

H stands for mercury (Hg, lat.: hydrargyrum)
B stands for high luminance (B = symbol for luminance)
O stands for unforced cooling (original meaning, no longer applicable today)

The letters following the data on the power consumption (including “W” for Watt) refer to certain special features of the respective type as a rule.

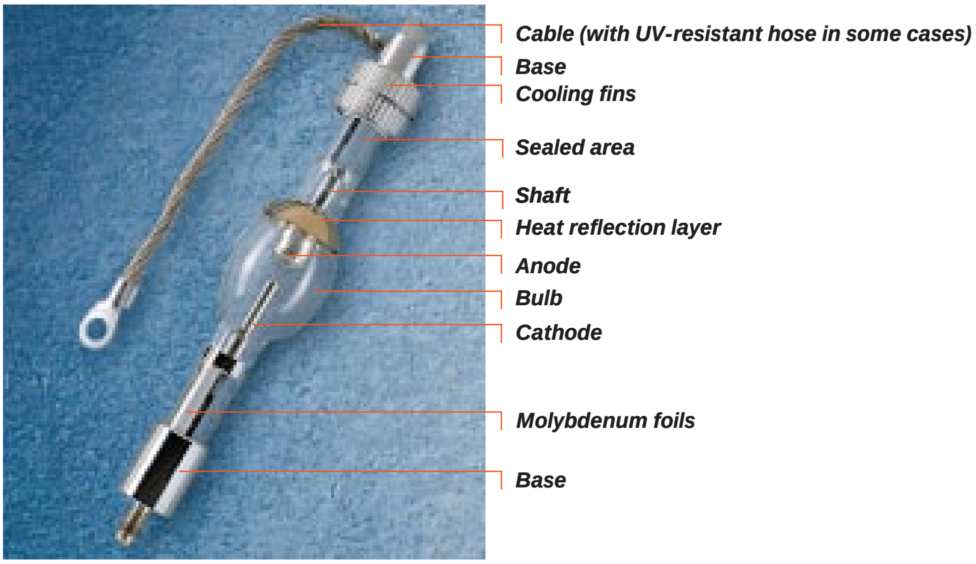
P	= for exposure units of ASML Company (previously Philips Company)
C	= for exposure units of Canon Company
N	= for exposure units of Nikon Company
S	= for exposure units of Karl Suess Company
G	= for exposure units of GCA Company
MR	= for exposure units of MRS Company
L	= long-life version
EL	= extended long-life version
I	= optimized for the i line (365 nm)

Exceptions to this notation are, for example HBO® 250 W/BY, HBO® 1000 W/D or HBO® 4000 W/PL.
The lamp is clearly and unmistakably defined only with the complete designation. The absence of one single letter may lead to mistakes.

3.2. Design characteristics

As versatile as the fields of application of the mercury short arc lamps may be, the design structure follows certain basic elements in principle – a double-ended arc-tube which is further processed to a lamp by corresponding modifications (geometry, base). However, in detail each lamp is individually optimized for the respective case of application. The most important elements are shown in Fig. 2 and 3.

Fig. 2: Picture of HBO® 1500 W/PIL



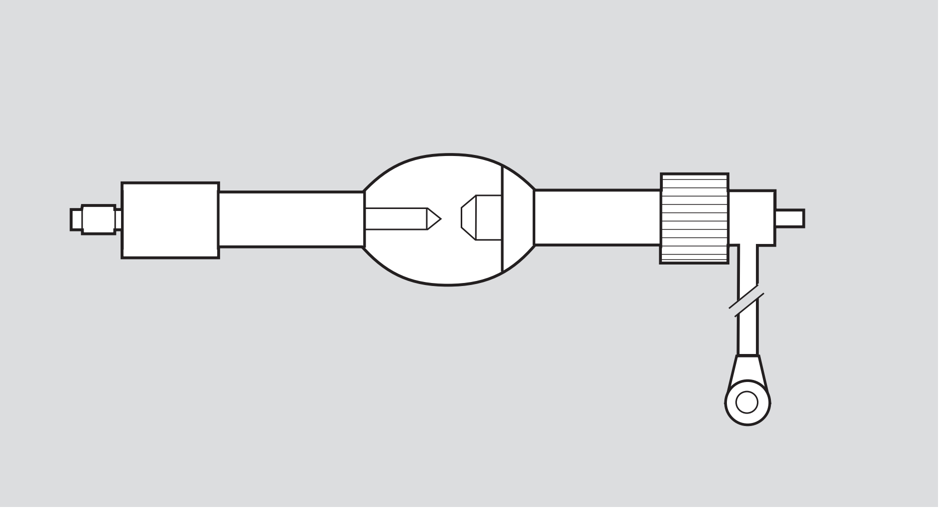


Fig. 3: Schematic structure of HBO® 1500 W/PIL
The lamp bulb made of quartz glass in the function of a discharge tube encloses the electrode system and contains the constituents of the fill. The lamp bulb passes into the lamp shafts. The discharge arc occurs between the two tungsten electrodes which are located in the lamp axis and protrude into the bulb - they are located opposite each other at a certain distance, the so-called electrode gap.

3.3 Geometric tolerances

On account of the precise position of the arc relative to the reference base, HBO® lamps are used as point-source lamps in high-quality optical systems without any major adjustment required.

3.4 Base

The nickel-coated brass base of the HBO® lamps is used to establish the contact to the power source and to attach the lamp if no cable is attached. By means of a non-gassing, temperature-resistant adhesive cement the lamp shaft is secured in the base in such a way that the position of the arc is adjusted with extreme precision. The maximum permissible temperature measured at the base surface is 200° Celsius (392° F) for all i line lamps and lamps with a power consumption of more than 1,000 W. A maximum temperature of 230° Celsius (446° F) is applicable for all other HBO® lamps.

In production, the lamp is aligned in the reference base (the base, to which the lamp is fixed in the system) in such a way that a precisely defined position of the discharge is produced when operated in the exposure unit. This position check-up belongs to the most important quality criterion of HBO® lamps.

3.5 Seal

The seal – each HBO® lamp has two – is the hermetic gas-tight connection for the electric current between the outside and the inside of the lamp.

Tungsten has a relatively high coefficient of expansion, which is a standard feature in metals. Quartz glass, however, expands very little when heated. For this reason, the electrodes cannot be sealed in the quartz glass directly because the significantly stronger expanding tungsten would shatter the quartz glass.

For this reason, the production of a tight connection between electrode and base is established by using molybdenum foils (cf. Fig. 4). The molybdenum foil is only some 1/100 mm in thickness and etched at the edges. Than, forces induced by temperature changes remain so small, that they do not damage the vacuum tight metal-glas seal.

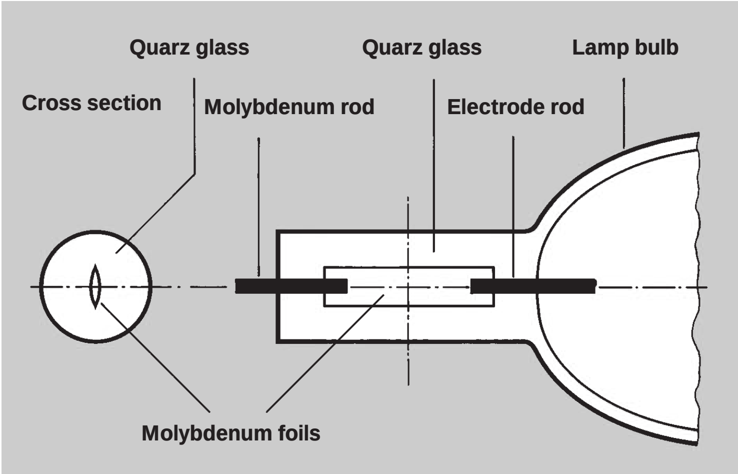


Fig. 4: Schematic diagram of a film seal

3.6 Electrodes

(a) General aspects

The electrodes of the HBO® lamps are made from tungsten powder in OSRAM's own production plants. As the electrodes are significantly responsible for the properties of the lamp, special attention is given to the optimization and further development at OSRAM by carrying our own research and by ensuring constant quality in the production.

(b) Direct-current operation

The smaller electrode, the **cathode**, is connected to the negative pole of the power supply, and is the current and electron supplier. In order to carry out this task as well as possible, the temperature of the cathode tip has to be sufficiently high. The shape of the cathode is defined in such a way that the temperature at the cathode tip is in the operative range at the rated power of the lamp. In the operative range the temperature is so high (typically 2,500° to 3,000° Celsius (4,532° to 5,432° F)) that, on the one hand, sufficient electrons are emitted, and on the other hand, however, the service life of the cathodes (caused by burn back) is not reduced.

The **anode** acquires the electrons emitted by the cathode. The entry energy of the electrons is converted into heat, which has to be dissipated by the anode by radiation and thermal conduction. In order to keep the temperature of the anode as low as possible in the interest of a long service life, it has to be big and massive. In order to improve the radiation properties for infrared radiation, the surface is treated often, which frequently seems pasted in gray or silver for the human eye. Apart from the shape, the material composition and the material structure are decisive for how long the anode can withstand the electron bombing. Whilst pure tungsten materials of highest density were used formerly, specific internal structure distributions can be produced by material composition and a strictly defined thermal and mechanical processing of the metal nowadays, which produce considerably better anode properties. In all cases the decisive criterion is how long the face of the anode can retain its shape. The wearing process, however, depends considerably on the operating conditions (pulse operation, overload)
of the lamp.

(c) Carburization
The task of the cathode is to emit electrons. For the emission of electrons by the cathode tip, a certain amount of energy (work function) is required to trigger the process, which is 4.53 eV for pure tungsten.

A significant improvement of the emission behavior of the cathode can be achieved, if the tungsten surface is coated with a monatomic thorium layer. In this case the work function is about 2.86 eV only.

As the work function is provided primarily by the thermal energy, i.e. the temperature of the cathode, such cathodes can be operated at lower temperatures.

In order to produce such a condition of the cathode, the cathode has to be doped with a small amount of thorium oxide. In addition, a controlled reduction of the oxide during the operation of the lamp has to be ensured.

For this purpose the cathodes are carburized. Carburization is a process, in which a thin layer of tungsten carbide is applied to a certain well specified area of the cathode.

The carbon continuously reduces the thorium oxide to metal thorium which is required to maintain the Th monolayer on the cathode tip.

The control of the temperature-related reaction and diffusion processes has been the subject of extensive examinations as it is only a detailed understanding of the processes which permits the useful utilization of this effect for the lamp operation.

The advantages of carburazation are numerous. By reducing the work function of the electrons, a lower temperature of the cathode results, which in turn reduces the electron back burn.
– stabilizes the cathode shape throughout the service life.
– increases the stability of the arc.
– improves the maintenance of the lamp.
– increases the light flux.

3.7 Lamp bulb

The discharge tube of the HBO® lamps always consists of quartz glass. It is quartz glass only that can withstand the high mechanical loads caused by the operating pressure of some 10 bar (145 psi) as well as the thermal load in case of surface temperatures of up to 800°C (1472°F).

Depending on the type and the predominant application, a more oval or more spherical cross-sectional shape is chosen. The thickness of the quartz glass wall is only a few millimeters, and has been specified precisely for each type of lamp. In order to achieve a high optical projection quality, selected types of quartz glass free from reams and bubbles are used only. A special further-developed quartz glass is used for i line optimized lamps, which on account of the IOFR technology ensure that the ozone-generating part of the Hg emission spectrum does not emerge from the lamp (cf. chapter 9.4). For the user this means that ozone-related problems, such as the reaction with HMDS vapors is a thing of the past. A strict quality control of the raw materials as well as of the produced bulb ensures that perfect material only is used for the production of lamps. An inert gas is filled into the bulb (for safe ignition and start) as well as a precisely metered amount of mercury. This amount is calculated in such a way that, depending on the power output and the bulb shape, the lamps have a pressure of up to 75 bar (1,087 psi) in operating condition. As a rule the lamps are depressurized and harmless to handle in cold condition. The exceptions are, however, the HBO® 4300 W/N, for example. These lamps have been marked on the outside in addition. In each case, the quartz glass body has been designed in such a way with respect to material and shape that the highest operational safety possible is safeguarded.

During the production, the lamp is subjected to numerous heat treatments. Especially the sealing-in of the electrodes is carried out at very high temperatures, which are required to soften the quartz. After these heat treatments, internal tensions remain in the glass which are caused by the inhomogeneous heating during the manufacturing processes. For a maximum safety against bursting, these residual tensions have to be removed, which is done by a process called tempering: The finished lamp (prior to base fitting) is heated again uniformly up to a point, at which the viscosity of the quartz is lowered so much that the internal tensions are decreased. A uniform cooling process subsequently prevents the formation of new tensions.

3.8 Heat reflection

A heat-reflecting layer on the quartz glass bulb in the vicinity of the anode or cathode supports the starting process and contributes to achieving a stable thermal balance. Depending on the type of lamp, a gold or palladium layer is used for this purpose. The type and size of the heat reflector is determined by the operation and cooling in the respective exposure unit. The optimization of the size of the heat reflector is an important step during the development of a lamp.

4. LIGHTING AND OPTICAL PROPERTIES

4.1 Lighting parameters

We have dispensed with a detailed description of all radiometric and photometric quantities of mercury short arc lamps at this point as they are dealt with in detail in the publication: "HBO® Mercury Short Arc Lamps: Technology and Application". Below please find the presentation of the quantities relevant for the applications mentioned only.

In order to achieve the properties of the light on the exposing level (on the wafer) required for the production of microchips nowadays, the lamp properties have to be taken into consideration in the design of the lens systems in the exposure units. Apart from the intensity, the arc stability and the local distribution of the light (luminance), the spectral purity of the radiation used (line width) and the beam characteristic of the lamp are decisive in the calculation of the lens systems. For this reason, these properties have to be part of the quality assurance in order to safeguard continuous properties from lamp to lamp.

4.2 Luminous flux

The luminous flux, that is to say all the light emitted by a lamp in all directions (total luminous flux Φ_L), depends directly on the input power. For OSRAM HBO® lamps, the luminous flux ranges between some 1,000 and over 100,000 lm.

4.3 Luminous intensity

The luminous intensity (dimensional unit: Candela [cd]) is defined as being the luminous flux [lm] relative to the solid angle area radiated through (dimensional unit: [steradiant [sr]): 1 cd = 1 lm/sr (cf. Fig. 5 on the definition of the luminous intensity).

If the solid angle area is reduced more and more, the luminous intensity of the light source in a certain beam direction is obtained as a limiting value.

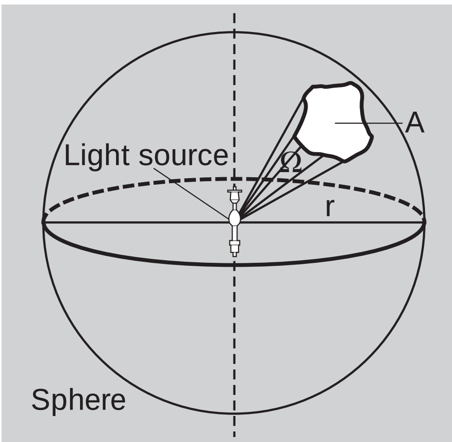


Fig. 5: On the definition of luminous intensity

The polar diagram ("the butterfly") of light distribution around a lamp in a given level is referred to as indicatrix, in which the length of the arrow from the lamp to the curve is an indication for the luminous intensity in this direction. Figs. 6 and 7 show the axial or radial light distribution, respectively of an HBO® 2001 W/CIL lamp. Relative to the lamp axis, the light distribution - with exception of the pump stem area - is almost rotationally symmetrical. As can be seen in Fig. 6, the intensity of the light is concentrated on a certain angle range. For this reason this distribution is an important part for the ideal performance of an exposure unit.

The mercury short arc lamps HBO® stand out for their high luminous intensity.

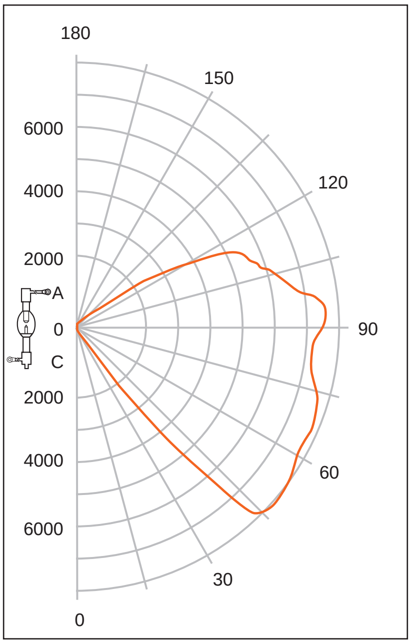


Fig. 6: Axial luminous intensity distribution of HBO® 2001 W/CIL operated at rated power

4.4 Luminance

One of the most important characteristics of HBO® lamps is their high luminance. The luminance of a light source or of a mat reflecting surface is a measure for how light appears to the human eye. The "more concentrated in area", the higher the luminance, and thus the brighter the source is. Luminance is defined as the luminous intensity (dimensional unit: Candela [cd]) in direction of the viewer relative to the shining surface in square meters, which he sees.

The intensity of the lamp radiation in the ultraviolet and infrared spectral band invisible to the human eye is described by the radiance. Radiance is calculated from the radiation power in Watt emitted by the spectral area observed relative to the shining surface in square meters. This area distribution of the light in an arc is also an important aspect for the calculation of the lens system in an exposure unit. As can be seen Fig. 7, the highest luminance is concentrated in the vicinity of the cathode tip (cathode spot). Many exposure units prefer to use this cathode spot.

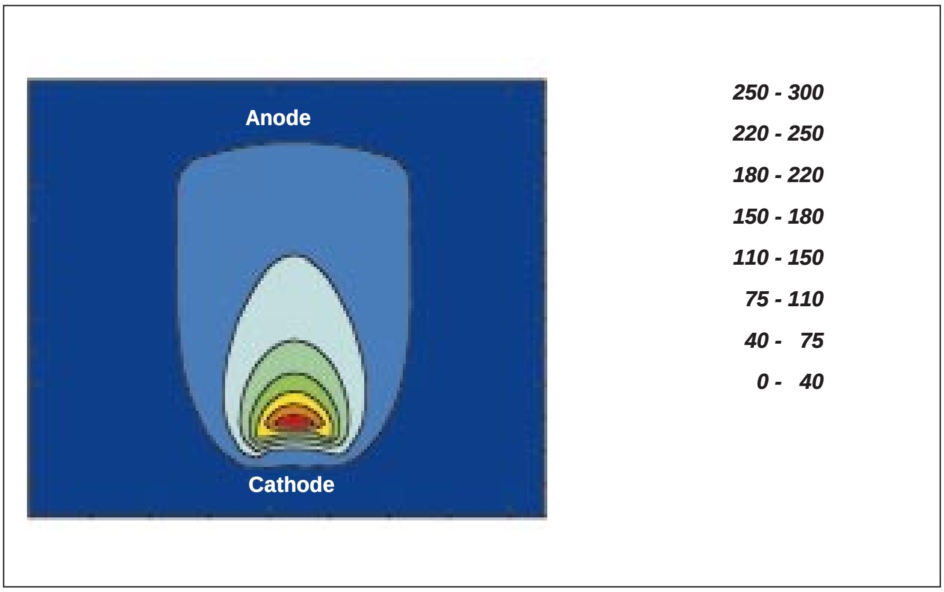


Fig. 7: Typical luminous intensity distribution in the arc of an HBO® 2001 W/CIL operated at rated power

Fig. 7 represents the typical luminous intensity distribution in the discharge arc of HBO® 2001 W/CIL. In direct-current operated lamps, the maximum luminance is found in front of the cathode tip (referred to as the “cathode hot spot”) which can be clearly seen in Fig. 8 in the longitudinal section of the luminous intensity distribution through the arc axis.

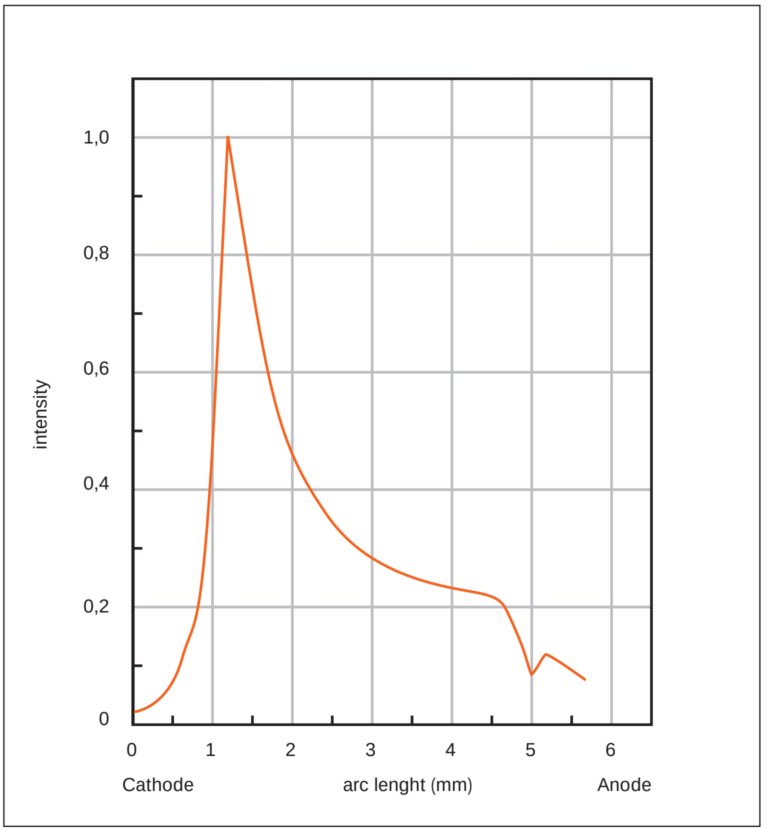


Fig. 8: Luminous intensity distribution along the arc axis of HBO® 2001 W/CIL operated at rated power

4.5 Spectral distribution of intensity

The mercury vapor column of the arc between the electrodes reaches temperatures of up to 10,000° Celsius (18,032° F) in operation. By collision the mercury atoms are converted to high-energy excitation conditions, the energy of which is released (in relatively complicated process steps) in the form of radiant energy when returning to lower energy levels. In the process the radiation consists of intensive spectral lines of the mercury and a continuous spectrum (cf. Fig. 9a, 9b and 9c), the share of which increases with increasing power concentration in the arc.

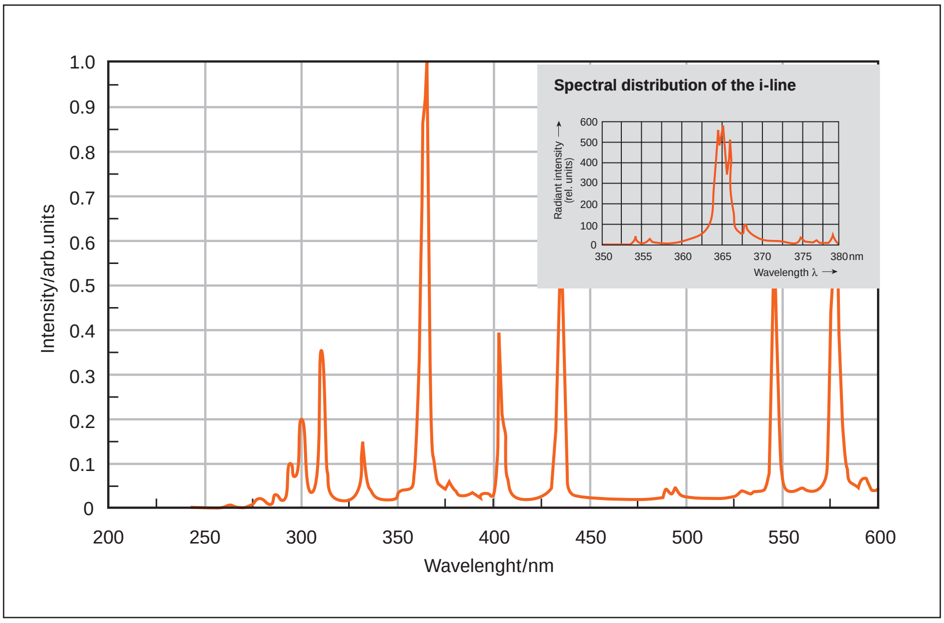


Fig. 9a: Spectral distribution i-line lamp

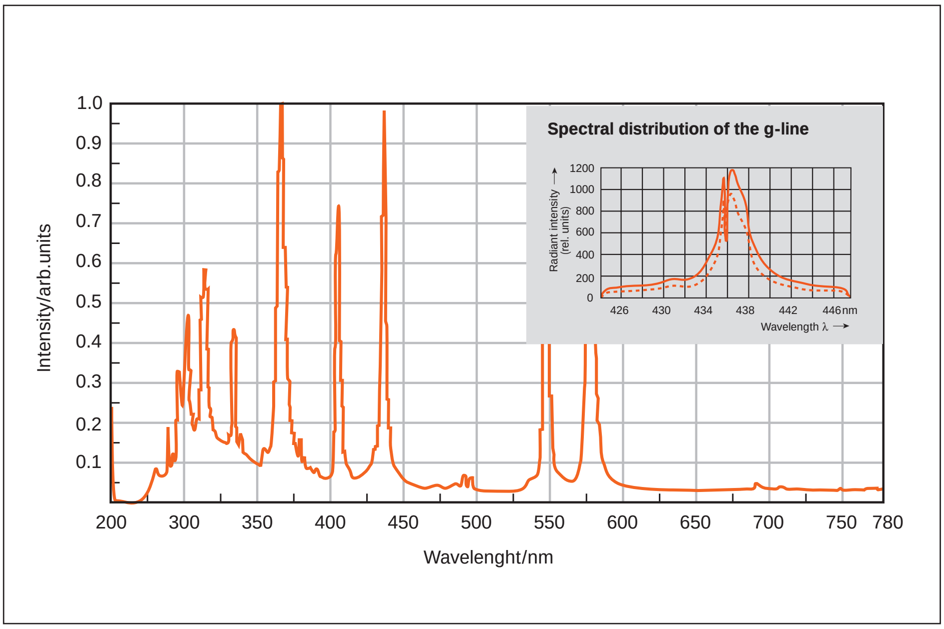


Fig. 9b: Spectral distribution g-line lamp

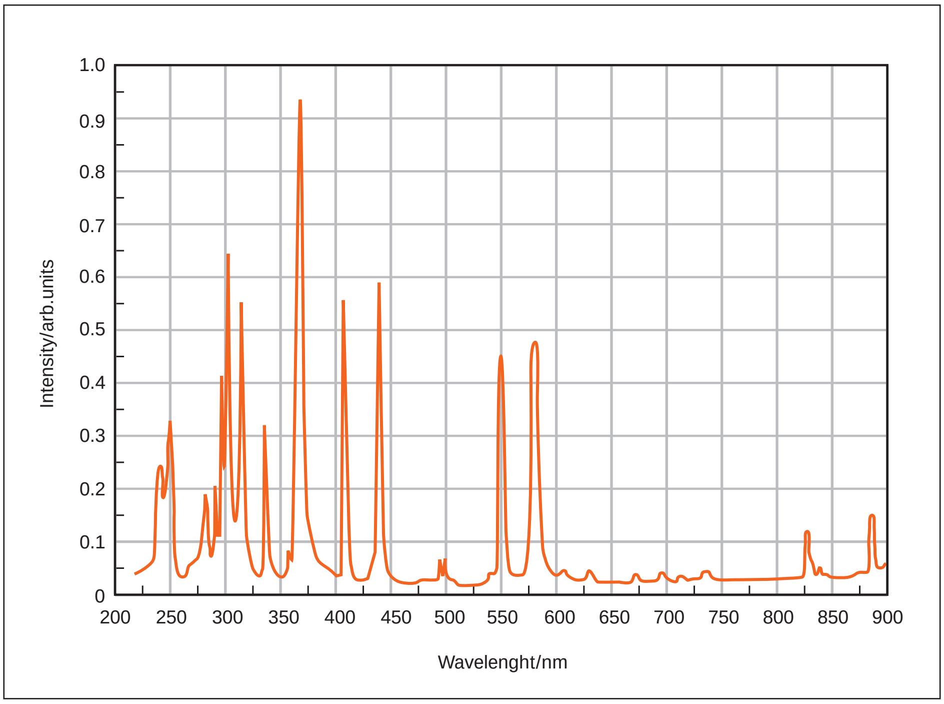


Fig. 9c: Spectral distribution DUV-lamp

Due to the high gas pressure the spectral lines of the mercury atoms are considerably widened. Another characteristic is that the light which is emitted by the internal part of the arc is absorbed in the external colder gas layers of the bulb. This fact causes a partial decrease of the spectral power in the line center (self-absorption) as shown in Fig. 9a by means of the 365 nm line.

Due to the interaction of ultraviolet radiation with wavelengths of below about 250 nm, the atmospheric oxygen of the surrounding air is partially converted into ozone (O_3), especially during the run-up phase, when the plasma is almost transparent for UV-radiation. The maximum ozone production is in the spectral range of 175 to 200 nm. Ozone is an odorless and invisible gas. For more detailed information, please refer to the Addendum (TI 4839). In conjunction with the IFOR quartz (cf. chapter 3.7) used, the HBO® i-line lamps thus do not produce any ozone during operation.

5. OPERATING PARAMETERS

5.1 Operating position

HBO® lamps may be operated only within the operating position rendered in the product specification. Naturally, this is ensured with all exposure units in the market. However, this has to be taken into consideration in any product modifications or new developments.

5.2 Lamp start

HBO® lamps used for the applications mentioned have to be started by means of ignition devices. During the ignition process, the insulating gas column is ionized by means of high voltage, which is generated by the starting device (DC or HF ignition), and the arc formation is initiated. At the point of ignition, at least the rated current of the lamp has to be available without delay for safe arc formation. Due to the discharge of the smoothing capacities at the outlet of the control gear, a starting current surge and an excessive energy action at the electrodes occurs. The starting current is used to operate the lamp until the lamp voltage is up, and the lamp current is generated in dependence of the permissible lamp output.

5.3 Starting behavior

The time spent between the ignition of the lamp and the reaching of steady operating conditions is referred to as start or run-up, in which the electrical and lighting rating values are reached. Depending on the type of lamp, and the amount of starting current, the run-up time may vary and amounts to about five to twenty minutes. Subsequently, the lamp is in a thermal balance.

After the ignition, a diffusely shining discharge in the ground gas occurs which decreases along with the increasing mercury vapor pressure and forms a clean-cut arc of high luminance. HBO® lamps have reached the operating condition when the entire amount of mercury has evaporated; subsequently the lamp voltage is constant.

5.4 Cooling

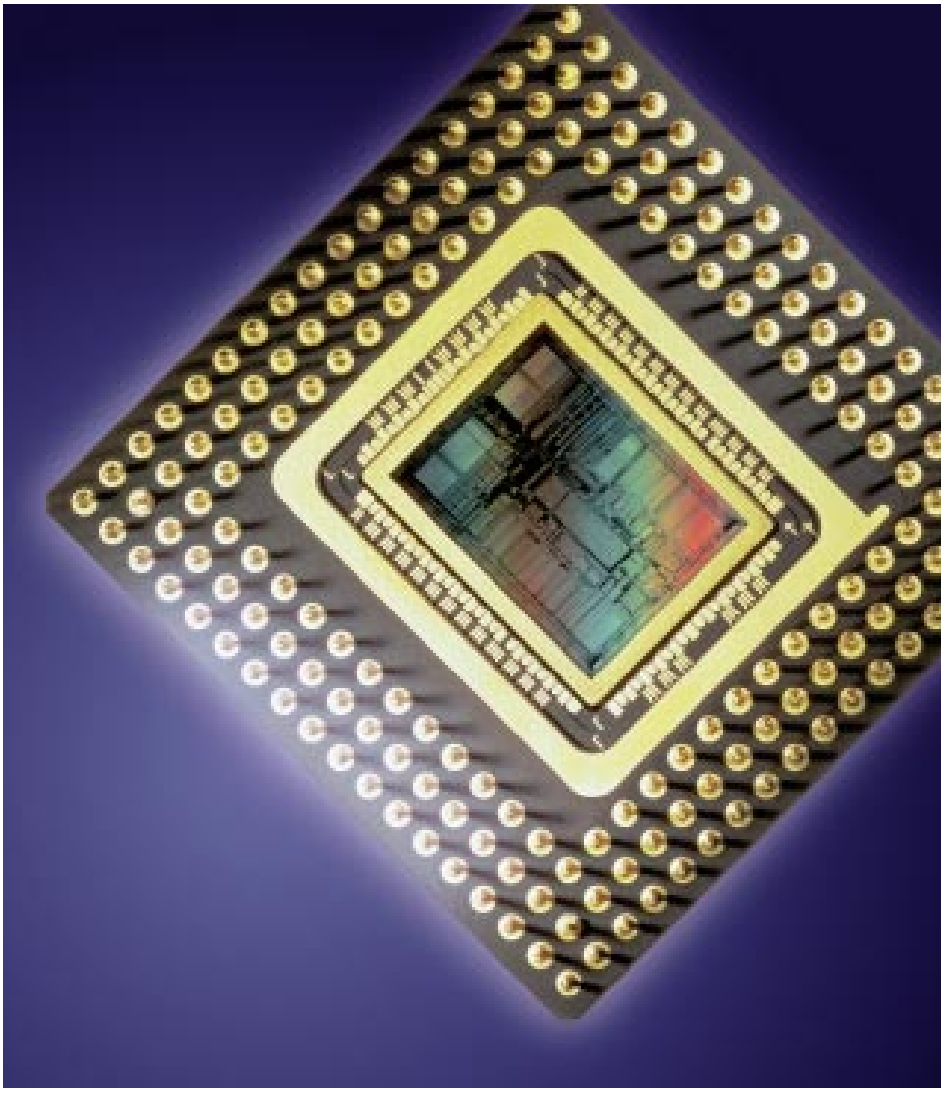
Due to the danger of glare, the radiation in the ultraviolet band, and the high mercury vapor pressure occurring during the operation, HBO® lamps must always be fitted in a housing, the so-called lamp house, provided with protected ventilation openings. The lamp house should be sufficiently large, and should be provided with ventilation shutters in such a way that the temperature of the base does not exceed the maximum value (cf. chapter 3.4) at the rated power of the lamp. In case of lamps with a higher wattage, a cooling system for the base is required as a rule.

If the base temperature of 200°C/230°C (for lamp below 1000 W) can be achieved by means of a forced cooling system, the cooling flow has to be directed mainly on to the base of the lamp (and not the bulb!) as otherwise a partial condensation of the mercury will occur and thus a reduction of the intensity. As a rule the lamp operating voltage will change as well, which thus is an indicator for an impermissible cooling. On some lamps, additional cooling fins are added in the works of the manufacturer to support the cooling of the base.

The mechanical lamp fitting has to be made in such a way that no forces are transmitted to the lamp in case of an expansion due to lamp heating. For this reason HBO® lamp may be fitted tightly to one base only. The connection to the other socket has to be flexible and strain relieved.

5.5 Duty cycle

The average service life of HBO® lamps is decisively determined by the construction of the lamp and the switching rate. On account of the typical application (continuous operation), the lamps have been designed for a small number of reignitions only. The lamp performance is reduced with increasing switching cycles.

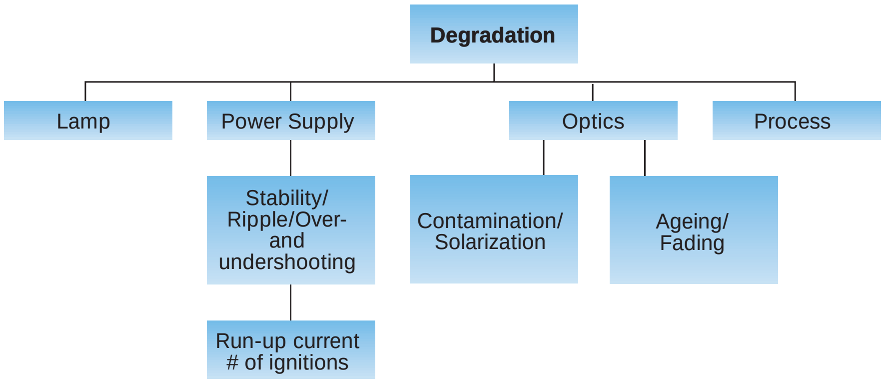


6. LAMP BEHAVIOR

6.1 Service life and performance

The service life of HBO® lamps used in the applications mentioned is defined as being the operating life, according to which the initial intensity of the lamp in the exposure unit used and in the corresponding wavelength range may not degrade by more than thirty percent.

The loss of intensity in the lighting level, which the user will notice during the service life of the lamp, is referred to as overall degradation, practically speaking. It is the sum of the lamp degradation and the system degradation of the exposure unit. The overall degradation depends on a number of influences:



a. First of all, a differentiation has to be made as to whether the lamp is operated with the nominal power mentioned or with a deviating lower electrical input power. Thus, the following may apply within certain limits: The lower the power consumption of the lamp, the lower is the lamp degradation. For this reason, comparisons of degradation curves of various lamps and machines are valid only in case of appliances with identical power consumption.

b. A reliable cooling of the lamp in compliance with the instructions of the lamp manufacturer will lead to an ideal behavior of the lamp in operation. If too little cooling is provided, an overheating of the lamp may be possible which will cause a premature failure of the lamp. If too much cooling is provided, a partial condensation of the mercury in the lamp may occur and thus will lead to a loss in intensity on the surface of the object to be exposed. The careful setting of the cooling system is a significant prerequisite for a maximum service life and performance of the lamp, primarily in case of lamps with a high mercury content (such as HBO® 2002 W/MA or lamps used for the production of LCDs).

c. Not only the lamp and the cooling conditions alone determine the overall degradation. The exposure unit contributes significantly as well, primarily by the fact that the transmission properties of optical components (lenses, filters, lens systems, et cetera) under ultraviolet irradiation deteriorate in the course of the time. Depending on the age of the machine, i-line steppers, for example, contribute up to 3 percent per month to the overall degradation.

Potential inaccuracies of the adjustment after the installation add to the above so that, depending on the type of exposure unit, the user will notice a decrease in intensity throughout the service life of five percent up to thirty percent.

For most exposure units, OSRAM offers the same type of lamp with different service life specification, which reflects the continuous further development of the products, similar to the developments in semi-conductor technology. For example, “standard lamps” with a service life of 750 h were available only for i-line exposure units at the beginning, until OSRAM was able to safeguard 850 h at first and then 1,500 h for lamps by further development. And, at OSRAM safeguarding means that the customer receives a one hundred percent credit note independent of the hours operated, if the lamp does not make the specified service life.

Just recently, OSRAM demonstrated impressively once again its technical leadership with the introduction of the “three-month lamp (2,250 h)” for selected i-line exposure units. OSRAM’s position as a market leader enables the customer to receive the best price-to-performance ratio, and thus to keep his costs of ownership as low as possible.

Statements on the service life of individual lamps and examples for the typical overall degradation of the most important types of lamp can be found in the catalogue section (page 52 ff).

6.2 Arc stability

On account of the narrow spacing between the electrode tips as well as their favorable geometry and material composition, the arcs of HBO® lamps are extremely stable, with respect to spatial fluctuation as well as temporal variations in intensity.

In order to permit a characterization of the arc stability, OSRAM has developed highly sensitive measuring processes, which permit a measurement of the spatial fluctuations of the arc directly in front of the cathode tip, for example a determination of the temporal variations in radiation capacity.

6.3 Uniformity

Uniformity refers to the uniformity of illumination of the exposure field in the wafer plane. A good uniformity is necessary for stable lithography processes, which is influenced by numerous factors:

Adjustment of the lamp
When the lamp is installed, it is adjusted first of all. The arc of the lamp has to be within the range of the focus of the optical mirror system. As a rule the precise location is determined by the search for maximum intensity at best uniformity. Maximum intensity sometimes does not coincide with best uniformity. Adjustment depends on customer’s choice/priority.

Change of cathode shape
In the course of the lamp’s service life, a slow change of uniformity will be noticed, which can be traced back to the changes in the arc position on the cathode. The main reasons here are electrode burn back and the change of shape. This process increases or lowers the uniformity to a minor extent.

Arc flickering
In very rare cases, a fast increase and decrease of the uniformity can be observed within minutes or hours. In such cases, the arc flickering may be the reason. The arc is no longer stable with respect to time and the position of the arc moves in the area of the cathode tip. In this case, first of all you should check whether the lamp has been operated in excess of its nominal service life.

Stepper:
Each stepper's lens system has minor individual deviations from an ideal system. The minimum uniformity is basically safeguarded by the adjustment of the individual lenses in the system (stepper and scanner only), which means that a bad system uniformity cannot be improved by the lamp. For this reason, the best uniformity to be achieved is given by the stepper. Other effects are superimposed or are added to this basic uniformity.

Soiling and degradation of stepper's lens systems including filter
The degradation of the lens systems in steppers, especially of filters (i-line filter) worsen the uniformity in the course of the time.
Frequently, the replacement of degraded filters will improve the uniformity considerably. The worsening of the uniformity in general progresses with a very different speed and may also depend on the purity of the air. On account of this degradation process of the stepper, the intensity and uniformity values in average worsen from one lamp to the next.

Misalignment of the lamp
In rare cases, an erratically changed uniformity can be traced back to a misalignment of the lamp in the optical system. Given a correct installation, this phenomenon can be excluded.

Exposure mode
Numerous steppers have various exposure modes. The uniformity to be achieved depends on the exposure mode used. Only the values of the same exposure mode are comparable in this case.

7. HANDLING

7.1 Mechanical installation

HBO® lamps are solid, but they are made of glass, and thus require a corresponding treatment, which means they have to be protected against impact, shock, and brute forces. For this reason, their handling should be subject to certain care criteria.

In no case may the lamp be subjected to force during the installation. As a matter of principle, lamps should be touched at the base only.

All metal parts of the lamp, which have contact with the corresponding lamp socket elements, have to be free from dirt and corrosion - if necessary, the sockets have to be replaced in order to ensure a safe operation of the lamp.

Double-sided base lamps

In order to compensate the expansion of the housing and the torsion, the lamp may be fitted tightly at one end only. The other end requires a flexible, soft support (cable) in order to permit expansion in direction of the longitudinal axis of the lamp without any obstructions.

7.2 Electrical connection

The electrical connection of the lamps requires the same care as the mechanical handling. Connected to the wrong polarity, a lamp will be destroyed immediately. However most of the exposure units in the market do not allow a wrong connection.

A discoloration or even corrosion of the contacts indicate a previous thermal overload. Such damaged components have to be replaced by all means as the service life of the lamp is negatively affected due to the increased contact resistance and the bad heat removal. Fig. 10 shows the typical tarnishing colors of a lamp base relative to the base temperature.

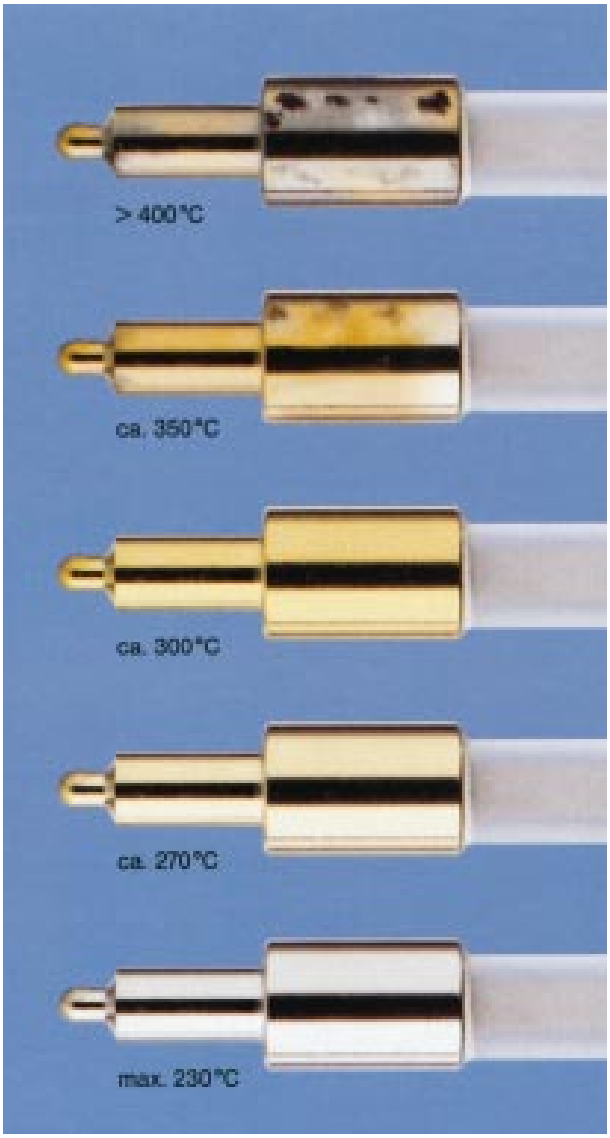


Fig. 10: Typical annealing colors on a lamp base after average service life as a function of the base temperature.

Caution: Sockets are wearing parts! Clean and large contact surfaces only ensure the best of operating conditions.

7.3 Cleaning the lamp

HBO® lamps may be touched at the bases only. If it happens that the bulb or the shafts of the lamp have been touched with naked fingers, the finger prints have to be removed immediately by means of a lintfree cloth (cloth for spectacles) sprinkled with isopropanol or ethanol, purity 90 % or higher.

If the finger prints are not removed, they will burn into the quartz glass surface during the operation and constitute a source for a constantly spreading recrystallisation of the glass. The quartz glass will lose its stability resulting in a premature failure of the lamp by rupture of the bulb/shaft.

7.4 Packaging

In order to prevent damage of HBO® lamps during transport, OSRAM has developed special packaging systems, which take the construction of the lamps into consideration. Packaging instructions within the framework of our quality assurance system and the continuous improvement of technology and material ensure a high standard of safety.

Dustfree packaging of the HBO® lamps is primarily used for effective protection against damage during transport. In this respect damage is to be understood as impermissible mechanical impact which makes the lamp useless for the customer.

In order to ensure a safe protection of the lamp, the OSRAM clean-room packaging including lamp are subjected to intensive drop and vibration tests. In this way OSRAM ensures that the product and the packaging meet the standard requirements for mail dispatch, for example.

7.5 Transport

OSRAM HBO® lamps stand out for their high standard of quality. The packaging of the lamps has been designed in such a way that no damage of the lamp can occur during transport under the influence of mechanical vibration and impact as a rule. In order to exclude transport and storage damage as far as possible, we recommend the observation of the following tips as a matter of principle:

- Transport the lamps in the original packaging (including the outer packaging) as a matter of principle.
- Remove the transport packaging only shortly before the actual utilization of the lamp.
- Avoid vibrations and pressure on the packaging or lamp, especially, if the outer packaging has been removed already.

All other types of transport, especially the transport of the lamp in an unsuitable type of packaging, do not offer a sufficient safety against damage. Returns to OSRAM (in case of samples, complaints or old lamps, for example) have to be dispatched in the original packaging always for the reasons mentioned above as otherwise all guarantee claims will terminate.

OSRAM demonstrates its leadership in the market also with respect to transport monitoring and safety. High wattage lamps with heavy anodes have been subject to a special transport monitoring system installed recently: The outside and inside packaging has been fitted with Shockwatch® indicators, which ensure that specified maximum loads on the lamps are not exceeded. If, however, these excessive loads have occurred nonetheless, this is clearly recognizable from the outside already.

Procedure in the event of transport damage
HBO® lamps contain a certain amount of mercury. In the event that the lamps have been damaged during the transport (e.g. bulb broken, quartz glass cracked, electrodes broken off), please proceed as follows:

- Do not open the damaged packaging.
- If a lamp damage is discovered after the packaging has been opened, use commercially available absorbing agents to bind and remove any leaked mercury. Please observe the safety instructions in compliance with FO 4574.
- Please inform your nearest OSRAM agent, the responsible forwarding agent, and the competent insurance company.

For more information on mercury and HBO® lamps, please refer to the technical information sheet: “Safety Aspects for HBO® Mercury Short Arc Lamps” (order No. FO 4574).

OSRAM warranty terms

The transport of HBO® lamps shall be permissible in the original packaging only. If another packaging material than the one specified by OSRAM is used for transport, any claims for warranty by OSRAM shall become extinct. Such a potential claim shall also become extinct in cases of impermissible handling.

7.6 Storage

Basically HBO® lamps can be stored for an unlimited period of time! The prerequisite is, however, that they are stored in non-aggressive environmental conditions, i.e. no storage temperatures exceeding 50° Celsius (122° F), no condensation, and a non-corrosive atmosphere. These conditions given, the material properties of quartz glass and the metals used change very slowly so that an aging of the lamp is not noticeable. If storage effects occur nonetheless, they will be noticeable primarily on the "outer" lamp parts, such as the bases. However, as R&D continues, very old lamps do not represent the latest state of the art.

7.7 Disposal of spent HBO® lamps

HBO® lamps do not belong into the domestic waste. Due to their constituents the lamps have to be considered hazardous waste. As HBO® lamps contain environmentally active harmful substances (such as mercury), they have to be disposed of as hazardous waste in Germany in compliance with the waste classification 35326 "Mercury, Mercury-Containing Residue, Mercury Vapor Lamps, Fluorescent Lamps, High Voltage Tubular Lamps". For this reason, HBO® lamps have to be disposed of at the special disposal points. In other countries, the respective national regulations have to be adhered to.

Mercury fill of OSRAM HBO® mercury short arc lamps

Power level	Mercury fill [mg]
200 W versions	maximum 120
350 W versions	maximum 300
500 W versions	maximum 500
1,000 W versions	maximum 600
1,500 W versions	maximum 800
2,000/2,500 W versions	maximum 5000
3,500 W and bigger	maximum 12,000

If there are no possibilities of local disposing of HBO® lamps correctly, which have reached the end of the service life, i.e. there is no competent regional disposal company, the spent lamps can be returned to the manufacturer for correct disposal in the original transport packaging (i.e. new replacement lamp) only. National regulations have to be observed. For more information, please refer to your OSRAM HBO® dealer.

8. PROBLEMS – FAULT ANALYSIS – TIPS AND REMEDIES

This chapter will render a description of the most significant problems in the operation of HBO® lamps. Typical and frequently occurring faults will be described in detail; tips and suggestions will be given to help the customer ensure faultless and satisfactory operating conditions. If you have any additional queries, please ask our personnel in the Technical Customer Service.

8.1 Ignition failure

First of all, we have to differentiate between ignition failure and start failure: the first is the case, if no ignition spark is noticeable between the electrodes, and the latter is the case, if a spark is noticeable but no discharge develops.

In direct-current operation, the following parameters have to be adhered to for the ignition of HBO® lamps:

If the lamp ignites badly or not at all, the following tests should be carried out:
– Does the high voltage get lost on the way from the ignition device to the lamp by corona discharge?
– Has the auxiliary ignition wire been fitted correct and is it undamaged (applies only for lamps, for which an auxiliary ignition wire is supplied) ?
– Is the current lead-in interrupted?
– Has the lamp been damaged (e.g. cracks in the glass, lose electrodes)?
– Is there an ideal electric contact between the lamp base and socket (no discoloration, no oxidation)?

8.2 Degradation

HBO® lamps will age in the course of their service life, which will also include the blackening of the bulb caused by material deposits from the electrode tips and the deposition of the vaporized tungsten on the inside wall of the bulb.

In case of prematurely blackened lamps, the following tests should be carried out:

– Are there altered current/voltage values in case of inadequate cooling?
– Is the starting behavior of the lamp normal (about five to ten minutes)? Severe blackening will be caused by a hold in the starting phase.
– Was the lamps switched on more frequently? A higher switching rate will reduce the service life and increases the blackening process!

8.3 Tarnished base and cable

HBO® lamps are power consumers with a high power consumption.
A large share of the electric power has to be dissipated as heat through convection/cooling and radiation.

In this respect, the metal bases (nickel-coated brass as a rule) are of special significance. While the bulb has to reach a high temperature and contributes not to heat dissipation the bases have to be cooled to avoid oxydation, as oxydation of the base and its inner parts might destroy electrical contact and sealing integrity. Base cooling is usually achieved by forced cooling and/or thermal conduction to the socket. Good mechanical contact to a socket free of surface corrosion is mandatory. Of course, the electrical connection must be sufficient as bad contact cause resistance which leads to extra heat generation.

The base temperature is a very good indicator for a correct and balanced temperature system. If the permissible upper limit of 200/230° Celsius is exceeded, the base will discolor due to oxidation. In case of a minor excess temperature the discoloration is slightly yellow, increasingly turning into straw yellow, yellowish orange, brown, and finally blue. A table with the tarnishing colors of bases can be found on page 26.

In order to prevent such thermal overloads, the following measures have to be observed:

– Do not use lamps with tarnished bases – check the cooling of the lamp (e.g. fan failed, convection openings blocked, nozzle misaligned?).
– In order to prevent contact resistance, the connection between base and socket should be positive locking.
– The socket is a wearing part which should be maintained in regular intervals, and which has to be replaced. If the socket has signs of discoloration or if it has a severely oxidized or corroded surface, a new lamp must not be fitted by any means. Even a perfectly new lamp would fail prematurely due to the damaged socket. Prior to the installation of a new lamp, the lamp housing and especially the lamp sockets should be checked in any case.

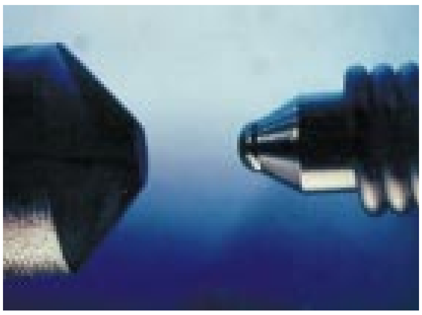
8.4 Too little light

HBO® lamps stand out for their highest luminance, large ultraviolet share, and good luminous efficacy. On account of the high power concentration in the arc, the luminous flux or radiation flux, respectively, can be utilized ideally for illumination applications. According to definition, the lamp may have a maximum of thirty percent decrease in intensity when reaching a specified service life. If there is “too little light”, please check as follows:

– Has the electrode spacing changed considerably compared to the new condition and/or are the electrode tips severely deformed?
– Is the lamp bulb considerably soiled on the outside?
– Is the optical system of the respective unit soiled?
– Has the optical adjustment been optimized in the unit?

8.5 Problems and solutions

There are a number of reasons why a lamp may not give satisfactory performance. The following may help you to locate and correct the more common problems that can cause failure, and ensure longer life for the replacement lamp.

		Symptom	Fault	Remedy
1		Connector base discolored	Connector base overheated above 230°C due to: – Faulty electrical connection – Improper lamp cooling – Improper operating current	Check electrical connections and cooling conditions: – Tighten or renew – Check operating current – Check cooling system (ventilator or convection)
2		Base cement blackened	Connector base overheated; improper lamp cooling	Check electrical connections and cooling conditions
3		Severe electrical damage on cathode, electrode tip melted spherical	Reversed polarity due to: – Electrical feed incorrectly supplied to lamp – Faulty wiring – Wrong lamp installed	– Check polarity, transpose connection if necessary – Check equipment and set-up – Check lamp type
4		Abnormal deformations of the electrode tips	– High current ripple – Lamp operated outside current control range (Overshooting)	– Check current setting – Ensure proper quality current (low current ripple) – Check rectifier/power supply

9. SAFETY ASPECTS

9.1 Properties of mercury

Mercury referred to by the chemical sign Hg, derived from the Greek and Latin hydrargyrum, is a silvery shining liquid metal at room temperature. In humid air it is covered with a gray oxide skin. Of all metals it has the highest vapor pressure which increases overproportionately with rising temperatures. For this reason, mercury is noticeably volatile at room temperature already. The colorless and odorless vapors produced are poisonous and heavier than air.

The inhalation of mercury or mercury compounds in vapor or dust state will lead to the damage of lungs, kidneys, and the nervous system. Apart from inhalation, mercury may be transmitted through the skin (penetration) or through the gastro-intestinal tract (resorption), which is harmful as well.

The threshold limit value for mercury is 0.1 mg/m^3 in compliance with the German Technical Regulations for Dangerous Substances TRGS 900. In Japan this value is 0.05 mg/m^3, in the USA 0.075 mg/m^3. The threshold limit value is a measure for the maximum concentration in case of repeated and long-time exposure until the general health of a worker is impaired.

Chemical and physical properties of mercury		
Density in liquid state (20° Celsius/68° F)	13.6 g/cm^3	
Melting point	-39° Celsius/-38.2° F	
Boiling point	357° Celsius/674° F	
Vapor pressure at a temperataure of	20° Celsius/68° F	160 Pa
	30° Celsius/86° F	370 Pa
	40° Celsius/104° F	823 Pa
Saturation contents of the air at a temperature of	20° Celsius/68° F	13.6 g/m^3
	30° Celsius/86° F	29.6 g/m^3
	40° Celsius/104° F	62.7 g/m^3

An analytical detection of mercury vapor is possible by means of gas detectors with test tubes (rough measurement) or monitors absorbing mercury vapor (room air monitoring), respectively.

For more information in Germany, please refer to the leaflets M024 “Mercury and Its Compounds”, and M053 “General Occupational Safety Measures When Handling Dangerous Substances” of the German Employers’ Liability Insurance Association for the Chemical Industry. In other countries please contact your local dealer.

9.2 Operating pressure

The discharge tube or bulb, respectively, of HBO® lamps have no or only little excess pressure (max. 3 bar/43.5 psi) in cold condition. During the run-up and the operation of HBO® lamps, the evaporating mercury produces an excess pressure in the lamp bulb, which will increase to the so-called “operating pressure” during the starting phase of the lamp. This operating pressure is achieved, if the mercury fill of the lamp has changed completely into the gaseous phase, and amounts to a multiple of the normal atmospheric pressure. For this reason, lamps of this type must be operated in closed-up lamp-housings only which in case of a lamp burst keep back the pieces of broken glass and splinters. After the HBO® lamps have been switched off, they have to cool down to room temperature first of all before handling is allowed.

9.3 Ultraviolet radiation and brightness

During the operation, HBO® lamps emit an intensive ultraviolet radiation which is detrimental to the health, especially for eyes and skin. The intensity of the radiation is so high that one single glance directly into the arc would be enough to irreparably damage the retina of the eye. For this reason, the lamps must only be operated in the devices, the so-called lamp houses, designed for this purpose, which prevent a direct look into the lamp and the arc, thus preventing a risk to health.

9.4 Ozone generation

During the electrical discharge in the HBO® lamps a spectrum is produced in the arc which ranges from about 150 nm in the ultraviolet region into the infra-red region.

If the quartz glass bulb is transparent in the ultraviolet region at least between 180 and 220 nm, thus is permeable to radiation, this short-wave radiation will convert a small share of the atmospheric oxygen (O2) surrounding the lamp into ozone (O3). Moreover, the oxygen molecules will link together with the nitrogen (N2) in the air, thus creating so-called nitrogen oxides (NOx).

Ozone itself is a colorless and odorless gas. The odor, which is frequently referred to as ozone smell, is primarily caused by the nitrogen oxides and the reaction products of the split atmospheric oxygen with the impurities in the air. This is the explanation for the unpleasant smell known to be around photocopying machines.

Like a nitrogen oxide, the ozone is also detrimental to health when inhaled in higher concentrations over a longer period of time. The general discussion about ozone as a detrimental gas has to be taken serious especially because of its inodorousness as a danger is detectable by measuring instruments but is not noticeable by the user.

The production of ozone and nitrogen oxide can be suppressed by the use of quartz glass, which absorbs the corresponding ultraviolet radiation region. The quartz glass (IOFR) used in HBO® i-line lamps is permeable only as from a wavelength of 250 nm so that ozone-free lamps can be considered.

Nonetheless, in individual cases (DUV lamps!) it may happen that an “ozone smell” (or better smell of nitrogen oxide) can be noticed shortly after the ignition, which may have two reasons: Either the NOx production is caused by the (short-time) radiation of the spark gap used for ignition or by the fact that in cold condition of the quartz glass bulb the absorption edge may be at about 210 nm, thus permitting minor shares of radiation in a very short-wave ultra-violet range to leave the bulb. After the lamp has run up into the operating region, almost no additional ozone is produced by the lamp as a rule due to the quartz glass absorption and the self-absorption of the plasma.

10. QUALITY CONTROL

The quality of our products is safeguarded by an extensive surveillance system adhering to the parameters specified with our customers and defined in our publications.

All manufacturing equipment used is tested for its processing ability.
With respect to the product test, a test plan determines which tests have to be carried out on the initial, semi-finished, and finished product.

The one hundred percent test at the end comprises the measurement of the electric parameters as well as the test of the geometry (such as Light Center Length (LCL) axiality, electrode spacing and concentricity), for example, apart from a visual inspection.
In addition, the parameters and processes are assessed critically by product and process audits, and are changed, if necessary. Potential faults can be identified by a recorded tracing system down to the causing material or process step, which can be used to remove any faults by suitable counter measures.
In order to obtain a statement on the service life behavior of the lamps, representative spot checks are carried out in our measuring laboratory by life tests accompanying the production.

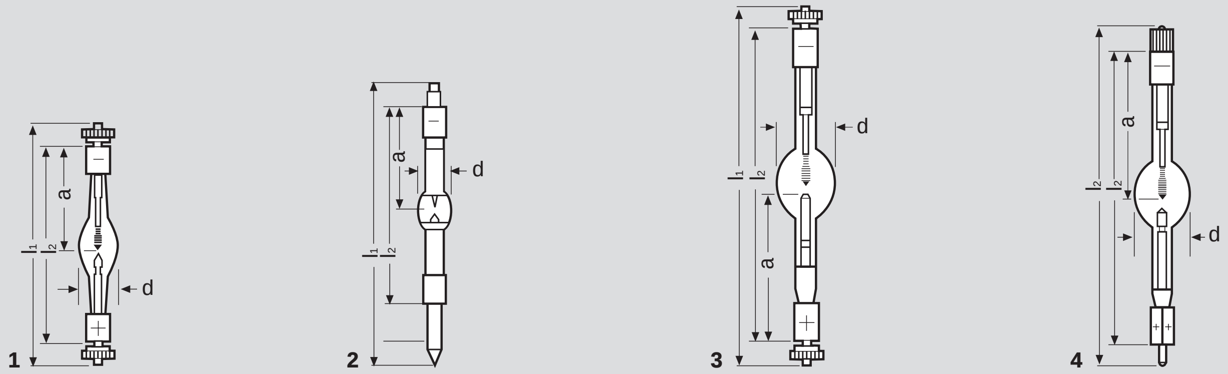
Any market problems are solved competently and by an accommodating arrangement by our technical service personnel in co-operation with the specialists from the production and development departments.

11. THE OSRAM PRODUCT RANGE

	Lamp type	Service life [h]	Equipment	page
Lamps for ASML Equipment	HBO 350 W	600	PAS 2500/10, /30, /40	36
	HBO 450 W/GS	600	PAS 2500/10; /30, /40	36
	HBO 500 W/A	800	PAS 5000/50, /60, /80-500W	36
	HBO 500 W/B	800	PAS 5000/45, /55	36
	HBO 1003 W/PI; PIL	850; 1500	PAS 5500/60B, /80B, /100, /100B	37
	HBO 1500 W/PI; PIL	850; 1500	PAS 2500/22, PAS 5500/100C, /100D	37
	HBO 2500 W/PI; PIL	850; 1500	PAS 5500/200	37
	HBO 3500 W/PI	850	PAS 5500/200B, /250C	37
	HBO 3501 W/PI	850	PAS 5500/400	37
Lamps for Canon Equipment	HBO 500 W/A	800	FPA 112 FA, 141	38
	HBO 500 W/B	800	FPA 1500	38
	HBO 1000 W/CL; /CEL	1500; 2500	FPA 1550 Mark I, II	38
	HBO 1002 W/CL; /CEL	1500; 2500	FPA 1550 Mark III, IV	38
	HBO 1500 W/CI; /CIL; /CIEL	850; 1500; 2250	FPA-2000 i1 & FPA-2500 i2, i3	39
	HBO 2001 W/CI; /CIL; /CIEL	850; 1500; 2250	FPA-3000 i4, i5, i5+(step1), iW, MR-type	39
	HBO 2002 W/MA	1000**	MPA-500, 501, 600 FA(b) / SUPER, MPA 1500 (LCD)	39
	HBO 2700 W/CIL	1500	FPA-3000 i5+ (step2)	39
Lamps for Nikon Equipment	HBO 500 W/B	800	NSR 1505 G, G3, NSR 1010 i3	40
	HBO 1000 W/NL; /NEL	1500; 2500	NSR-1505 G3,G4,A,B,C,D	40
	HBO 1002 W/NL; /NEL	1500; 2500	NSR-1505 G5,G6,7,8,L	40
	HBO 1002 W/NI; /NIL	850; 1500	NSR-1505 i6A,7A,8A, NSR 1755 i7A/B	41
	HBO 2000 W/NI; /NIL	850; 1500	NSR-2005 i8A	41
	HBO 2001 W/NI; /NIL; /NIEL	850; 1500; 2250	NSR-2005 i9C,i10; NSR-2205 i11C, D	41
	HBO 2002 W/NIL	1500	NSR-2205 i11SHRINC 3	41
	HBO 2011 W/NIL	1500	NSR-2205 i12 C, D; NSR -TFH i12	42
	HBO 2501 W/NI; NIL	850; 1500	NSR-4425i	42
	HBO 2510 W/NIL	1500	NSR-2205 i14E	42
	HBO 4300 W/N	850	FX-501 D3, D4, 601F	42
Lamps for Süss Equipment	HBO 200 W/DC	1000	MJB3	43
	HBO 350 W/S	600	MA4, MA6, MA 8, MA 150, MJB3, MJB 21, UV 300/500	43
	HBO 1000 W/D	600	MA150, MA200, MA4, MA6, MA8	43
Lamps for GCA Equipment	HBO 350 W	600	DSW 4800-5000	44
	HBO 450 W/GS	400	DSW 6000	44
	HBO 1000 W/G	750	DSW 8000 G, Maximum 2000	44
	HBO 1002 W/G	750	ALS, Auto stop pulsed	44
	HBO 1000 W/GI	750	DSW 8000 I	45
Lamps for SVGL Equipment	XBO 150 W/CR OFR	3000	Micrascan II Alignment lamp	46
	HBO 4000 W/PL	1000	Micrascan II	46
Lamps for MRS Equipment	HBO 3500 W/MR	1000	Series 4500 Panel Printer	46
Others	HBO 201 W/HS-D2	1000/2000*	TEL equipment, Mark 7/8	
	64602	1000	Halogen 12 V, 50 W for Nikon body 8	47
	HLX 64623	1000	Halogen 12 V, 100 W for Nikon body 14E	47
	64743 HT	300	Halogen 120 V, 1000 W FEL for Fusion Gemini Asher	47
	64773	200	Halogen 120 V, 2000 W for Gasonics Asher	47
	HBO 50 W/AC	100	Wafer Inspection, microscopes	47
	HBO 100 W/2	200	Wafer Inspection, microscopes	47
	HBO 103 W/2	300	Wafer Inspection, microscopes	47
	HBO 250 W/BY	1000	Edge bead exposure	38
	LF 62YELLOW 18, 36 and 58 W		Yellow fluorescent for cleanrooms	47

*1000 h maintenance, 2000 h explosion, **initial input wattage ≤ 1,700 W

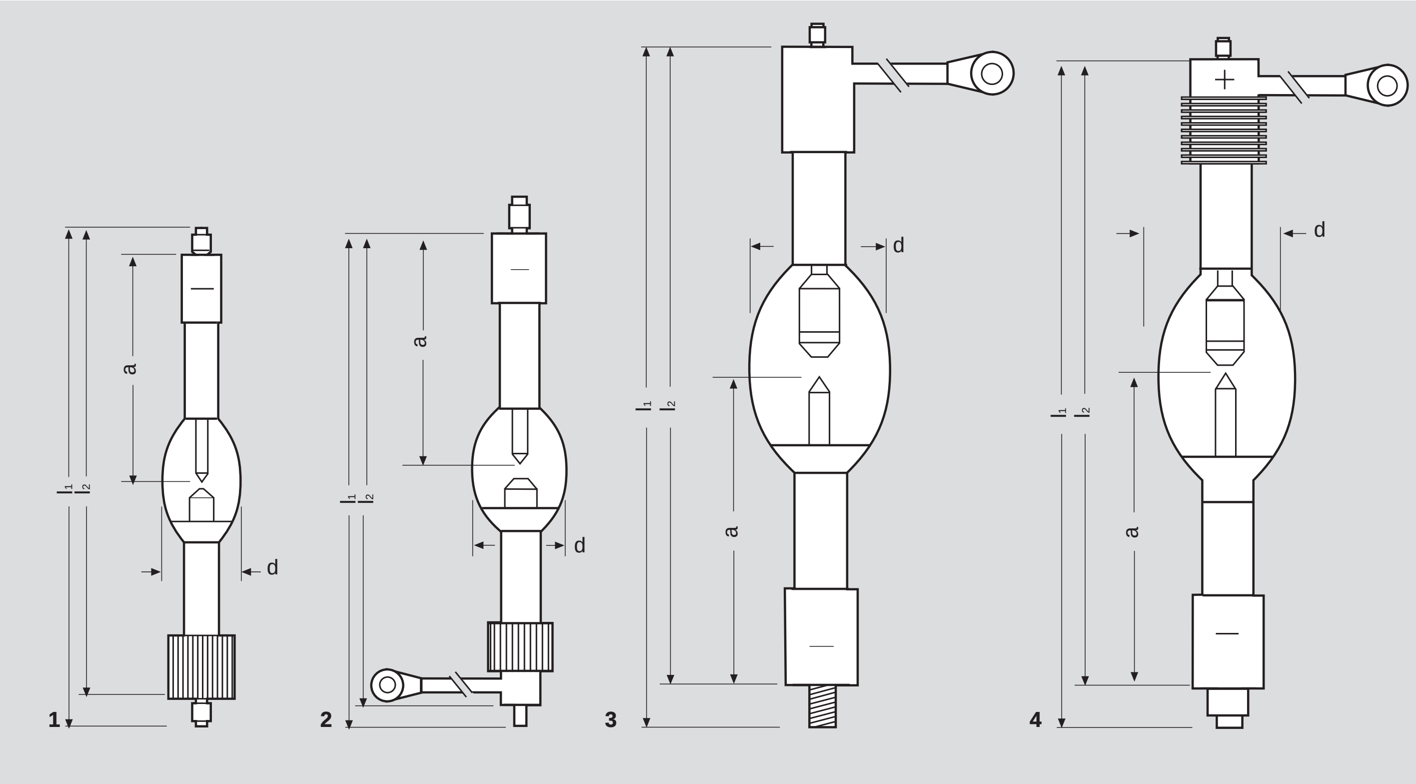
ASML



Equipment type		PAS 2500/10, /30, /40	PAS 2500	PAS 5000/50, /60, /80	PAS 5000/45, /55
Lamp type		HBO 350 W[3]	HBO 450 W/GS	HBO 500 W/A	HBO 500 W/B
Type of current		DC	DC	DC	DC
Rated lamp wattage	W	350	450	500	500
Lamp voltage (rated value)	V	67,5	50	60	48,5
Lamp current (rated value)	A	5,3	9	8,3	10,3
Radiant power in 350 ... 450 nm range	W	46	–	61	60
Radiant intensity in 350 ...450 nm range	mw/sr	4600	–	6200	5800
Average lamp life	h	600	600	800	800
Cooling[2]		convection	convection	convection	convection
Operating position		vertical, anode underneath	vertical, anode underneath	vertical, anode underneath	vertical, anode underneath
Diameter d	mm	20	22	29	29
Length l_1 max.	mm	128	150	190	180
Length l_2 nominal/max.	mm	100/102	105	160/161,5	150/151,5
Distance a[1]	mm	45	52	73	78,5
Electrode gap cold	mm	2,9	2,2	4,5	3
Base	anode	SFcY 10-4 with thread 8-32 UNC-3	SFcY 13-5	SFcY 13-5 with thread M 5x 0,9	SFcY 13-5/20 with thread M 5x 0,9
	cathode	SFcY 10-4 with thread 8-32 UNC-3A	SFcY 13-4 with thread 8-32 UNC-3A	SFcY 13-5 with thread M 5x 0,9	SXFc 13-5/20 hexagon base with thread M 5x 0,9
Fig. No		1	2	3	4

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C
3) HBO 350 W/G was substituted by HBO 350

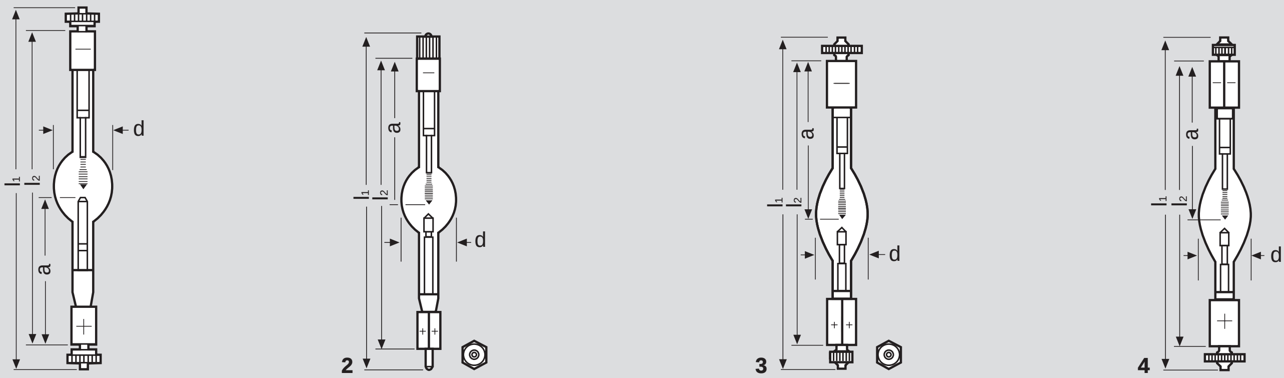
ASML



Equipment type		PAS 5500/60B, /80B, /100, /100B	PAS 5500/100C, /100D	PAS 5500/200	PAS 5500/200B, /250C	PAS 5500/400
Lamp type		HBO 1003 W/PIL	HBO 1500 W/PIL	HBO 2500 W/PIL	HBO 3500 W/PI	HBO 3501 W/PI
Type of current		DC	DC	DC	DC	DC
Rated lamp wattage	W	750 (700/1000)	1500	2500	3400	3400
Lamp voltage (rated value)	V	27,1	23	28	23	23
Lamp current (rated value)	A	25,8	65	90	148	148
Radiant intensity in the wavelength range 365 +/- 2,5 nm	mW/sr	2400	4850	8200	9000	9000
Average lamp life	h	1500[3)]	1500[3)]	1500[3)]	850	850
Cooling[2)]		forced base cooling, cooling fins on anode base	forced base cooling, cooling fins	Forced base cooling	Forced base cooling	Forced base cooling
Operating position		vertical, anode underneath	vertical, anode underneath	vertical, anode up	vertical, anode up	vertical, anode up
Diameter d	mm	29	46	62	77	77
Length l_1 max.	mm	197	263	350	340	340
Length l_2 nominal/max.	mm	167,5/169,5	240/242	312,5/315	312,5/315	312,5/315
Distance a[1)]	mm	85	118	149	154	154
Electrode gap cold	mm	3	4	6,7	4,5	4,5
Base	cathode	SFc 15-6/25	SFc 27-10/35	SFc 30-6.5/50	SFc 32,5-6.7/50	SFc 32,5-6.7/50
	anode	SFcX 14-6/25 with cooling fins	SFc 30-6/25 with cooling fins and cable connection (M8)	Sfa 30-6/50 with cable connection (M10)	SfaX 40-6/50 with cable connection (M10)	SfaX 40-6/50 with cable connection (M10)
Fig. No		1	2	3	4	4

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C
3) Also available with 850 h (PI-type).

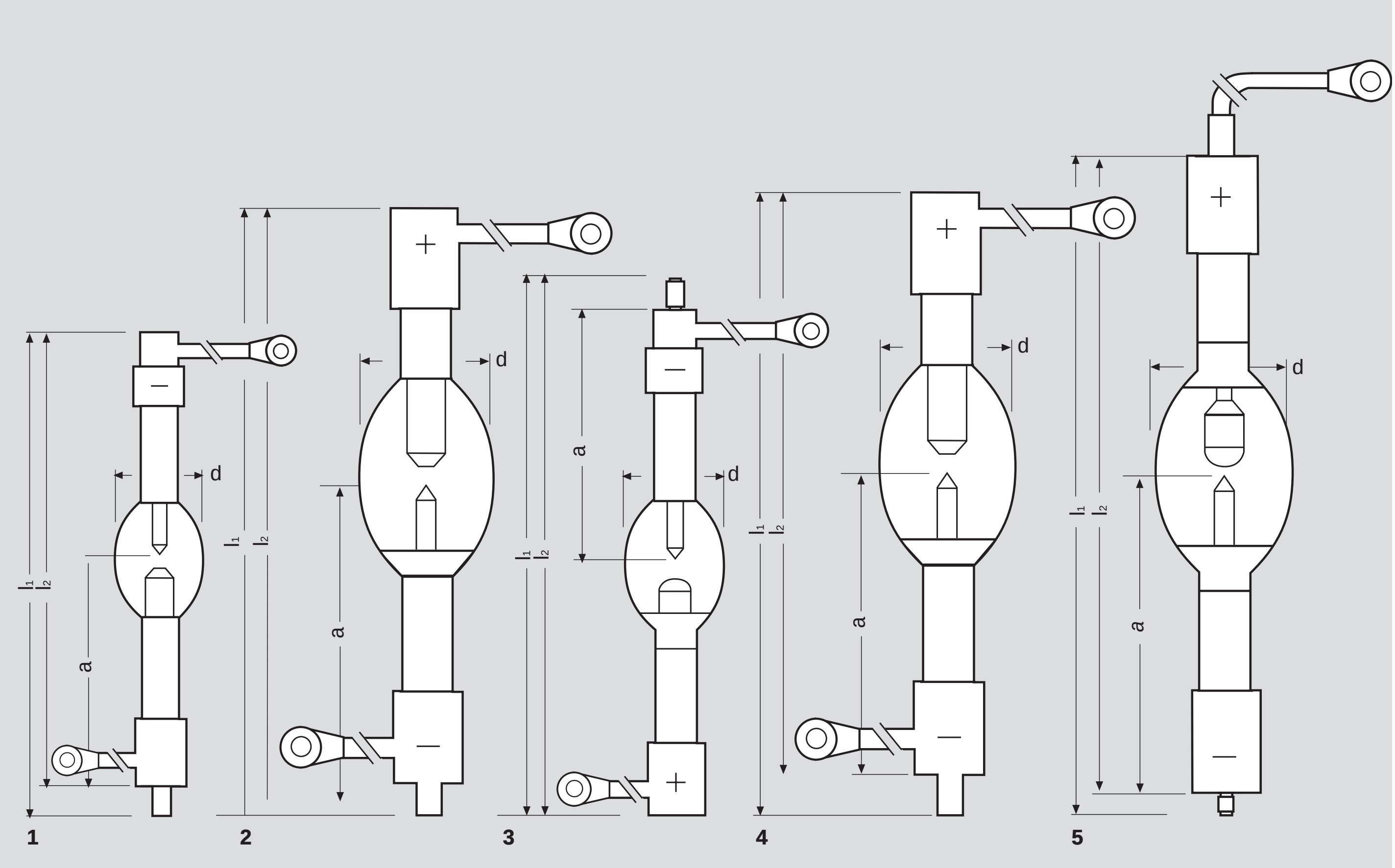
Canon


1 2 3 4

Equipment type		FPA 112 FA, FPA 141	FPA 1500	FPA 1550 Mark I, II	FPA 1550 Mark III, IV
Lamp type		HBO 500 W/A	HBO 500 W/B	HBO 1000 W/ CEL[3,4]	HBO 1002 W/ CEL[3,4]
Type of current		DC	DC	DC	DC
Rated lamp wattage	W	500	500	750 (700/1000)	750 (700/1000)
Lamp voltage (rated value)	V	460	48,5	47	47
Lamp current (rated value)	A	8,3	10,3	16	16
Radiant power in 350 ... 450 nm range	W	61	60	85	85
Radiant intensity in 350 ...450 nm range	mw/sr	6200	5800	8300	8300
Average lamp life	h	800	800	2500[3]	2500[3]
Cooling[2]		convection	convection	convection	convection
Operating position		vertical, anode underneath	vertical, anode underneath	verticaL anode underneath	vertical, anode underneath
Diameter d	mm	29	29	28	28
Length l_1 max.	mm	190	180	175	175
Length l_2 nominal/max.	mm	160/161,5	150/151,5	155/157	155/157
Distance a[1]	mm	73	78,5	78,5	73,5
Electrode gap cold	mm	4,5	3	3	3
Base	anode	SFcY 13-5 with thread M 5x 0,9	SFcY 13-5/20 with thread M 5x 0,9	SFc 15-6/20 sleeve base thread M6	SXFc 15-6/20 hexagon base with thread M6
	cathode	SFcY 13-5 with thread M 5x 0,9	SFcY 13-5/20 hexagon base with thread M6	SFc 15-6/20 hexagon base with thread M6	SXFc 15-6/20 sleeve base thread M6
Fig. No		1	2	3	4

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C
3) Also available with 1500 h (CL-Type). 750 h lamp (C-type) obsolete
4) 1500 h (CL-type) available in Europe, Singapore and Japan through Canon only

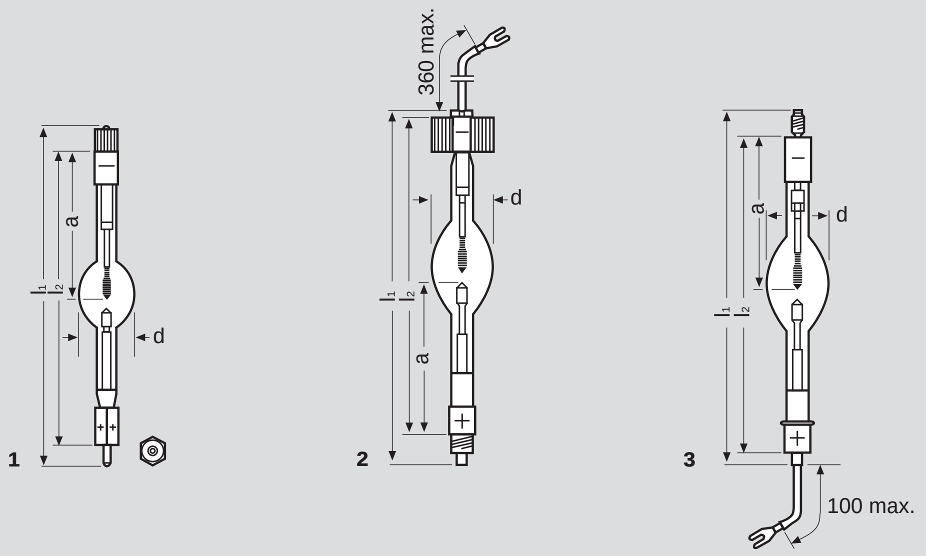
Canon



Equipment type		FPA-2000 i1 & FPA-2500 i2, i3	FPA-3000 i4, i5, i5+(step1), iW, MR-type	MPA-500, 501, 600 FA(b) / SUPER, MPA 1500 (LCD)	FPA-3000 i5+ (step2)	MPA-5000 (LCD)
Lamp type		HBO 1500 W/CIEL 3)	HBO 2001 W/CIL 4) 6)	HBO 2002 W/MA	HBO 2700 W/CIL 5)	HBO 5000 W/C
Type of current		DC	DC	DC	DC	DC
Rated lamp wattage	W	1500	2000	max. 2400	2700	max. 5500
Lamp voltage (rated value)	V	23	26	37	24,5	56
Lamp current (rated value)	A	65	77	54	110	77
Radiant intensity in the wave-length range 365 +/- 2,5 nm	mW/sr	4850	6050	4200	7900	
Average lamp life	h	2250 3)	1500 4)	1000 7)	1500	500
Cooling 2)		Forced base cooling	Forced base cooling	Forced base cooling	forced base cooling	forced base cooling
Operating position		vertical, anode underneath	vertical, anode up	vertical, anode underneath	vertical, anode up	vertical, anode up
Diameter d	mm	52	62	62	62	82
Length l_1 max.	mm	262	329	292	334	352
Length l_2 nominal/max.	mm	240/242	307/309	270/272	307/309	328/330
Distance a 1)	mm	122	148,75	138,5	148,75	157,5
Electrode gap cold	mm	4	4,5	3		5
Base	cathode	SFa 27-20/22 with cable connection (M8)	SFa 33,5-10/50 with cable connection (M6)	Sfa 27-10/35 with cable connection (8)	SFa 33.5-14/50	SFc 33.5-12/50
	anode	SFa 27-10/35 with cable connection (M8)	SF 33,5/50 with cable connection (M8)	Sfa 27/35 with cable connection (8)	SFa 33.5/50 with cable connection (M8)	SFc 33.5-24/33 with cable connection (M10)
Fig. No		1	2	3	4	5

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C
3) Also available with 1500 h (CIL-type). 850 h (CI-Type) obsolete in 1999, delivery on demand only.
4) Also available with 850 h (CI-type)
5) Local sales restrictions apply
6) Available in Europe, Singapore and Japan through Canon only
7) If initial input wattage ≤ 1700 W, for details please contact your nearest sales office

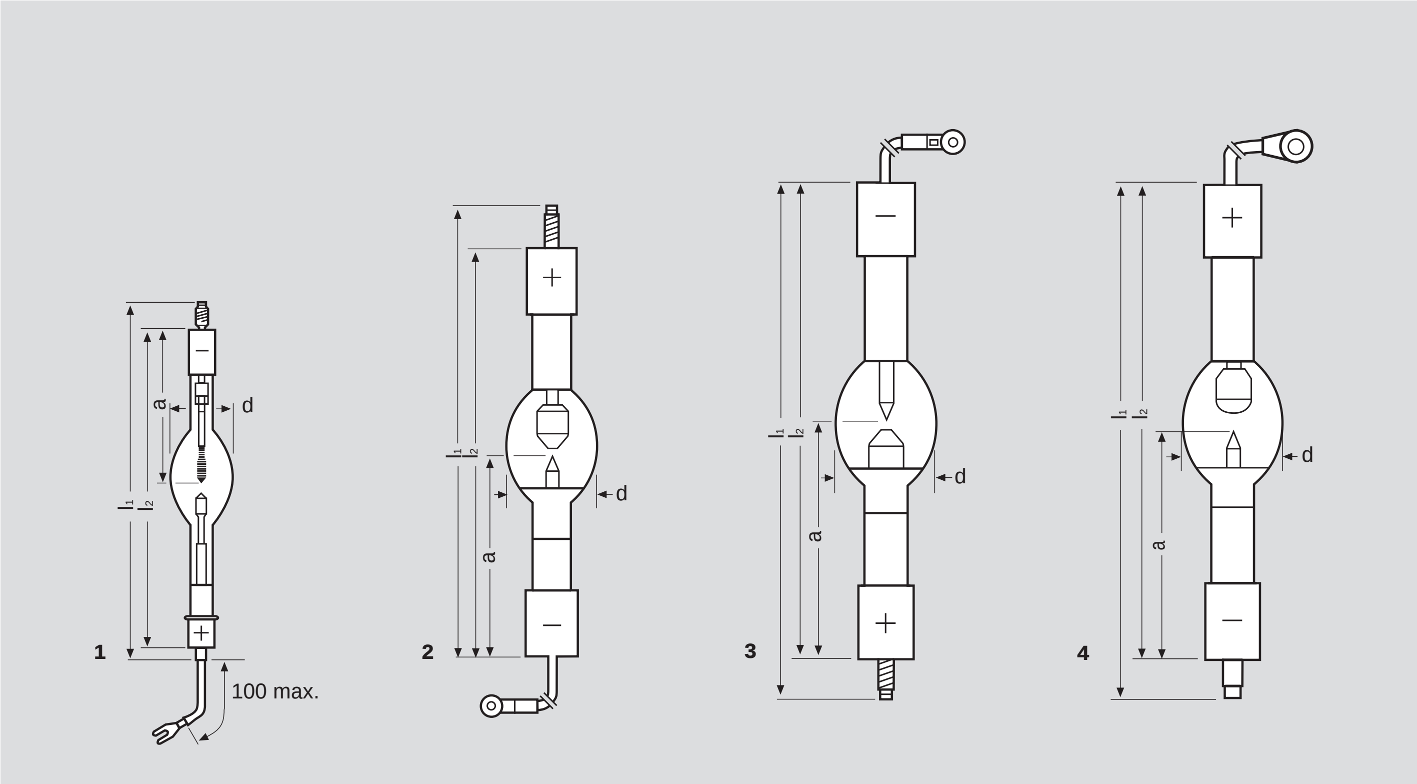
Nikon



Equipment type		NSR 1505 G	NSR-1505 G3, G4, A, B, C, D	NSR-1505 G5, G6, 7, 8, L
Lamp type		HBO 500 W/B	HBO 1000 W/NEL	HBO 1002 W/NEL
Type of current		DC	DC	DC
Rated lamp wattage	W	500	750 (700/1000)	750 (700/1000)
Lamp voltage (rated value)	V	48,5	47	47
Lamp current (rated value)	A	10,3	16	16
Radiant power in 350 ... 450 nm range	W	60	85	85
Radiant intensity in 350 ...450 nm range	mw/sr	5800	8300	8300
Average lamp life	h	800	2500 [3)]	2500 [3)]
Cooling [2)]		convection	convection, cooling fins on cathode base	convection
Operating position		vertical, anode underneath	vertical, anode underneath	vertical, anode underneath
Diameter d	mm	29	28	28
Length l_1 max.	mm	180	187	187
Length l_2 nominal/max.	mm	150/151,5	166/168	166/168
Distance a [1)]	mm	78,5	84,5	78,5
Electrode gap cold	mm	3	3	3
Base	anode	SFcY 13-5/20 with thread M 5x 0,9	SFaX 14-5/21 cooling fins cable connection (M5)	SFc 15-6/25 sleeve base with thread M6
	cathode	SXFc 13-5/20 hexagon base with thread M 5x 0,9	SFa 15-5/16 sleeve base without thread	SFaX 14-5/21 sleeve base with cable connection (M5)
Fig. No		1	2	3

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C
3) Also available with 1500 h (NL-Type). 750 h lamp (N-type) obsolete

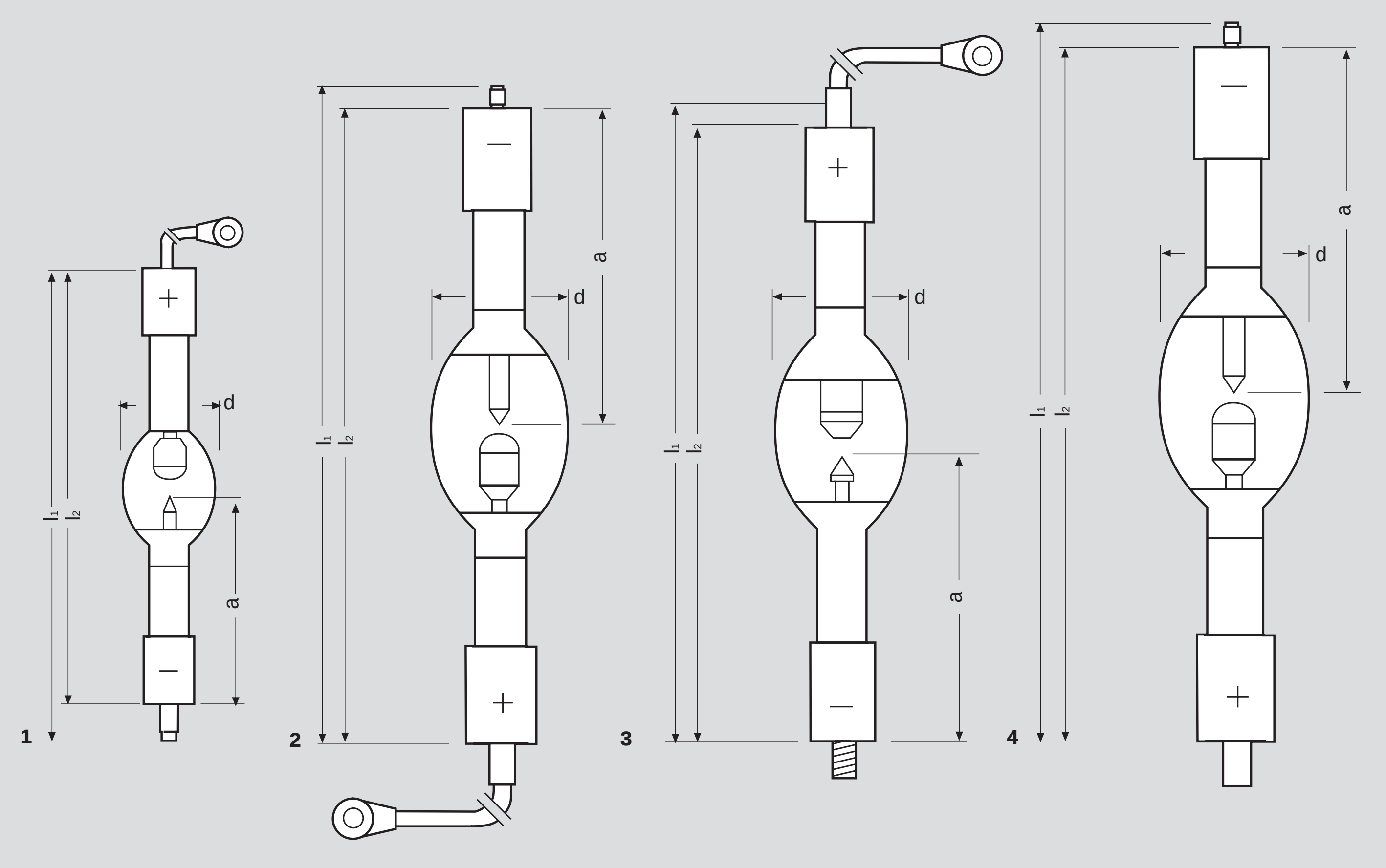
Nikon



Equipment type		NSR-1505 i6A, 7A, 8A	NSR-2005 i8A	NSR-2005 i9C, i10; NSR-2205 i11C, D	NSR-2205 i11 SHRINC 3
Lamp type		HBO 1002 W/NIL	HBO 2000 W/NIL	HBO 2001 W/NIEL	HBO 2002 W/NIL
Type of current		DC	DC	DC	DC
Rated lamp wattage	W	750 (700/1000)	1750	1750	1750
Lamp voltage (rated value)	V	27,1	26	26	26
Lamp current (rated value)	A	25,8	67	67	67
Radiant intensity in the wave-length range 365 +/- 2,5 nm	mW/sr	2400	5200	5500	5100
Average lamp life	h	1500 4)	1500 4)	2250 3)	1500
Cooling 2)		forced base cooling	Forced base cooling	Forced base cooling	Forced base cooling
Operating position		vertical, anode underneath	vertical, anode up	vertical, anode underneath	vertical, anode up
Diameter d	mm	29	52	52	52
Length l_1 max.	mm	189	241	251	254
Length l_2 nominal/max.	mm	166/168	219/221	229/231	232/234
Distance a 1)	mm	78,5	112,25	112,25	107,75
Electrode gap cold	mm	3	4,5	4,5	4,5
Base	cathode	SFcX 15-6/25 with thread M6	SFaX 27-7/35 with cable connection (M8)	SFaX 27-7/35 with cable connection (M8)	SFc 27-10x1,25/35
	anode	SFaX 14-5/21 with cable connection (M5)	SFc 27-12/35	SFc 27-10/35	SFc 27-7/35 with cable connector (M8)
Fig. No		1	2	3	4

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C
3) Also available with 1500 h (NIL-type). 850 h (NI-Type) obsolete in 1999, delivery on demand only.
4) Also available with 850 h (NI-type)

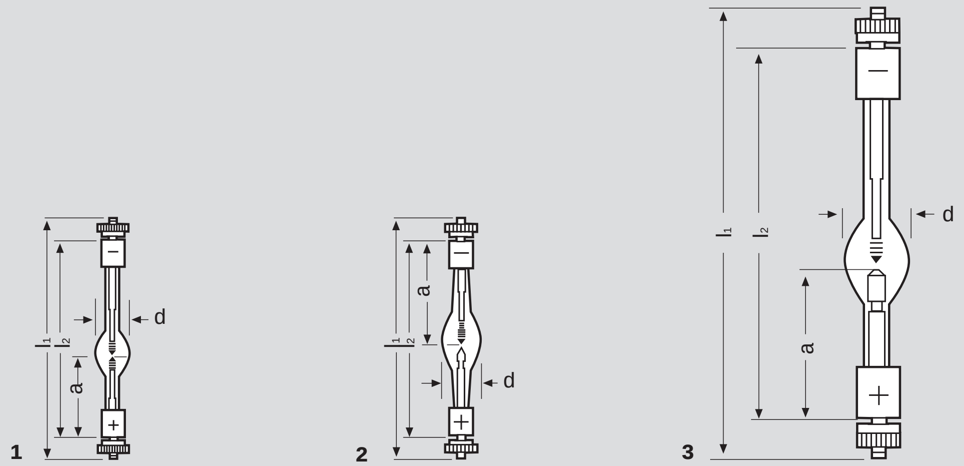
Nikon



Equipment type		NSR-2205 i12 C, D; NSR -TFH i12	NSR-4425i	NSR-2205 i14E	FX-501, 601F
Lamp type		HBO 2011 W/NIL	HBO 2501 W/NIL	HBO 2510 W/NIL	HBO 4300 W/N
Type of current		DC	DC	DC	DC
Rated lamp wattage	W	2000	2500	2500	4300
Lamp voltage (rated value)	V	25	23	23	45
Lamp current (rated value)	A	80	110	110	96
Radiant intensity in the wave-length range 365 +/- 2,5 nm	mW/sr	5700	7800	7800	-
Average lamp life	h	1500	1500 3)	1500	750
Cooling 2)		Forced base cooling	Forced base cooling	Forced base cooling	Forced base cooling
Operating position		vertical, anode up	vertical, anode underneath	vertical, anode up	vertical, anode up
Diameter d	mm	52	70	70	80
Length l_1 max.	mm	256	358	358	391
Length l_2 nominal/max.	mm	234/236	325/327	325/327	335/337
Distance a 1)	mm	107,75	157,75	157,75	177,5
Electrode gap cold	mm	4,5	4,5	4,5	5
Base	cathode	SFc 27-12x1,5/35	SFc 33,5-14/50	SFc 33,5-14/50	SFc 33,5-12/50
	anode	SFc 27-7/35 with cable connector (M8)	SFc 33,5-8/50 with cable connector (M8)	SFc 33,5-8/50	SFc 33,5-14/50
Fig. No		1	2	3	4

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C
3) Also available with 850 h (NI-type)

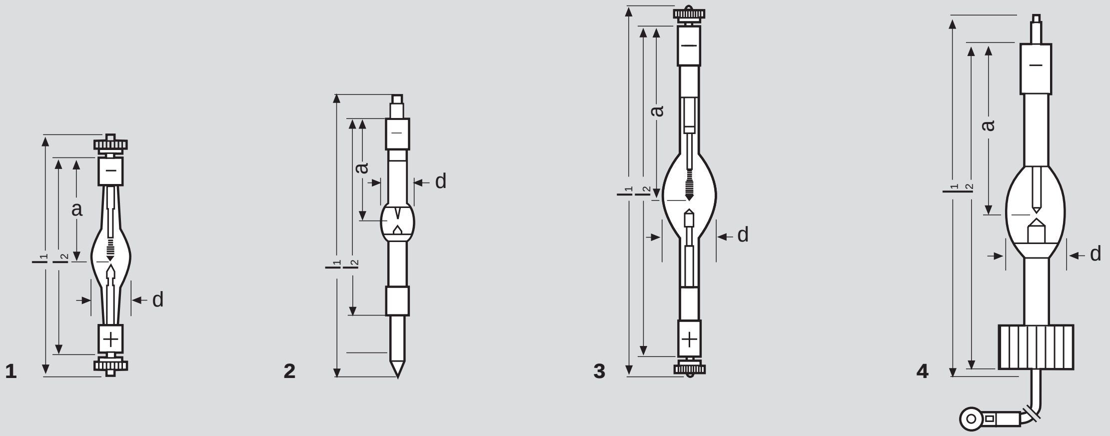
Süss



Equipment type		MJB3	MA4, MA6, MA8, MA150, MJB3, MJB21, UV 300/500	MA150, MA200, MA4, MA6, MA8
Lamp type		HBO 200 W/DC	HBO 350 W/S	HBO 1000 W/D
Type of current		DC	DC	DC
Rated lamp wattage	W	200	350	1000
Lamp voltage (rated value)	V	57	68	37,7
Lamp current (rated value)	A	3,5	5,15	26,5
Radiant power in 350 ... 450 nm range	W	-	50	105
Radiant intensity in 350 ...450 nm range	mw/sr	-	4700	10,8
Average lamp life	h	1000	600	600
Cooling 2)		convection	convection	convection
Operating position		vertical, anode underneath	vertical, anode underneath	vertical, anode up
Diameter d	mm	17	20	40
Length l_1 max.	mm	128	127	240
Length l_2 nominal/max.	mm	100/102	101/103	206/208
Distance a 1)	mm	40	52.5	89,5
Electrode gap cold	mm	2,3	3	3
Base	anode	SFc 10-4	SFcY 10-4 with thread 8-32 UNC-3A	SFc 16-6/25
	cathode	SFc 10-4	SFcY 10-4 with thread 8-32 UNC-3A	SFc 16-6/25
Fig. No		1	2	3

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C

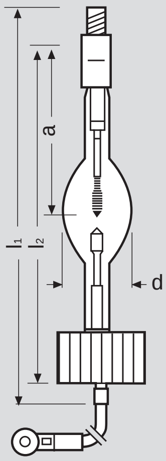
GCA



Equipment type		DSW 4800-5000	DSW 6000	DSW 8000 G, Maximum 2000	ALS, Auto stop pulsed
Lamp type		HBO 350 W 3)	HBO 450 W/GS	HBO 1000 W/G	HBO 1002 W/G
Type of current		DC	DC	DC	DC
Rated lamp wattage	W	350	350	750 (700/1000)	750 (700/1000)
Lamp voltage (rated value)	V	67,5	50	47	47
Lamp current (rated value)	A	5,3	7	16	16
Radiant power in 350 ... 450 nm range	W	-	43,8	85	85
Radiant intensity in 350 ...450 nm range	mw/sr	-	4500	8300	8300
Average lamp life	h	600	600	600	600
Cooling 2)		convection	convection	convection	convection, cooling fins on anode base
Operating position		vertical, anode underneath	vertical, anode underneath	vertical, anode underneath	vertical, anode underneath
Diameter d	mm	20	20	28	28
Length l_1 max.	mm	128	127	197	190
Length l_2 nominal/max.	mm	100/102	101/103	167,5/169,5	167,5/169,5
Distance a 1)	mm	45	52,5	85	85
Electrode gap cold	mm	2,9	3	3	3
Base	anode	SFcY 10-4 with thread 8-32 UNC-3A	SFcY10-4/15	SFcX 15-4/20 with thread 8-32 UNC-3A	SFcX 15-4/20 with thread 8-32 UNC-3A
	cathode	SFcY 10-4 with thread 8-32 UNC-3A	SFcY10-4/15	SFcX 15-4/20 with thread 8-32 UNC-3A	SFcX 15-6/25 with cooling fins and cable connection (M4)
Fig. No		1	2	3	4

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C
3) HBO 350 W/G was substituted by HBO 350

GCA



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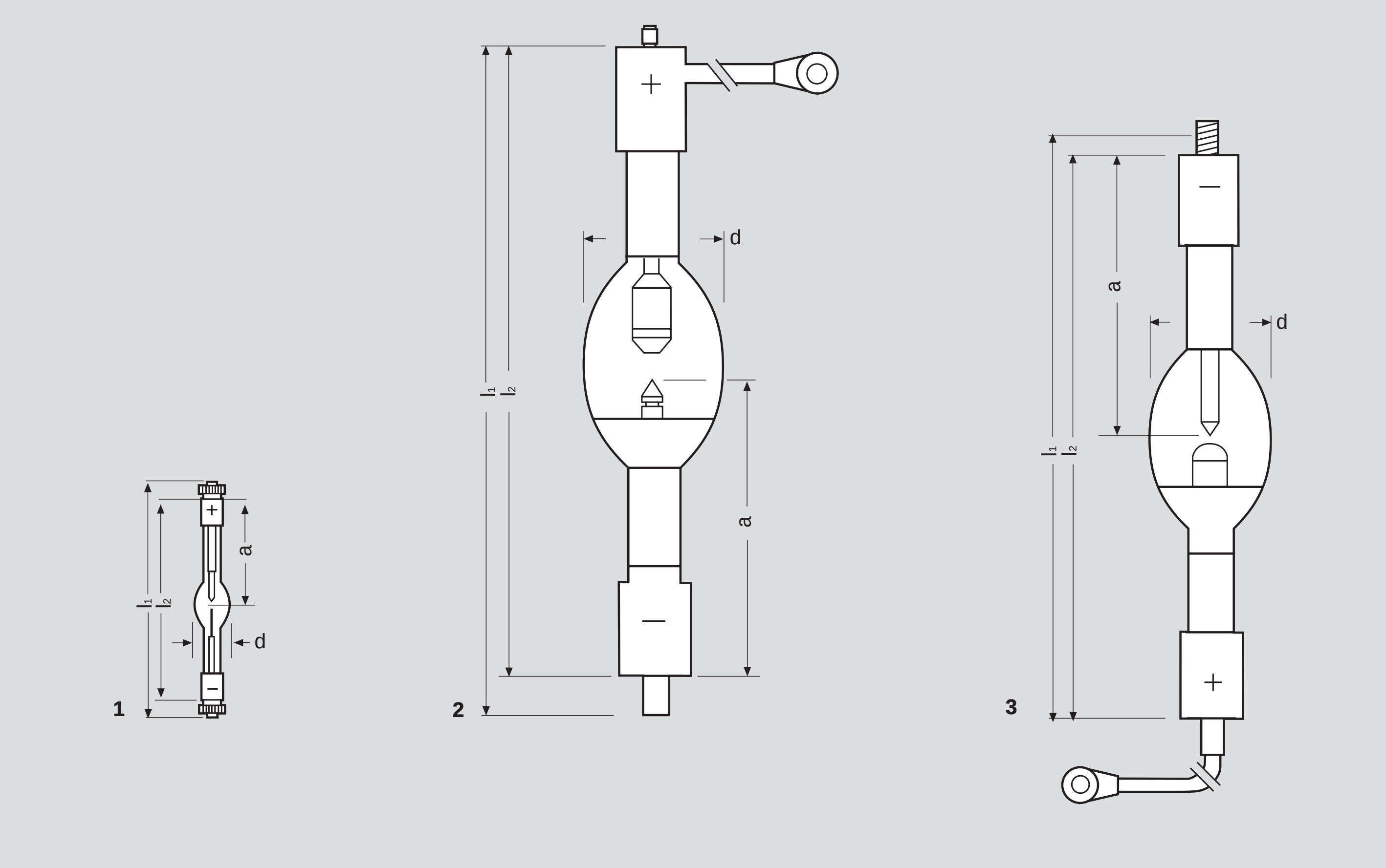
Equipment type		DSW 8000 I
Lamp type		HBO 1000 W/GI
Type of current		DC
Rated lamp wattage	W	700 (700/1000)
Lamp voltage (rated value)	V	27,1
Lamp current (rated value)	A	25,8
Radiant intensity in the wave-length range 365 +/- 2,5 nm	mW/sr	2400
Average lamp life	h	850
Cooling [2)]		convection, cooling fins on anode base
Operating position		vertical, anode underneath
Diameter d	mm	29
Length l_1 max.	mm	197
Length l_2 nominal/max.	mm	167,5/169,5
Distance a [1)]	mm	85
Electrode gap cold	mm	3
Base	cathode	SFc 15-6/25
	anode	SFcX 14-6/25 with cable connection (M5)
Fig. No		1

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C

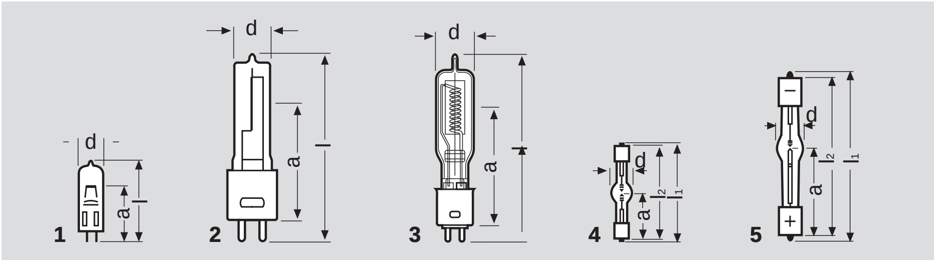
SVGL and MRS



Equipment type		SVGL Micrascan II Alignment lamp	SVGL Micrascan II	MRS Series 4500 Panel Printer
Lamp type		XBO 150 W/CR OFR	HBO 4000 W/PL	HBO 3500 W/MR
Type of current		DC	DC	DC
Rated lamp wattage	W	150	3500 / 4000	3500
Lamp voltage (rated value)	V	17,5	38 / 42	62
Lamp current (rated value)	A	8,5	92.5 / 95	56
Average lamp life	h	3000	1000	1000
Cooling [2)]		convection	forced base cooling	forced base cooling
Operating position		vertical, anode up	vertical, anode up	vertical, anode underneath
Diameter d	mm	20	77	70
Length l_1 max.	mm	150	363	317
Length l_2 nominal/max.	mm	127	338/340	290/292
Distance a[1)]	mm	57	158	141,7
Electrode gap cold	mm	1,6	5	6,6
Base	anode	SFc12-4	SFc 33.5-10/50	SXFc 27-8/35
	cathode	SFcX 12-4	SF 33.5/50 with cable connection	SFc 27-5/35 with cable connection (M8)
Fig. No		1	2	3

1) Distance from end of base to tip of anode or cathode, resp. (cold)
2) Maximum permissible base temperature 200 °C

Lamps for other application in semi-conductor industry

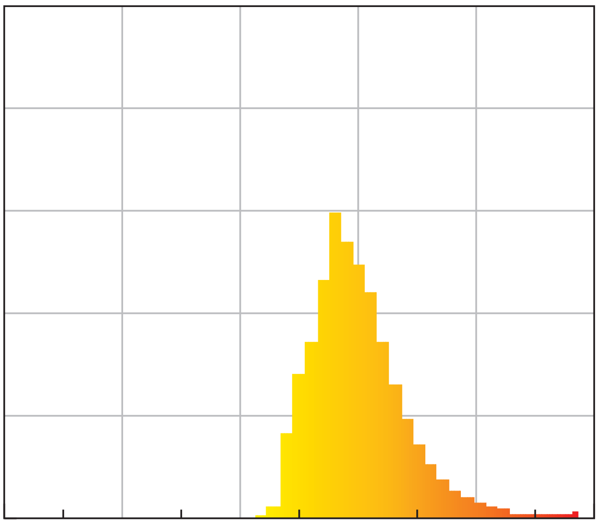


Lamp reference		64602	HLX64623	64743 HT	64773	HBO 50 W/AC	HBO 100 W/2	HBO 103 W/2
ANSI Code		–	EVA	FEL	–	–	–	–
NADED Code		54138	54052	54570	54588	69215	69217	69182
Type of current						AC	DC	DC
LIF Code		M/134	M/28	CP/ 77	–	–	–	–
Lamp voltage	V	12	12	120	120	23	20	23
Wattage	W	50	100	1000	2000	50	100	100
Current	A					2.3	5.0	4.3
Base		G6.35	G6.35	G9.5	G9.5	–	–	–
Base anode						SFa8-2	SFa9-2	SFa9-2
Base cathode						SFa6-2	SFa7,5-2	SFa7,5-2
Average/service life	h	1100	2000	300	200	200	200	300
Luminous flux	lm	100	2800	27500	–	1300	2200	3000
Luminous efficacy	lm/W					26	22	30
Luminous intensity	cd					150	260	300
Average luminance	cd/cm²					90000	170000	170000
Luminous area w x h	mm					0.2 x 0.35	0.25 x 0.25	0.25 x 0.25
Bulb Type		–	–	T-6	–	–	–	–
Color temperatur		–	–	3200	3200	–	–	–
Operating position		s90	p90/15	any	any	s45 anode underneath	s90 anode underneath	s90 anode underneath
Diameter d	mm	11,5	9	20	27	9.0	10	10
Length l	mm	44	35	101	101	53	90	90
Length l_2	mm	–	–	–	–	47	82	82
Distance a	mm	30	27	60.3	60.3			
Filament dimensions w x h	mm	3.0 x 3.0	4.7x2.7	7x18	–			
Standard pack	pcs	100	100	12	12			
Fig. no.		1	1	2	3	4	5	5

The perfect light for clean-room manufacture

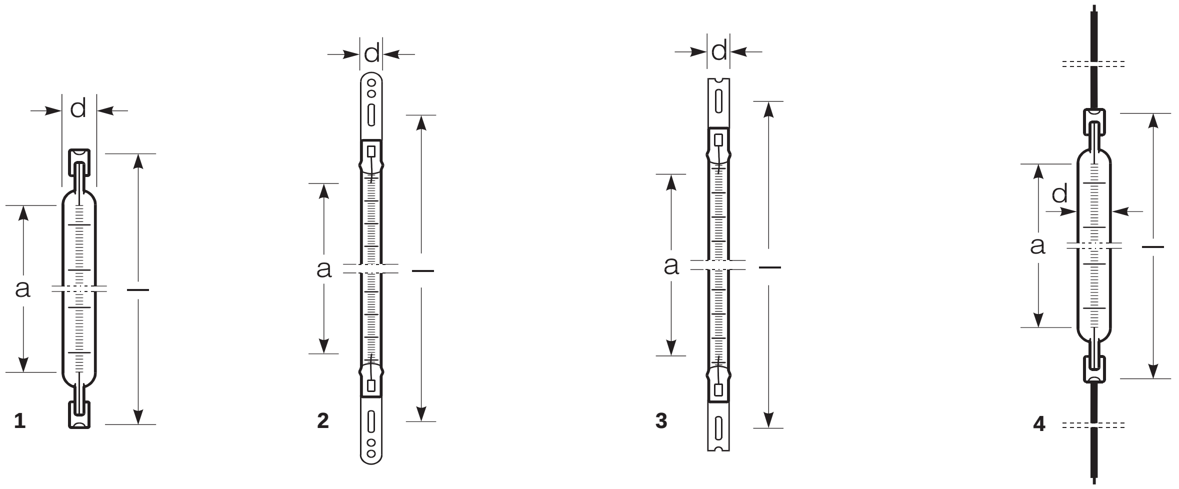
UV-STOP LF 62 YELLOW has been specially developed for use in areas in which the UV and blue components of the spectrum are prohibited. It is therefore used primarily in microchip fabrication plants for clean-room lighting and in print shops for exposing printing plates.

Spectral radiation distribution of LF 22-940 UVS



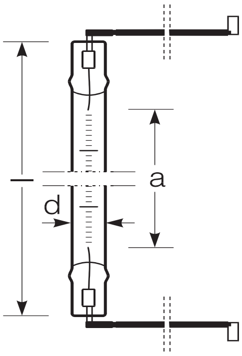
LF 62 YELLOW (UV-STOP)			
Lamp reference	L 18 W/62	L 36 W/62	L 58 W/62
Luminous flux	980 lm	2300 lm	3700 lm
Light colour	62 YELLOW	62 YELLOW	62 YELLOW
Length	590 mm	1200 mm	1500 mm
Diameter	26 mm	26 mm	26 mm

Infrared lamps



Code/Type		ITT 200/235-0170	ITT 350/235-0170	ITT 500/235-0170	ITT 500/235-01X0	ITT 700/235-0170 K	ITT 700/235-0170
Mains voltage	V	235	235	235	235	235	235
Wattage	W	200	350	500	500	700	700
Nominal current	A	0,85	1,50	2,10	2,10	3,00	3,00
Length l	mm	185,7	185,7	250,7	243,0	250,7	327,4
Distance a	mm	115	115	167	167	167	260
Diameter d	mm	10	10	10	8	10	10
Operating position		p15	p15	s180	s180	p15	p15
Base		R7s	R7s	R7s	X[1)]	R7s	R7s
Picture		1	1	1	2	1	1
Box quantity	St.	12	12	12	60	12	12

Code/Type		ITT 1000/235-0170	ITT 1000/235-01X0	ITT 1200/235-0170	ITT 16007600-0145	ITT 2000/235-0103K	ITT 2000/235-01Y0 K
Mains voltage	V	235	235	235	600	235	235
Wattage	W	1000	1000	1200	1600	2000	2000
Nominal current	A	4,30	4,30	5,10	2,66	8,50	8,50
Length l	mm	327,4	368,0	327,4	730,0	345,0	368,0
Distance a	mm	268	268	260	416	280	280
Diameter d	mm	10	8	10	8	12	12
Operating position		p15	p15	p15	p15	s180	s180
Base		R7s	X[1)]	R7s	Hülse[2)]	Kabel	Y
Picture		1	2	1	4	7	3
Box quantity	St.	12	60	60	60	60	60



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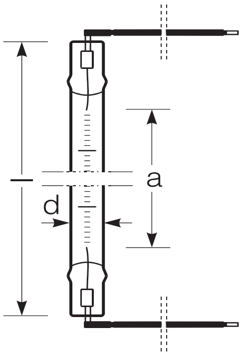

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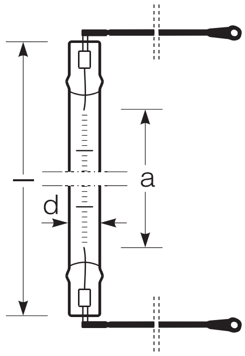


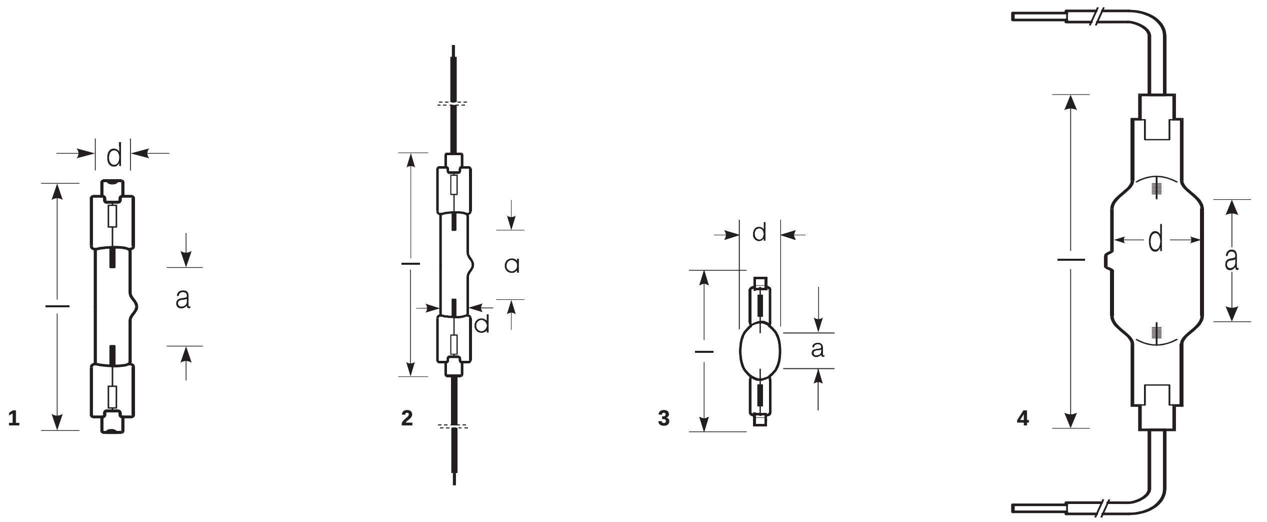
7

Code/Type	ITT 2000/235-0108 K	ITT 2000/235-0102 K	ITT 2000/235-01X0 K	ITT 2000/235-01X0	ITT 2000/400-01X0	ITT 2200/235-0102
Mains voltage V	235	235	235	235	400	235
Wattage W	2000	2000	2000	2000	2000	2200
Nominal current A	8,50	8,50	8,50	8,50	5,00	9,30
Length l mm	345,0	345,0	368,0	508,0	508,0	335,0
Distance a mm	280	280	290	410	410	281
Diameter d mm	12	12	12	10	10	12
Operating position	s180	s180	s180	p15	p15	s180
Base	Kabel	Kabel	X[1)]	X[1)]	X[1)]	Kabel
Picture	6	5	2	2	2	5
Box quantity St.	60	60	60	60	60	60

Code/Type	OTT 2500/575-0145	ITT 2550/600-0145	ITT 3000/235-01X0 K	ITT 3000/235-01Y0 K	ITT 3000/235-01X0	ITT 3000/400-01X0
Mains voltage V	575	600	235	235	235	400
Wattage W	2500	2500	3000	3000	3000	3000
Nominal current A	4,35	4,25	12,80	12,80	12,80	7,50
Length l mm	1058,0	1058,0	368,0	368,0	798,0	798,0
Distance a mm	638	638	280	280	700	700
Diameter d mm	8	8	12	12	10	10
Operating position	p15	p15	s180	s180	p15	p15
Base	Hülse[2)]	Hülse[2)]	X[1)]	Y	X[1)]	X[1)]
Picture	4	4	2	3	2	2
Box quantity St.	60	60	60	60	60	60

1) Metal strip
2) Ceramic socket

UV-High Pressure Lamps, double ended

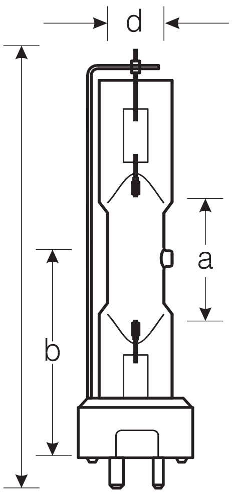


Code/Type		HAT 150-221	HTT 150-211	HTT 150-211	HTT 150-211	HTT 400-221	HTC 400-221
Wattage	W	170	165	165	160	460	460
Length l	mm	132	59,5	57,6	62	110	104
Distance a	mm	10	10	10	8	33	33
Diameter d	mm	23	10	10	13	14	14
Picture		1	2	1	3	2	1
Base		R7s-24	Litze	R7s	X515	Litze	R7s
Box quantity	St.	25	25	25	25	25	25
Mains Voltage	V	230	230	230	230	230	230
Lamp current	A	1,5	1,5	1,5	1,8	4,0	4,0
UVA Radiation power (315-400 nm)	W	22	22	22	20	90	90
UVB Radiation power (280-315 nm)	W	5	6	6	5	22	22
Operating position		s180	p30	p30	p30	s180	s180
Ignitor	kV	4,0	4,0	4,0	4,0	4,0	4,0
Economic lifetime	h	1000	1000	1000	500	1000	1000

Code/Type		HTC 400-241 *	HTC 1000-221	HTC 1000-241 *	HTC 2000-327	HTC 2000-347 *	HTC 2000-349 *
Wattage	W	460	1000	1000	2000	2000	2000
Length l	mm	104	141	141	174	174	210
Distance a	mm	33	48	48	72	72	104
Diameter d	mm	14	28	28	28	28	28
Picture		1	4	4	4	4	4
Base		R7s	KY10s	KY10s	KX10s	KX10s	KX10s
Box quantity	St.	25	25	25	25	25	25
Mains Voltage	V	230	230	230	400	400	400
Lamp current	A	4,0	9,0	9,0	9,0	9,0	9,0
UVA Radiation power (315-400 nm)	W	82	200	200	500	500	460
UVB Radiation power (280-315 nm)	W	10	60	30	120	60	50
Operating position		s180	s180	s180	s180	s180	s180
Ignitor	kV	4,0	4,0	4,0	4,0	4,0	4,0
Economic lifetime	h	1000	800	800	800	800	800

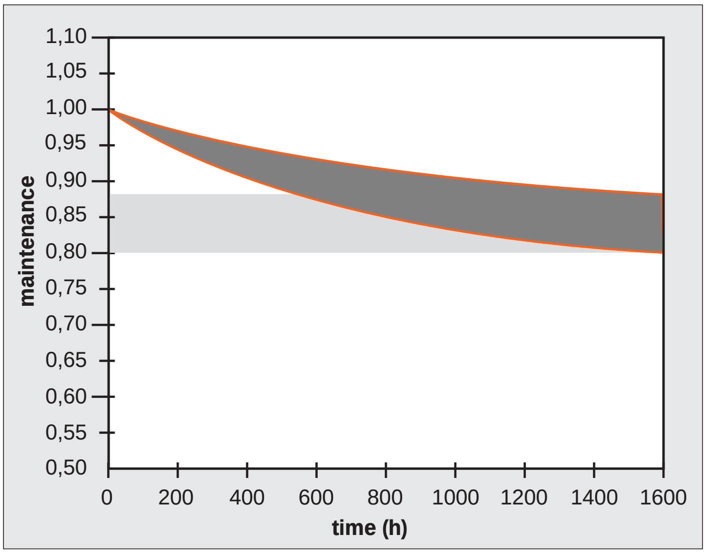
*FDA admission available (UVC/UVB < 0,3%)

UV-High Pressure Lamps, single ended

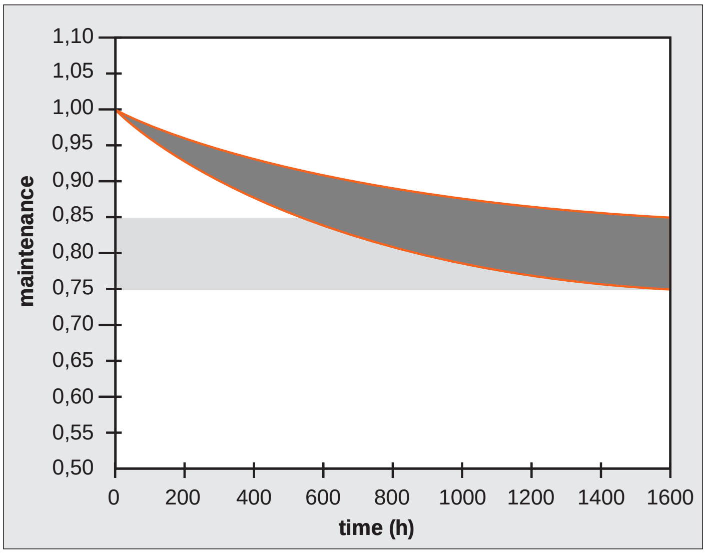


1

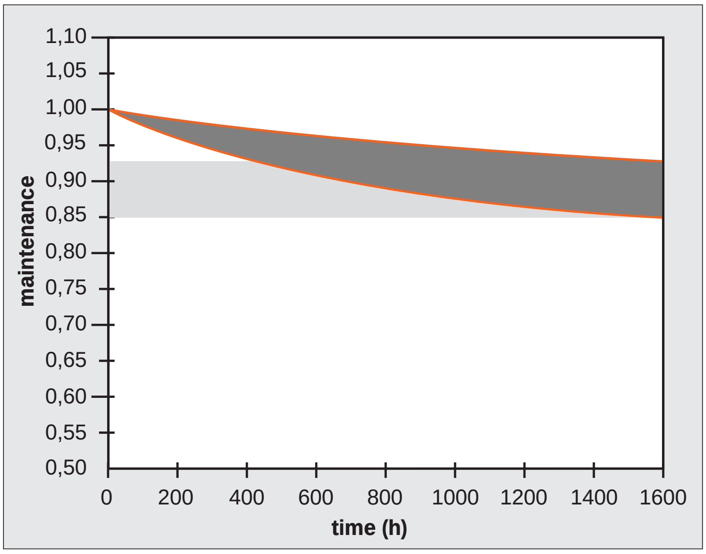
Code/Type		HSC 400-221	HSC 1000-221
Wattage	W	460	1000
Length l	mm	114	139
Distance a	mm	33	30
Distance b	mm	51	74
Diameter d	mm	14	23
Picture		1	1
Base		GY9,5	GYX9,5
Box quantity	St.	25	25
Mains Voltage	V	230	230
Lamp current	A	4,0	9,0
UVA Radiation power (315-400 nm)	W	80	200
UVB Radiation power (280-315 nm)	W	20	38
Operating position		s180	s180
Ignitor	kV	4,0	4,0
Economic lifetime	h	1000	800



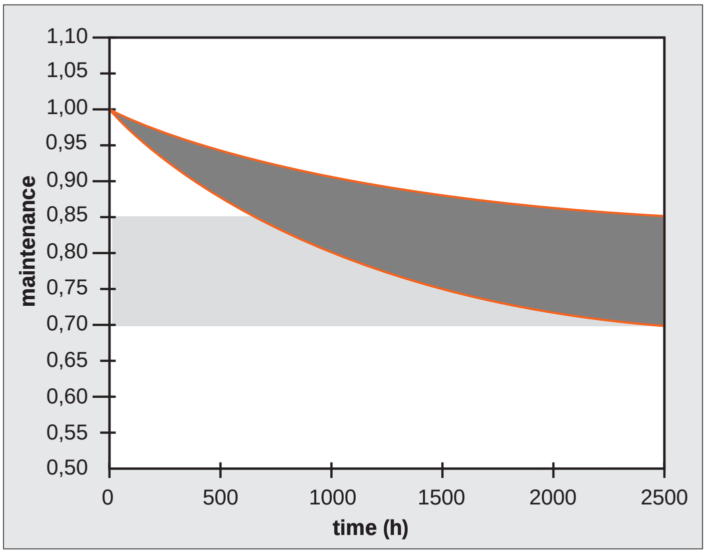
HBO 2002 W/NIL



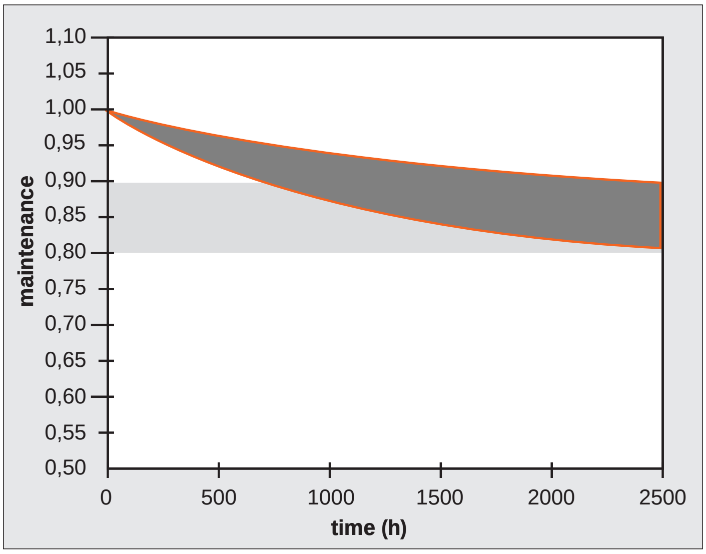
HBO 2011 W/NIL



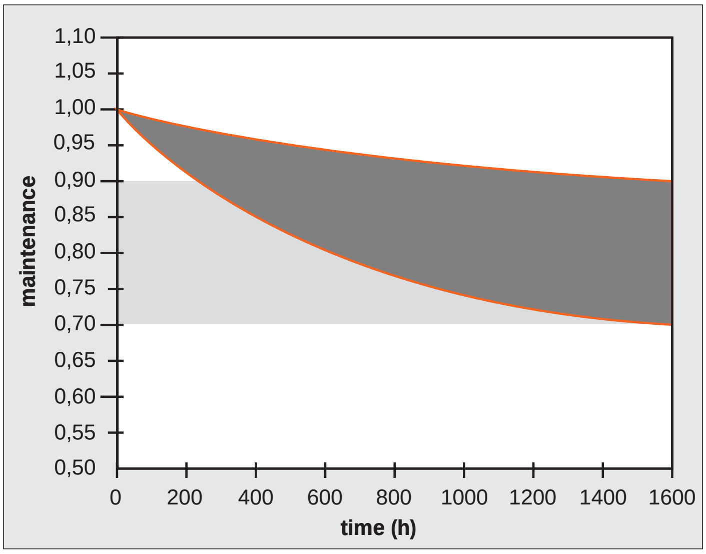
HBO 2501 W/NIL



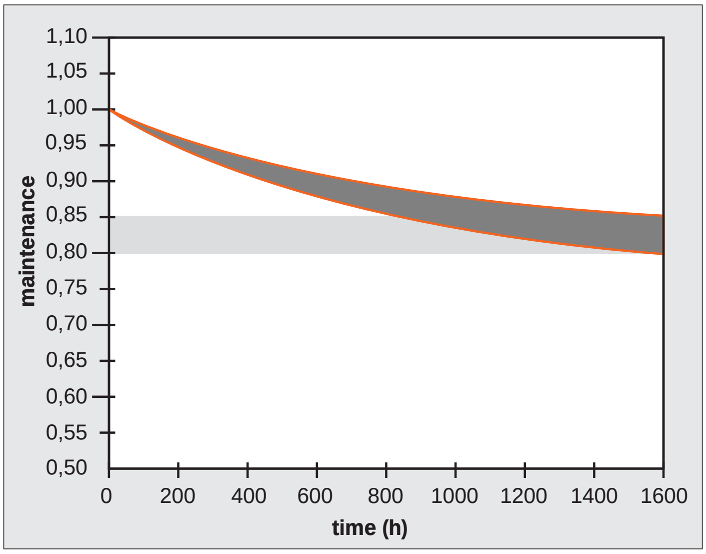
HBO 1000 W/NEL



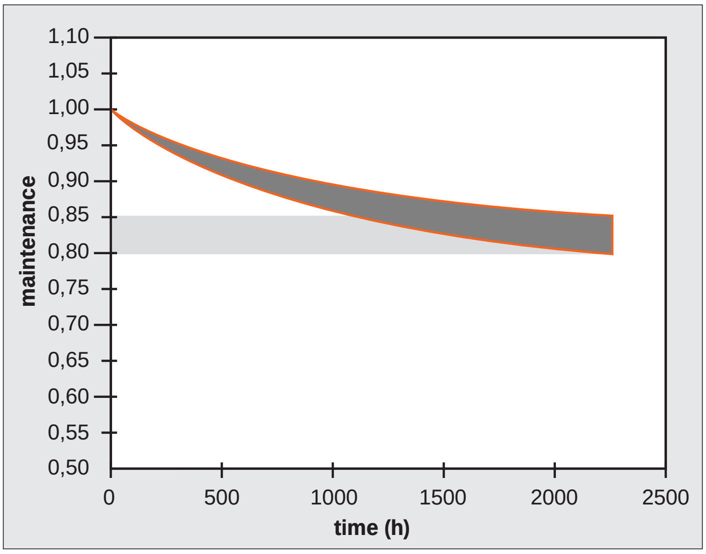
HBO 1002 W/CEL



HBO 1002 W/NIL



HBO 2001 W/NIL



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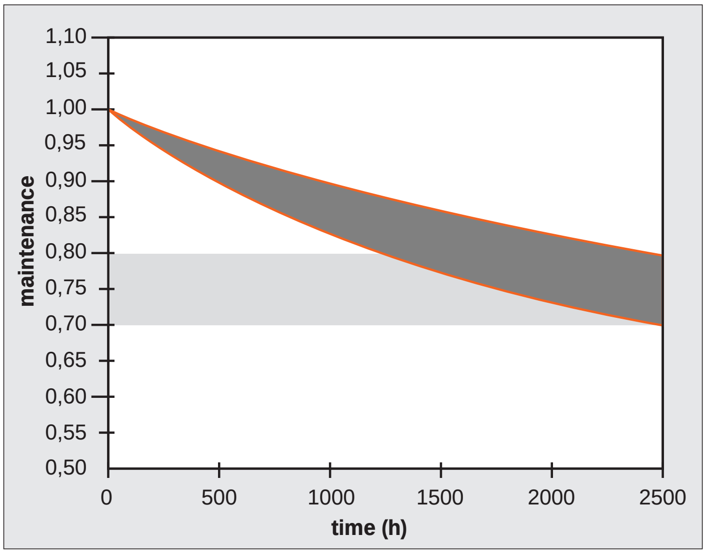

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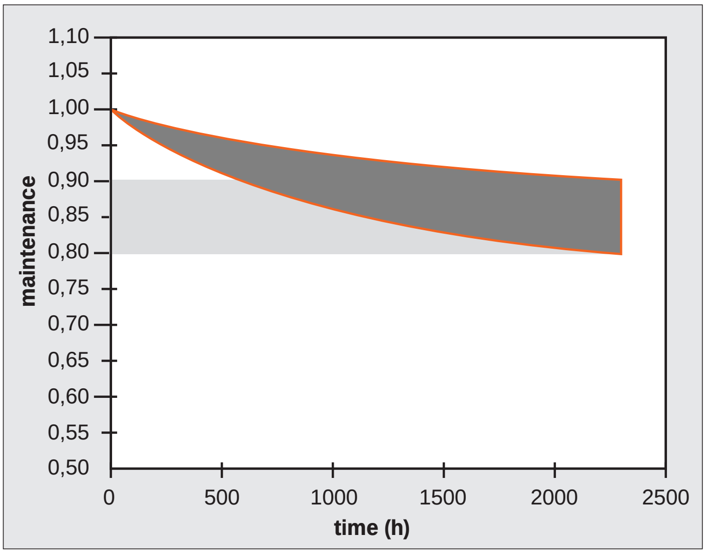
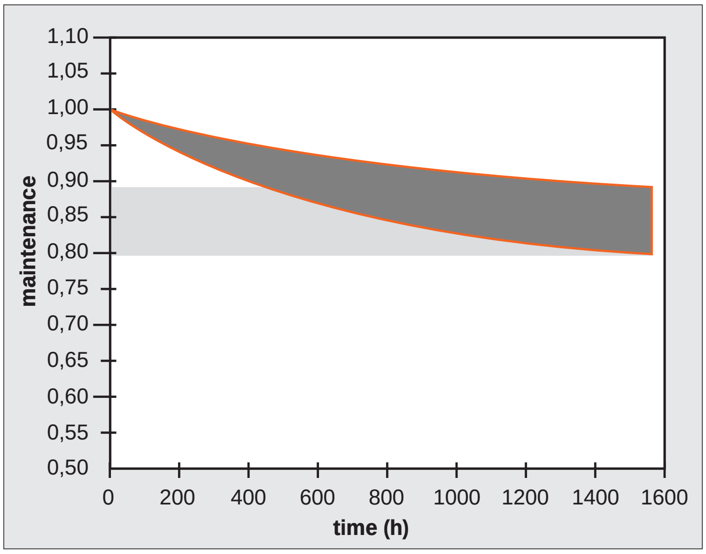
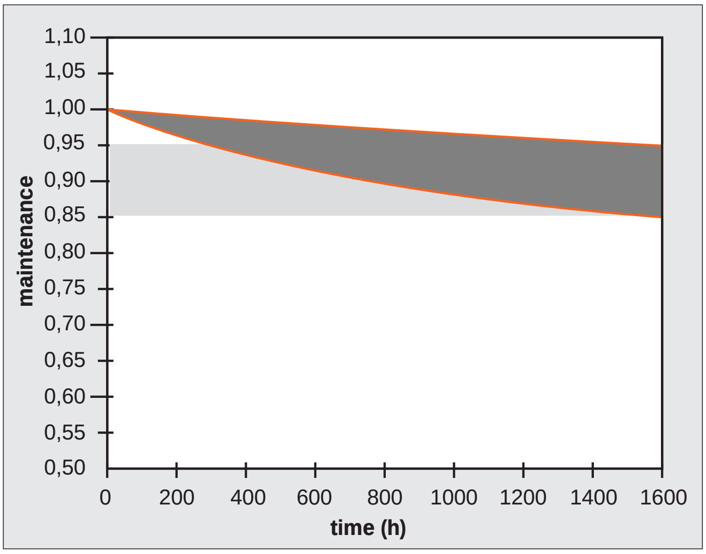


HBO 1500 W/CIEL



HBO 2000 W/NIL



HBO 2001 W/CIL

13. FINAL REMARKS

The market for lamps is changing and developing at a breath-taking speed - this has been experienced in the recent past. Corresponding to this dynamic development, OSRAM HBO® lamps are subjected to a constant further development and improvement. For this reason, this brochure can only reflect an “as-is” status. Thus, all lamp-related data quoted are subject to technical modifications as a matter of principle.

Suggestions from the circle of interested readers are welcome and necessary as future-oriented products can be developed only in a dialog between the lamp and appliance manufacturers and the user. In case of any questions and suggestions, please get in touch directly with OSRAM, FOMK-B Division in Berlin, Germany (see backside of the catalogue).

14. ADDITIONAL LITERATURE

For other technical information with respect to HBO® lamps, purchasing sources for corresponding power supplies, and information on other special discharge lamps from OSRAM, please refer to the following publications, which can be ordered from OSRAM:

– HBO® Mercury Short Arc Lamps: Technology and Application
– List of Suppliers of Control Gear and Starting Devices
– Lighting Program
– Technology and Application - Halogen-Metal Halide Lamps
– Technology and Application - XBO Cinema Lamps
– Technology and Application - Halogen Low Voltage Lamps
– Guidelines for control gear and starting devices for halogen metal halide lamps
– Guidelines for control gear and starting devices for Xenon short arc lamps
– Guidelines for control gear and starting devices for mercury short arc lamps

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