Short Wave

INFRARED

Halogen Heater Lamp

Not Just Lamp
Applied Photonic Energy

TOSHIBA

TOSHIBA Lighting Product(France) S.A.

Table of Contents

Introduction

Dear Clients,

The blessings bestowed by nature are inestimable. Obviously the sun gives plentiful benefits to humankinds and its energy is indispensable for our modern life as well. We, Toshiba Lighting Products (France) S.A., present Infrared Halogen Heater Lamp which fully optimizes the advantage of the solar energy, and is extremely remarkable as the great heating source for our society.

In today's industrial world the process of thermal treatment, such as drying, heating, molding, curing and bonding substances, requires the high-speed throughput to pursue the highest efficiency and productivity, whilst saving its running cost. Instant heat (switch-on & off), clean (odorless), radiant heat (not affected by air draught), high controllability, high-power, long life etc, lots of benefits by TOSHIBA Infrared Halogen Heater Lamp would be delivered to you.

As one of major industrial light source suppliers, taking full advantage of the experience over one century in numerous fields, we are proud to present the hottest line-ups of Infrared Halogen Heater Lamps in this brochure.

TOSHIBA

TOSHIBA Lighting Product(France) S.A.

The technical world of Halogen Heater Lamp

TOSHIBA **INFRARED** Halogen heater lamp is a kind of infrared light source, emitting infrared short wave rays efficiently from a compact tubular body.

Features

1) **Dependable infrared heat source**

Long life and high reliability are achieved thanks to the regenerative halogen cycle inside the quartz tube.

2) **Simple to install**

Like a conventional incandescent lamp, no ballasts nor special circuits are necessary for basic usage.

3) **Quick to start**

Infrared heating process starts within one second after plugging into a power source.

4) **Efficient to heat**

Slim body makes shorter thermal conduction path to the target object, achieving better efficiency.

5) **Easy to build up a heat source array**

By laying plural halogen heaters, it is easy to make a high capacity infrared heat source.

6) **Simple to design an infrared reflector system**

Focused infrared rays can be generated with a simple reflector system.

7) **Easy to control infrared emission rate**

Infrared emission rate can be controlled simply with a transformer.

8) **Clean and odour-free heat source**

No risk of contamination over environment or target objects.

Variations

1) **Rating : lamp Voltage(V), Wattage(W), Coil Length(CL), Over-all lenght(OAL), Fixation length(FL)**

Considering application usage, an optimised lamp design will be proposed for each customer.

2) **Basing structure/wire harness design**

Various types of basing structures as well as wire harness designs are available.

3) **Burning position**

Horizontal position is the basic use. For universal positioning, dimpled tube option is available.

4) **Vibration/shock proof**

Excessive vibration or shock may deform the lamp filament, shortening the lamp life as a result.
Dimpled tube option is recommended to withstand harsh environment.

5) **Super Slim Ruby heater lamp – JHR type**

For an application that demands more reddish light, a heater made with ruby colour quartz tube “JHR type” is the best choice. It has also an anti-dazzling effect.

6) **Coated reflector heater lamp – JHC type**

To produce extremely concentrated thermal field, heaters with ceramics reflective films are available as JHC type.

Handling Caution

1) **Do not touch halogen lamp quartz body with bare hands**

Quartz tube material can be deteriorated by salt to lose mechanical strength. Sweat or finger print contain salt components, have unfavourable influence on quartz tubes.

2) **Do not touch halogen lamp just after cutting off its power supply**

Temperature of a halogen heater surface can exceed 600°C during its operation.

3) **The application design - lamp voltage, thermal environment, reflector system etc... must prevent excessive temperature on lamp surface, which may inflate or bend at over 900°C.**

4) **Design the application so that the temperature of a lamp sealing part not to exceed 300°C.**

Excessive temperature at this part, often caused by a reflector structure or coverings etc, may destroy conductive film in the sealing part.

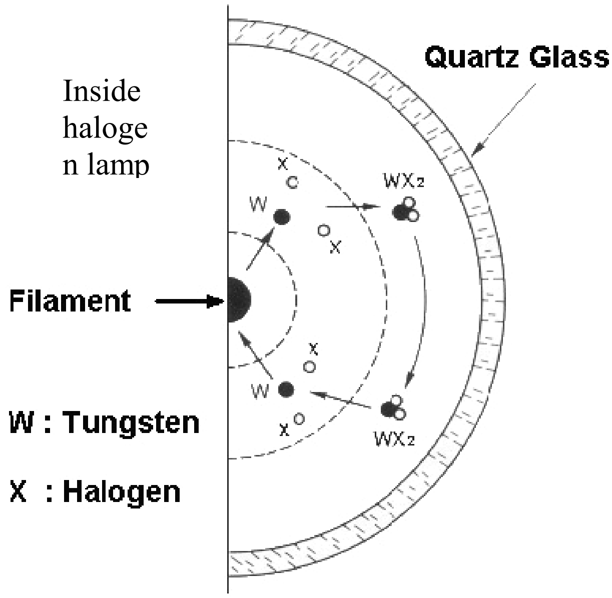
Comparison of

	Short-Wave IR	Medium-Wave IR	Long-Wave IR
Major element	IR halogen heater lamp	IR fused quartz emitter	Metal sheathed elements
Construction	Linear coiled tungsten filament surrounded by quartz tube	Alloy spiral element surrounded by open-ended linear quartz tube	Alloy elements in the form of tubular rods
Power effiency	more than 90%	60%	less than 50%
Switch ON/OFF speed	within 1 second	30 to 60 seconds	5 minutes
Color temperature (Kelvin)	2400 K	1300K	800K
Peak wavelength	1.2 µm	2.2 µm	4.0 µm
Heating	Radiation	Radiation and convection	Convection
Air draughts sensitivity	NO (because of radiation)	Influenced	Highly influenced
Brightness	High(except for Super Slim Ruby lamp)	Medium	Low
Color sensitivity	Important	Medium	Low

1. Introduction

A Halogen lamp is a kind of gas-fillet tungsten filament lamp. Its gas consists of not only inert gas (nitrogen, argon, etc..) which is commonly used in gas-filled lamp technology, but also a small trace of halogen material (such as bromine, iodine, chlorine, fluorine).

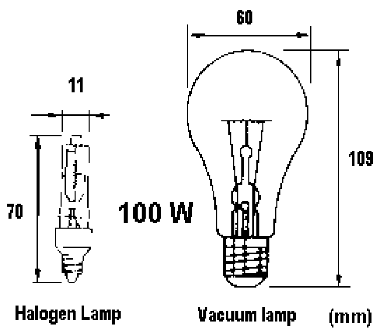
Conventional incandescent lamps lose their light flux gradually during the operation, due to tungsten vapour accumulation on inner bulb surfaces (blackening phenomenon).
Halogen lamps do not have this slow deterioration thanks To a chemical process that is called “halogen cycle”.



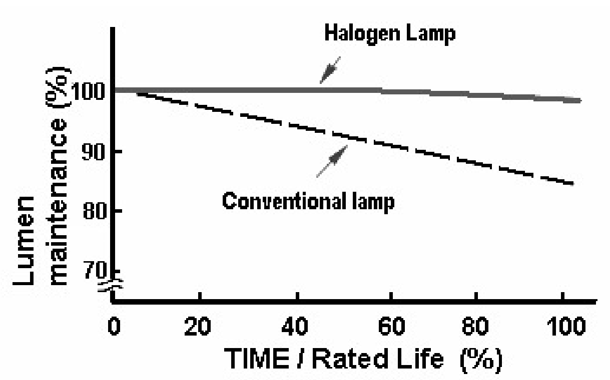
Halogen Cycle

The figure above illustrates chemical reaction inside a halogen lamp. Tungsten atoms W which have evaporated from the filament combine with halogen vapour to form WX2, which traverse towards the quartz glass wall. If the temperature at the quartz glass is above 250 °C, which is over the condensation temperature of WX2, the molecules can not condensate themselves on the wall, therefore circulate back towards the filament. Since the temperature near the filament exceeds 2000°C, WX2 is disintegrated to W and Xs again. The free tungsten atom W can deposit itself onto a cold portion of the filament, but the X remains floated in the gas, repeating the process over and over.

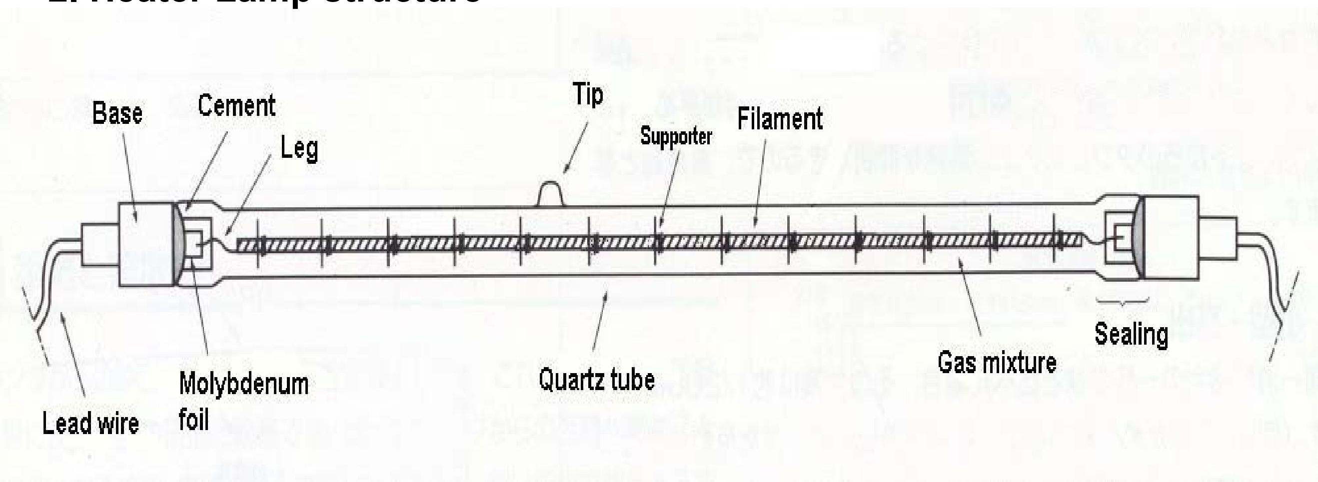
In order to achieve good halogen cycle, halogen lamps have generally much compact bodies (made of quartz to withstand the high temperature) compared with conventional lamps. This results in building up higher gas pressure inside, suppressing tungsten vaporization, thus achieving long life as well as better lumen maintenance performance as shown in the figures below.



Size comparison



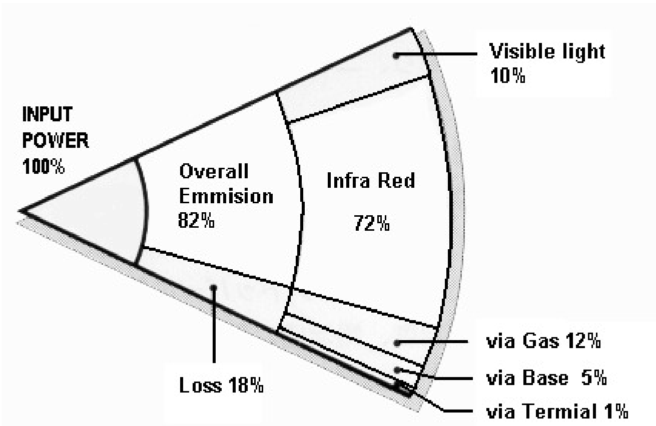
2. Heater Lamp structure



Name	Material	Description
Quartz tube	Quartz glass	To withstand a high temperature to keep halogen cycle, quartz tube is used
Filament	Tungsten	Specially manufactured tungsten wire is used to make solid crystal grain system after being coiled to a filament
Molybdenum foil	Molybdenum	To absorb the thermal expansion stress between lead-in wire and quartz glass at high temperature, specially produced molybdenum foil is used.
Tip	Quartz glass	Remained portion of a exhausting and gas-feeding inlet during lamp manufacturing process
Gas		Inert gas : N_2, Ar.... Halogen : Br_2, Cl_2 .... Gas pressure as well as gas blending are optimised by TOSHIBA for each application.
Base	Ceramic / Metal	Lamps must be held by base portions. Variety of bases are available from TOSHIBA

3. Energy conversion

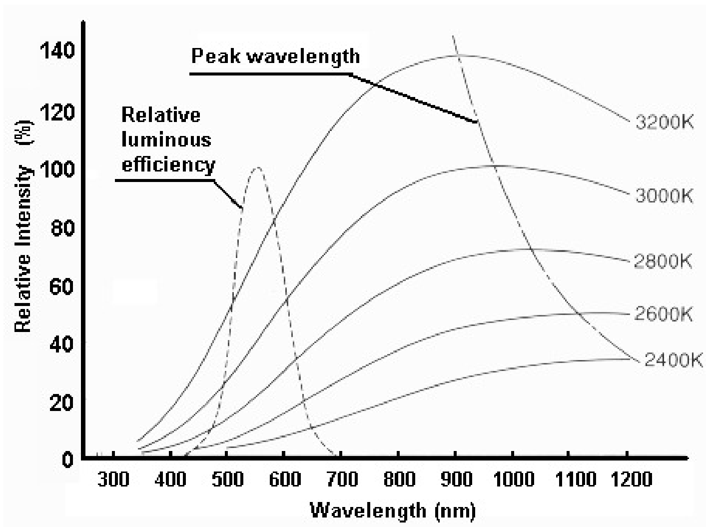
As shown in the figure below, about more than 80% of the input energy is converted to photon emission, including 70% as infra-red radiation.
The rest of the energy is lost in a form of heat, some of which contributes to increases the lamp temperature.



Spectrum of halogen lamps is continuous, easy to be calculated from Planck's law.

Planck's low

$$Me(\lambda, T) = \frac{C_1}{\lambda^5 \{\exp(C_2/\lambda T) - 1\}}$$



This equation tells us :

1) Higher filament temperature will increase the ratio of visible light, which belongs to rather short wavelength band of emission from a halogen lamp.
2) Light produced with a higher temperature filament has more bluish spectrum, which gives an impression of whiter light to human eyes.

The following simple equation explains the relationship between the peak wavelength and the filament temperature.

$$\lambda max\ T = 2898\ [\mu m \cdot K]$$

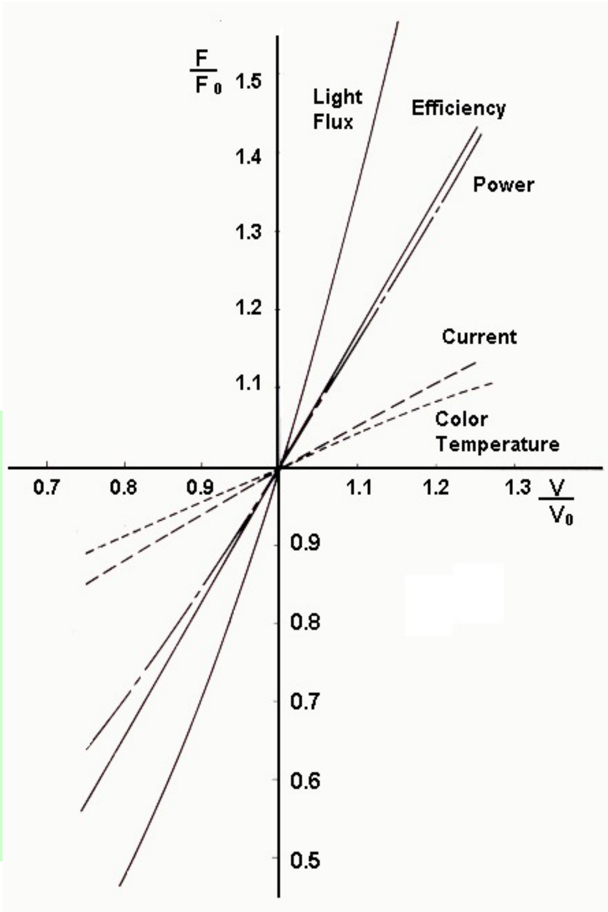
l max : Peak Wavelength (um)
T : Filament temperature (K)

4. Characteristics vs. Lamp Voltage

Some important lamp characteristics can be estimated
With the following equation :

$$\frac{F}{F_0} = \left(\frac{V}{V_0}\right)^k$$

F : Value to be estimated
F_0 : Value at the rate voltage V_0
V : Lamp Voltage
V_0 : Rated Lamp Voltage



Ex) Power consumption of a 500W lamp at 105% input voltage.

$$\frac{\text{Power}}{500} = \left(\frac{105}{100}\right)^{1,54}$$

$$= 1,07$$

Therefore,

Power = 530 W

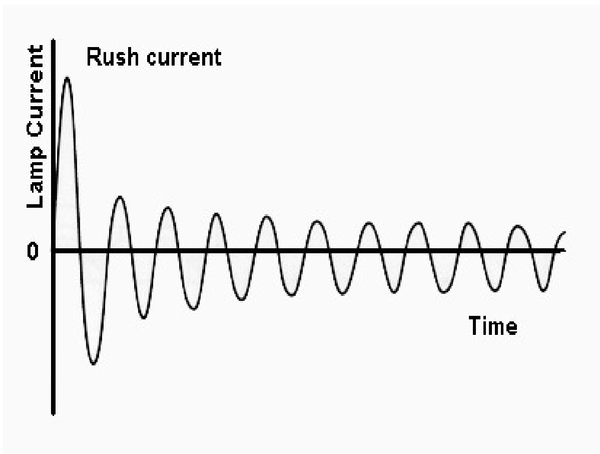
5. Rush current

Resistance of filament changes dramatically by its working temperature. For example, a tungsten filament designed to operate at 2727°C (with a resistance of 90,4 x 10-6) decreases its resistance down to its mere 6% (5,65 x 10-6) at a room temperature.

Theoretically, since the filament design is based on its operating temperature, the cold start rush current becomes 13 to 17 times larger than the rated current. In actual applications, the impedance of power supply networks helps to suppress the current to a certain degree, but still 7 to 10 times larger current will be experienced usually.

Power supply capacity should be taken into consideration before installation to protect from halogen lamp rush current. Especially, halogen lamp heater applications, which have rather long time constant, often require big enough margins to power supply capacity and/or current controller capacity.

In case of power supply capacity is limited, usage of pre-heating, soft start circuit or other protective means should be studied.



6. Lamp life vs. Lamp voltage

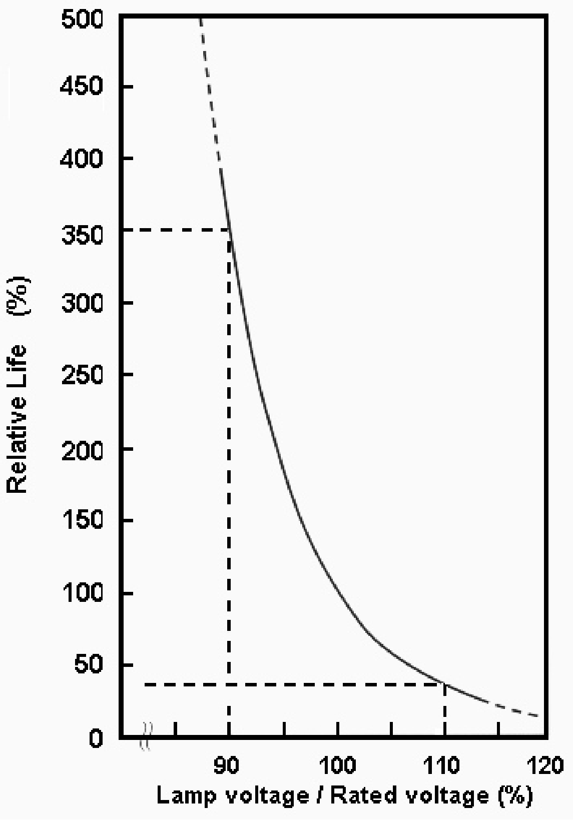
Lamp voltage has a big impact on lamp life.
An approximate equation is known as :

$$\frac{L}{L_0} = \left(\frac{V_0}{V}\right)^{10\sim14}$$

L : Life to be estimated
L_0 : Life as the rated voltage V_0
V : Lamp Voltage
V_0 : Rated Lamp Voltage

This is rather a general rule to understand filament life. Actual lamp life may vary depending on many design parameters.
For example, this equation estimates that additional 10% of lamp voltage will accelerate the filament cut by 70%. Practically, before this filament failure, light flux drop may be experienced because of the blackening effect caused by halogen shortage with more active tungsten vapour production.

Likewise, 10% lamp voltage decrease may not save the lamp life by all 350% because of ironic halogen etching effect on the filament.



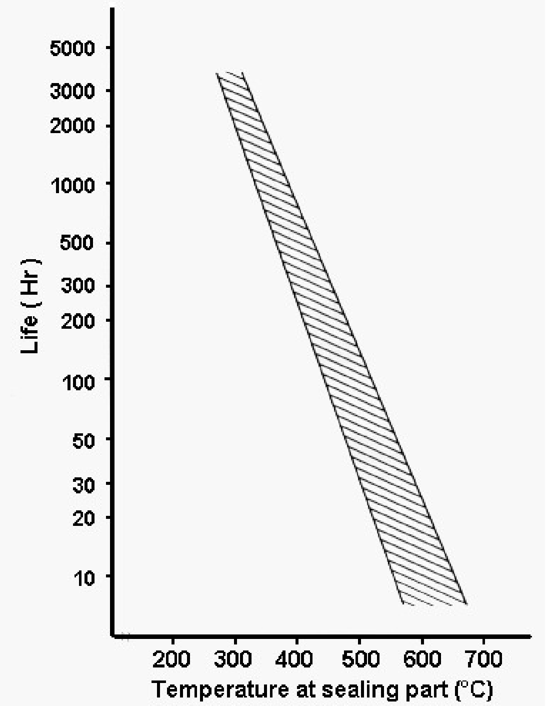
7. Lamp life vs. Sealing part temperature

Temperature at the lamp seal must be kept lower than 350°C, due to the following reasons :

1) High temperature accelerates the oxidation on molybdenum foil to damage its electrical conductivity.
2) Thermal expansion may create a slow-leak path between the foil and the glass.
3) Excessive thermal stress creates unbearable mechanical stress in the glass.

The temperature at sealing part is thus important but not very easy to be controlled. Power consumption, lamp current, distance to the nearest coiling element, glass tube diameter, base holding method and other factors affect this temperature.

Upon customer's request, TOSHIBA offers a sample halogen heater lamp with thermo couples to measure important temperatures (including lamp sealing) in order to feed back to lamp/application design .



8. Halogen cycle behaviour vs. Glass tube temperature.

In order to maintain good halogen cycle, glass tube temperature is one of the most important factors.
There are four temperature ranges regarding the behaviour of halogen cycle. It is necessary to ensure the glass tube temperature falls between 250°C and 600°C by lamp/application design.

Below 250°C

This situation can occur due to
- excessive ventilation around the lamp.

Low temperature at the glass allows halogen molecules stick to t
results in inferior halogen cycle.

Or it can occur due to
- low duty operation, low voltage operation etc.

The inferior halogen cycle might be compensated at some degree because of the less tungsten vapour generation by the filament temperature. However, excessive tungsten atoms will reach the glass wall gradually to make thin blackening layer.

The blackening layer can be washed away by occasional normal operation to achieve 250°C at the glass tube.

600 °C to 800 °C

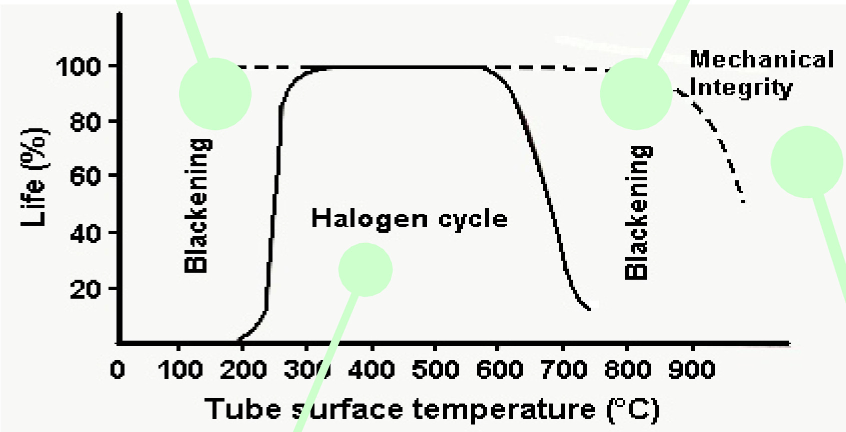
This situation can occur due to
- usage in semi-closed space by reflector,
- insufficient air ventilation around the lamp.

High tube temperature allows tungsten vapour (W) to reach the glass wall without forming WX2.

Or it can occur due to
- over voltage applied to the lamp.

High temperature at the filament produces more tungsten vapour (W). Since halogen material (X) inside the tube is limited, some part of tungsten vapour can reach the glass wall without forming WX2.

Anyway the direct hit by W will cause blackening spot on the glass wall



Good halogen cycle will be maintained.
Temperature at the sealing part should be kept much
prevent premature failure.

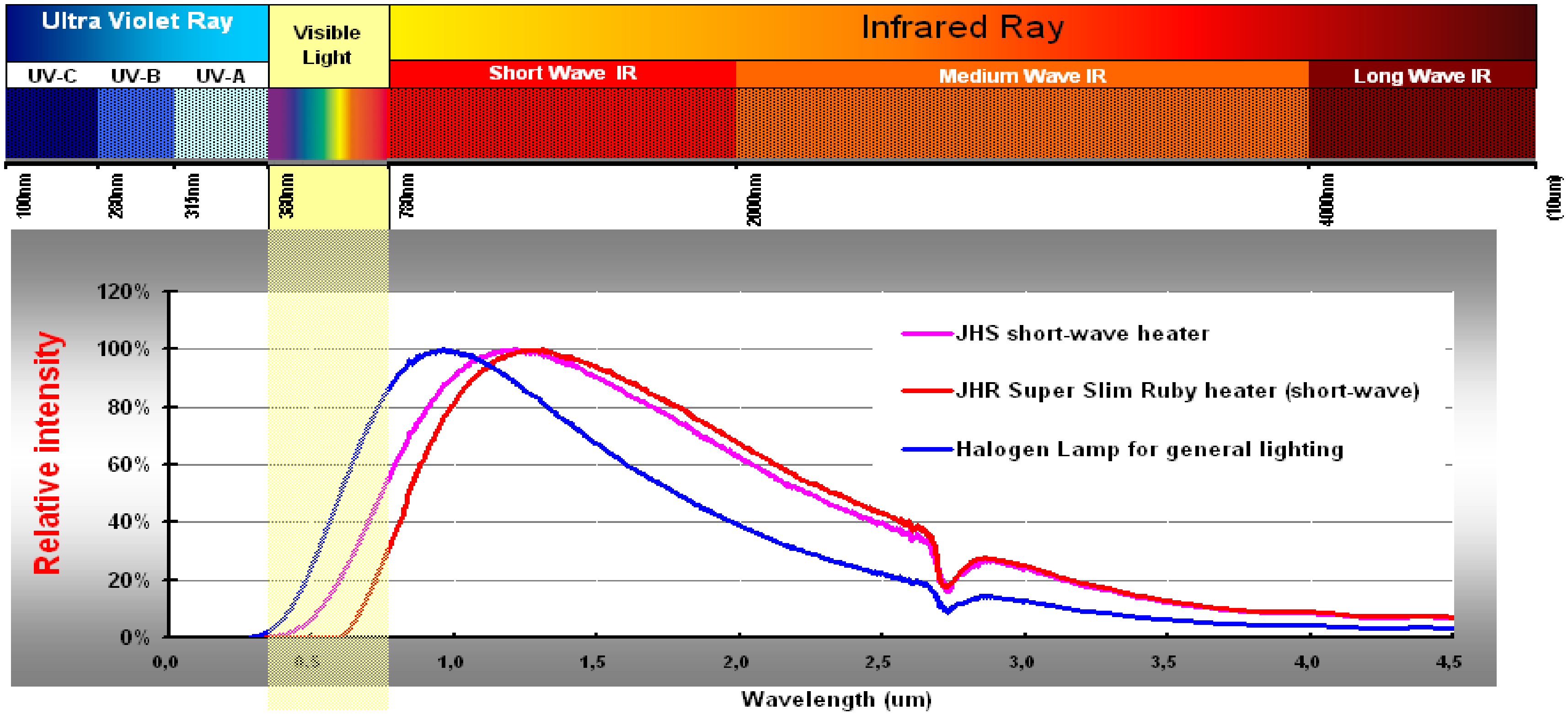
Higher than 800 °C

High temperature can soften the quartz glass to lose its mechanical integrity as a lamp. This results in warped tube or partial inflation on the tube exterior surface

Note)
Chemicals, especially salt content on the tube reacts with glass to formulate white crystallization, which reduces visible light transparency.

Spectrum Distribution - Relative Intensity -

Special note) Remarkably JHR Super Slim Ruby reduces visible glare



*This illustration is just a sample to understand spectrum distribution tendency of various heaters.