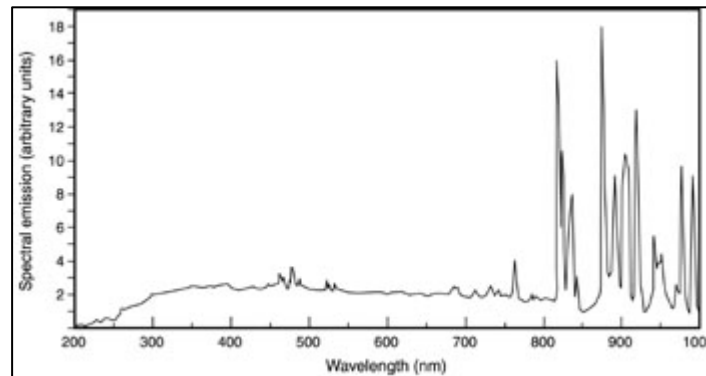


## Optical Characteristics

The light emitted from flashlamps contains both discrete line structure and continuum radiation. The line structure arises from transitions between energy levels of the atoms and ions in the discharge. The continuum radiation is blackbody radiation, characteristic of the temperature of the plasma in the discharge. The exact spectral content is complicated, depending in a complex way on the gas type and pressure, the current, the plasma temperature, and the electron density. In addition, the spectral content of the light can change during the course of the pulse.



**Fig. 1** Spectral emission from xenon flashlamp filled to a pressure of 390 torr at low electrical loading (100-microfarad capacitor charged to 500 V).

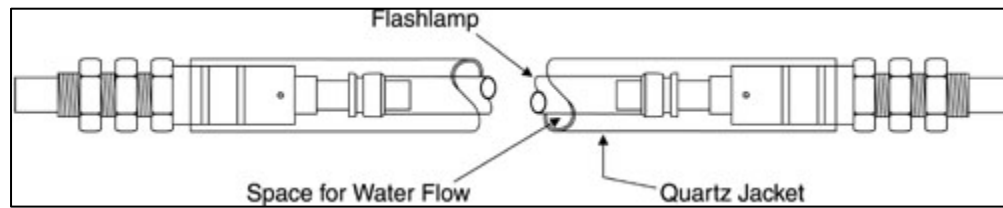
The conversion of the electrical input energy to optical radiant energy can be high, often in the 40-60% range for xenon and in the 25-30% range for krypton. Because of the higher efficiency, xenon gas fills are preferred for many applications.

The output of the flashlamp emerges through the envelope. The spectral absorption of the envelope will affect the spectral content. Most often the envelope is fused silica (silicon dioxide, also called fused quartz).

## Mechanical Characteristics

Important considerations in the structure of flashlamps include the envelope, the electrodes, and the seal of the electrodes to the envelope.

The material used as the envelope for flashlamps for laser-pumping applications is silica fused quartz, also known as vitreous silica or fused quartz.



**Fig. 2** Diagram of liquid-cooled flashlamp showing outer quartz jacket

The electrodes in flashlamps must withstand high temperature and high electrical-current density. Because of the high melting temperature of tungsten, some form of tungsten is used.

There are two commonly used structures for sealing the electrodes into the quartz tubes for flashlamps: tungsten rod seals and end cap seals, also called solder seals.

### **Cooling for Flashlamps**

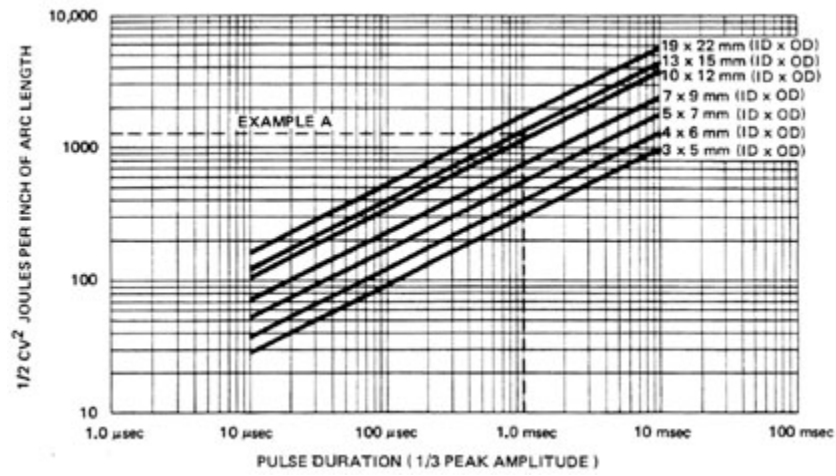
The main goal of lamp cooling is to keep acceptable average temperatures for the lamp electrodes and internal envelope surface. When the temperature in these regions exceeds safe values, lamp lifetime is reduced because of erosion of material. Sputtering of the electrodes and vaporization of the inside surface of the quartz envelope result from exceeding safe temperature values. Other effects of overheating include buildup of stress in the lamp envelope. This may lead to bending or fracturing of the envelope.

### **Failure Mechanisms and Lifetime**

The lifetime of a flashlamp is rated according to the number of "shots" or discharges it will undergo before it is no longer operable, or until its output light level drops below an acceptable level. Lifetime varies with pulse duration, peak loading of the lamp, and rise time of the current pulse. Lamp failure is characterized by either a catastrophic explosion or fracturing of the lamp envelope, or by a gradual lowering of the output (that is, due to absorption of light inside the lamp).

Figure 3 is a graph of explosion energy per inch of arc length versus pulse duration for linear xenon flashlamps. Lines that indicate explosion energies of seven different lamp diameters are shown. The vertical scale is calibrated in joules of explosion energy per inch of arc length. The horizontal scale is in

seconds of pulse duration, with pulse duration defined as the full width of the pulse at one-third the maximum power.



**Fig. 3** Explosion energy per inch of arc length versus pulse duration for several Xe-filled lamp diameters.