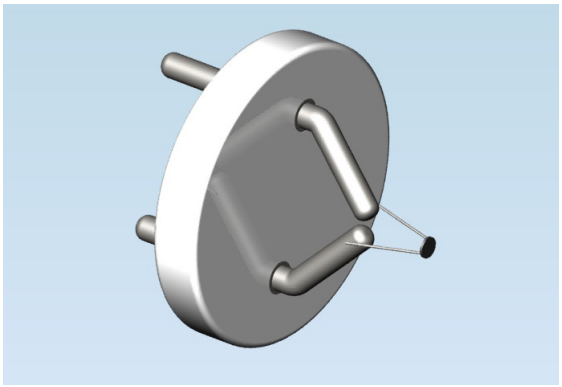
TANTALUM DISC CATHODES
THERMIONIC EMITTERS

FEATURES / OPTIONS

REFRACTORY-METAL PLANAR CATHODE
NOT HARMED BY REPEATED EXPOSURE TO ATMOSPHERE WHEN COLD
EXCEPTIONAL STABILITY
LOW ENERGY SPREAD
ACCURATELY PRE-ALIGNED
INTERNATIONAL STANDARD AEI BASE
NON-STANDARD MOUNTING AVAILABLE

ES-042, ES-044 and ES-046 Tantalum Disc Cathodes

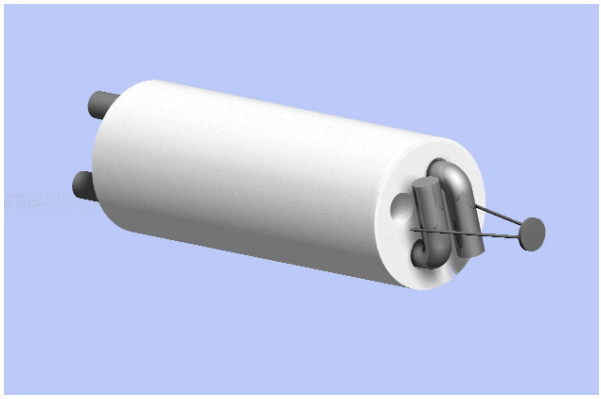


Tantalum Disc Cathode
mounted on a standard AEI ceramic base

The Kimball Physics Tantalum Disc Cathode is a general purpose thermionic emitter. This refractory metal cathode is quite sturdy and provides stable and uniform electron emission for a wide variety of electron source applications. The cathode structure of the ES-042, ES-044, and ES-046 consists of a tantalum disc that is heated by conduction from a tungsten 3% rhenium hairpin and mounted on an industry-standard ceramic AEI base or on a compact Kimball Physics ceramic base. Other bases are available on a custom basis. When ordering a spare cathode or firing unit for use in a Kimball Physics electron gun, simply specify the gun model and options (for example, EMG-12, high current) as this will determine the particular cathode configuration.

The tantalum disc is welded to the tungsten hairpin at a single point, which results in a unipotential and planar emission surface. Since no heating current passes through the tantalum disc, the energy spread is kept to a minimum (<0.7 eV). Tantalum has a very low vapor pressure at high temperatures, a high melting point (3188 K) and a work function of 4.1 eV.

The cathode is not harmed by repeated exposure to atmosphere when cold; however, at temperatures above 700 K, oxidation of both the tantalum and tungsten takes place in the presence of water vapor, air or oxygen with a resulting decrease in cathode lifetime. At temperatures above 1200 K, tantalum nitrides form in the presence of nitrogen; these compounds degrade the emitting characteristics of the tantalum disc.



Tantalum Disc Cathode
mounted on a CB-104 ceramic base (4X)

Some power is lost from the tantalum disc due to radiation. Therefore, in order to obtain the desired disc temperature, the tungsten hairpin heater must reach an even higher temperature (see temperature graphs). The temperature of the tantalum disc determines its electron current density; this relationship can be described by the Richardson-Dushman equation (see emission graphs).

Actual emission currents will vary depending on the applied DC voltage and the geometry of the gun structure. The higher tungsten hairpin leg temperatures make the decrease in leg diameter due to evaporation the determining factor in cathode lifetime, assuming lifetime is not foreshortened due to other factors such as contamination, poor vacuum or damage. As the tungsten legs evaporate, the resistance of the tungsten wire increases; thus small changes in a cathode's V-I characteristic over its lifetime can be expected. The longest possible lifetime is achieved by running the cathode at the lowest possible temperature.

There are several factors to consider in choosing a cathode size. A larger disc has a larger emission area, and thus more total current for a given current density. The current density of course is a monotonically increasing function of temperature. However, a larger disc loses more power to radiation, and thus more heating power is required. A smaller disc tends to have a more uniform temperature distribution, which results in a more uniform emission. Larger discs with larger legs tend to have a longer lifetime.

Kimball Physics has determined several combinations of cathode dimensions that have proved to work well in the Kimball Physics electron guns. The model ES-042 consists of a 0.033 inch (0.84 mm) diameter tantalum disc, attached to a 0.003 inch (0.08 mm) diameter tungsten 3% rhenium heater wire. The higher current models, ES-044 and ES-046 have larger discs and thicker heater wires (see specifications table). Custom cathodes are available with different refractory metals, optional emitter styles (disc, hairpin, or ribbon), various disc sizes, and various filament lengths and diameters.

All models of the tantalum disc cathode structure are available mounted on an industry-standard ceramic AEI base, or on a Kimball Physics ceramic base (CB-104 or CB-105), as well as on custom or nonstandard bases. Base options include two or four pins, pins made of molybdenum or Kovar, various pin lengths and positions, as well as different mounting heights of the cathode surface from the ceramic base. The edge of an AEI base can be ground to a specified custom diameter. Some combinations of various options may not be possible due to design considerations. All cathodes are shipped vacuum clean and ready to install.

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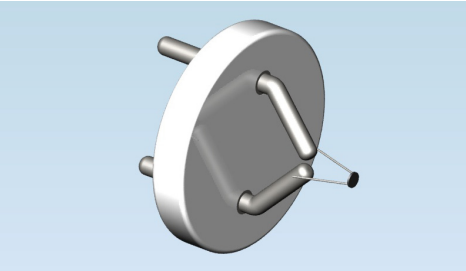
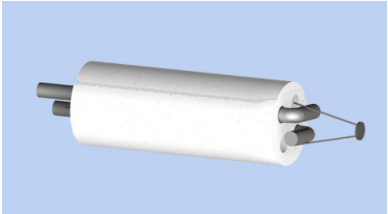
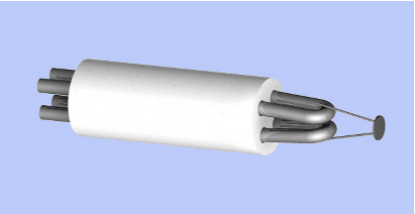
TANTALUM DISC CATHODES



ES-042 Ta disc on AEI ceramic base

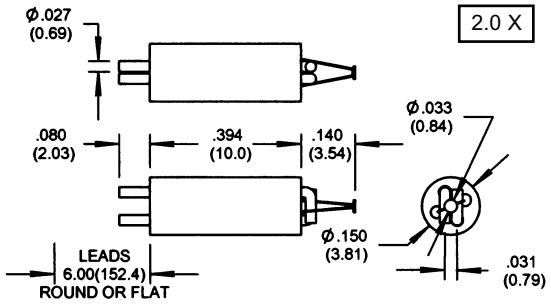


ES-042 Ta disc on CB-104 base

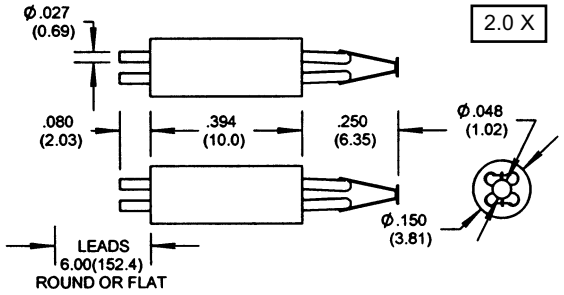


ES-044 Ta disc on CB-105 base

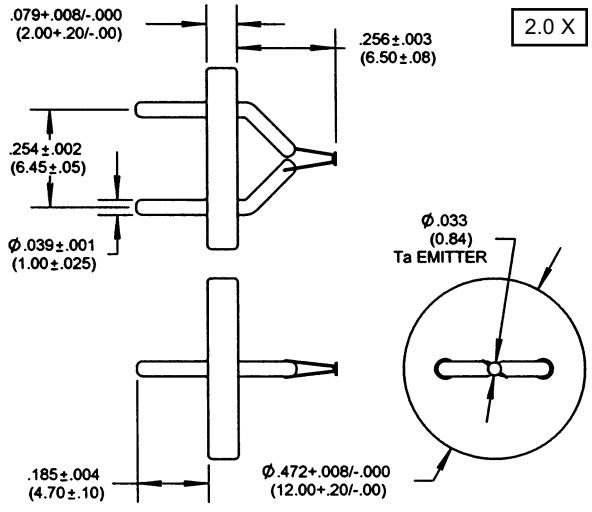
	ES-042	ES-044	ES-046
CATHODE MATERIAL	Tantalum		
DISC SIZE	0.033 in dia. x .004 in thick (0.84 mm dia. x 0.1 mm thick)	0.048 in dia. x .004 in thick (1.22 mm dia.x 0.1 mm thick)	0.062 in dia. x .004 in thick (1.57 mm dia. x 0.1 mm thick)
HEATER WIRE SIZE	0.003 in dia. (0.08 mm dia.)	0.004 in dia. (0.1 mm dia.)	0.007 in dia. (0.18 mm dia.)
LEG LENGTH	approx. 0.11 in (2.8 mm)	approx. 0.12 in (2.8 mm)	approx. 0.15 in (3.8 mm)
HEIGHT ABOVE CERAMIC BASE	on CB-104 base: 0.14 in (3.5 mm) on AEI base: 0.256 in (6.5 mm)	on CB-105 base: 0.25 in (6.4 mm) on AEI base: 0.256 in (6.5 mm)	on CB-105 base: 0.27 in (6.9 mm) on AEI base: 0.256 in (6.5 mm)
EMISSION AREA	5.52×10^{-3} cm^2	11.7×10^{-3} cm^2	19.5×10^{-3} cm^2
EMISSION CURRENT	1 mA typical	3 mA typical	5 mA typical
HEATING CURRENT	1.4 A to 1.8 A	2.4 A to 2.8 A	5.7 A to 6.6 A
POWER SUPPLY CAPABILITY	Voltage regulated power supply recommended, 2 V, 2 A	Voltage regulated power supply recommended, 2 V, 3 A	Voltage regulated power supply recommended, 2 V, 7 A
CATHODE LOADING	0.25 A/cm^2 recommended, typical; High loadings result in reduced lifetime		
WORK FUNCTION	4.1 eV		
OPERATING TEMP	2200 K typical		
ENERGY SPREAD	approx. 0.6 eV		
LIFETIME	Hundreds of hours with medium currents		
VACUUM LEVEL	10^{-5} torr or better, recommended		



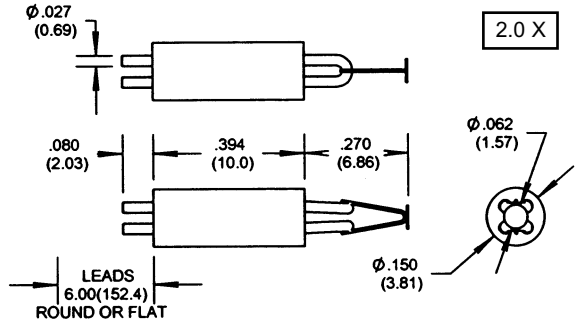
ES-042 Tantalum Disc Cathode mounted on a CB-104 ceramic base



ES-044 Tantalum Disc Cathode mounted on a high current CB-105 ceramic base



ES-042 Tantalum Disc Cathode mounted on an AEI ceramic base
ES-044 and ES-046 also available on AEI bases



ES-046 Tantalum Disc Cathode mounted on a high current CB-105 ceramic base

ALL DIMENSIONS ARE IN INCHES
(MILLIMETERS IN PARENTHESES)