

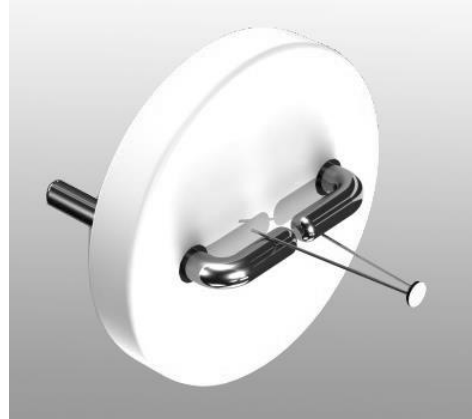
Yttria-Coated Iridium Disc Cathodes ES-535, ES-535W, ES-526 and ES-529

FOR USE IN:

- Kimball Physics Electron Sources/
Guns
- Custom Applications

FEATURES / OPTIONS:

- Yttrium Oxide (Y_2O_3) Coating
- Operation in Poor Vacuum Conditions
- Non-Radioactive
- Iridium Planar Disc Cathode
- Resists Oxidation
- Withstands Exposure to Atmosphere
When Cold
- Exceptional Stability
- Low Energy Spread
- Accurately Pre-Aligned
- International Standard AEI Base
- Non-Standard Mounting Available



*ES-535 Yttria-coated Iridium Disc Cathode
mounted on a standard AEI ceramic base.*

Kimball Physics offers a Yttria-coated Iridium Disc Cathode. In addition to being a ruggedized thermionic emitter that resists oxidation, these cathodes provide stable and uniform electron emission for a wide variety of electron source applications, especially where vacuum conditions are not ideal.

The cathode structure of the ES-535, ES-526, and ES-529 consists of a yttrium oxide coated iridium disc that is heated by conduction from an iridium hairpin and mounted on an AEI or a Kimball Physics base.

The ES-535W consists of a yttrium oxide coated iridium disc with tungsten hairpin in place of the iridium hairpin. Other bases are available on a custom basis. When ordering a spare cathode or firing unit for use in a Kimball Physics electron source / gun, simply specify the gun model and options (for example, high current, yttria) as this will determine the particular cathode configuration.

The yttria-coated disc cathode is the optimal choice for some applications. Yttrium has a lower work function than uncoated refractory

metals, so more electrons are emitted at a given temperature, or a given electron emission can be achieved at a lower temperature.

As the cathode is heated, the yttrium oxide (Y_2O_3) also known as yttria that is near the surface of the coating breaks down, and the positive yttrium ion migrates to the surface, while the more negative oxygen remains behind; this acts as a dipole accelerating electrons near the surface, which further decreases the work function. Yttria has the additional advantage of being non-radioactive.

Iridium, a noble metal, is more resistant to oxidation and other forms of chemical attack than the refractory metals. Thus, the cathode will not easily burn out if accidentally exposed to atmosphere while running, and it can be used at operating temperature in poorer vacuum conditions. The yttria-coated iridium cathode can be operated in a vacuum of 10^{-4} torr; 10^{-5} torr is recommended for the ES-535W with tungsten hairpin heater. The cathodes also are not damaged by repeated exposure to atmospheric gases or water vapor when cold. The yttria-coated cathode does not require any special

care other than protection from mechanical shock which could physically remove the coating.

The performance of all coated cathodes will degrade as coating is depleted through use, lost due to mechanical shock, or sputtered away by ion bombardment. The lifetime of a yttria-coated iridium cathode is based on the evaporation rate or degradation of the coating materials and heater wire, which are dependent on the temperature at which the cathode is run and the vacuum. The work function of the cathode also affects its lifetime; contamination of the cathode surface can increase the work function, increasing the filament current needed to produce the same beam current.

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 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

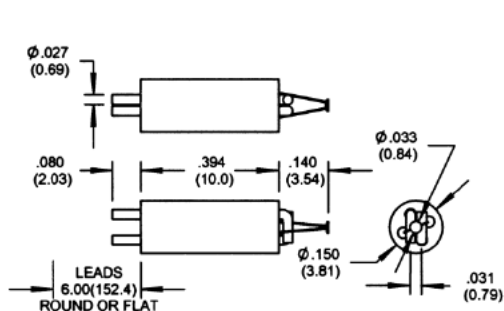
a more uniform emission. Larger discs with larger legs tend to have a longer lifetime.

Kimball Physics has determined several combinations of cathode dimensions that have proved to work well in Kimball Physics electron guns. Refer to the Specifications Table to review the various disc and heater wire options that are standard. Custom Y_2O_3 cathodes are available with different disc sizes and various heater designs.

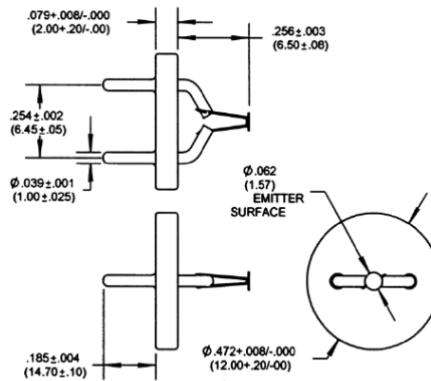
Most models of the yttria-coated cathode structure are available mounted on an industry-standard ceramic AEI base or on a Kimball Physics ceramic base (CB-104 or CB-105), as well as on custom or nonstandard bases. Base options include two or four pins, pins made of molybdenum or Kovar, various pin lengths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



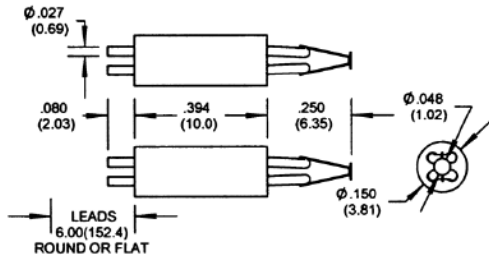
	ES-535	ES-535W	ES-526	ES-529
CATHODE DISC MATERIAL	Yttrium oxide coated Iridium	Yttrium oxide coated Iridium	Yttrium oxide coated Iridium	Yttrium oxide coated Iridium
DISC SIZE	0.033 in dia. x .004 in thick (0.84 mm dia. x 0.1 mm thick)	0.033 in dia. x .004 in thick (0.84 mm dia. x 0.1 mm thick)	0.048 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	0.004 in dia. (0.1 mm dia.) Ir	0.003 in dia. (0.08 mm dia.) W	0.005 in dia. (0.13 mm dia.) Ir	0.006 in dia. (0.15 mm dia.) Ir
LEG LENGTH	approx. 0.20 in (5.1 mm)	approx. 0.11 in (2.8 mm)	approx. 0.12 in (3.0 mm)	approx. 0.15 in (3.8 mm)
HEIGHT ABOVE CERAMIC BASE	on AEI base: 0.256 in (6.5 mm)	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	$5.5 \times 10^{-3} \text{ cm}^2$	$5.5 \times 10^{-3} \text{ cm}^2$	$1.17 \times 10^{-2} \text{ cm}^2$	$1.95 \times 10^{-2} \text{ cm}^2$
EMISSION CURRENT	1-2 mA typical	1-2 mA typical	3-5 mA typical	8-10 mA typical
HEATING CURRENT	1.6A to 1.8A	1.3A to 1.5A	3.8 A to 4.2 A	5.3A to 5.8 A
POWER SUPPLY CAPABILITY	Voltage regulated power supply recommended, 2 V, 2 A	Voltage regulated power supply recommended, 2 V, 2 A	Voltage regulated power supply recommended, 2 V, 5 A	Voltage regulated power supply recommended, 2 V, 6 A
CATHODE BASES	AEI	AEI, CB-104	AEI, CB-105	AEI, CB-105
CATHODE LOADING	0.5A/cm ² recommended, typical; High loadings result in reduced lifetime			
WORK FUNCTION	Approximately 2.6 eV			
OPERATING TEMP	1800 K typical			
ENERGY SPREAD	Approx. 0.6 eV			
LIFETIME	Hundreds of hours with medium current and proper handling			
VACUUM LEVEL	10 ⁻⁴ torr or better, recommended	10 ⁻⁵ torr or better, recommended	10 ⁻⁴ torr or better, recommended	10 ⁻⁴ torr or better, recommended



ES-535W Yttria-coated Ir Disc with W legs mounted on a CB-104 ceramic base

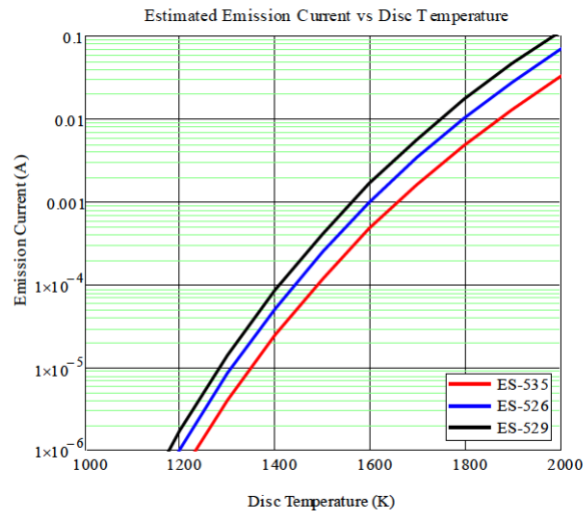


ES-529 Yttria-coated Ir Disc Cathode mounted on an AEI base. ES-535, ES-535W and ES-526 are also available on AEI bases.



ES-526 Yttria-coated Ir Disc mounted on a high current CB-105 ceramic base

-ALL DIMENSIONS ARE IN INCHES. (MILLIMETERS IN PARENTHESES)
- MAGNIFICATIONS ARE APPROXIMATE (TO PROVIDE SIZE ESTIMATE)



References

For more information on Cathode Operations, you may download additional detailed technical bulletins (not listed below) from the website Resources Page.

Cathodes- Emitters (Overview)

Yttria Coated Iridium Cathodes / Emitters- Description and Specifications (Overview)

Yttria Coated Cathode (ES-526) Y₂O₃ Disc Cathode: User Information

Yttria Coated Cathode (ES-529) Y₂O₃ Disc Cathode: User Information

Yttria Coated Cathode (ES-535) Y₂O₃ Disc Cathode: User Information

Yttria Coated Cathode (ES-535W) Y₂O₃ Disc Cathode: User Information

Notes:

1. Charts /graphs show typical performance, data is for guidance only
2. It is not necessarily possible to achieve all maximum specifications simultaneously.
3. Specifications Subject to Change Without Notice.
4. DE Altobelli, DT Taylor 10/2/2023

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