3M Science. Applied to Life.™

3M Advanced Materials Division

How a connected world stays connected.

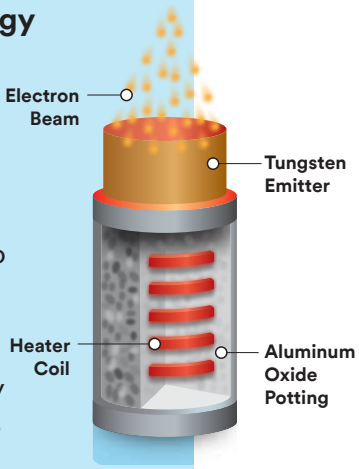
3M™ Cathodes and Electron Guns for reliable long-range communications

Staying in touch. In the air and on the ground.

In today's connected world, distance is no barrier to the flow of information. A small but critical piece of technology from 3M helps us stay connected, from your satellite TV service to civilian and military radar systems … and even spacecraft exploring the farthest reaches of our solar system.

Cathode Technology

The cathode acts as an electron source, emitting a beam through a process known as thermoionic emission. When a radio wave passes near this beam, the energy it absorbs from the beam serves to amplify the power of the wave, enabling an increased range of communication.



Applications

- High-frequency radio communications
- Military and civilian avionics
- Weather and communications satellites
- Spacecraft for low earth orbit and deep space exploration programs
- X-ray and cancer treatment medical devices
- Molecular microscopy and spectroscopy research
- Printing and copying
- Entertainment

3M™ Cathodes and Electron Guns

Critical components of vacuum tube amplifiers, 3M™ Cathodes and Electron Guns provide the high power needed to beam radio signals across vast distances around the world – from sky to tower, and from outer space back to earth.

3M cathodes and electron guns are precisely engineered and rigorously tested for high performance in communication systems for spacecraft, civilian and military aircraft, satellites, and other applications requiring a high degree of reliability, range and longevity.

Because they can operate at high power levels and frequency with minimal loss of efficiency or material integrity, 3M cathodes are well suited for use in mission-critical applications where powerful, sensitive instruments need to operate at high frequencies for extended periods of time. We offer cathode structures capable of withstanding the high shock and vibration of satellite launch, and our space qualified cathodes are engineered for extraordinary reliability in the hostile environment of outer space.

Precision through process

3M cathodes and electron guns are manufactured by 3M Technical Ceramics (formerly Semicon Associates) at our facility in Lexington, Kentucky. We have over 60 years of industry experience, and we are the only independent supplier of dispenser cathodes qualified for use in outer space.

Our highly controlled manufacturing processes are designed to ensure consistent performance and to meet the exacting standards of a wide array of military and civilian applications. We are involved at each stage of the cathode manufacturing process, from basic raw materials through the manufacturing of critical components to final assembly.

RADAR: The key to 3M's quality production

3M™ Remote Access Data Acquisition and Recovery System (RADAR)

The manufacture of quality components for Vacuum Electron Devices (VEDs) used in the communications, space and defense industries requires precisely controlled and traceable process steps. Based on 60 years of industry experience, we offer customers a proven software solution that can help automate and simplify their data collection, training and documentation requirements through 3M™ Remote Access Data Acquisition and Recovery System (RADAR).

The 3M remote access data acquisition and recovery system is a suite of software communications tools. Its purpose is to establish best practices for controlling the manufacture of cathodes and cathode assemblies, and to provide customers with all required backward and forward material and process traceability. The system acts as a "bridge," allowing the exchange of data between multiple software platforms.

RADAR provides nearly instantaneous access to any combination of data, including:

- Employee Training and Task Qualification Records
- ISO Procedures and Revision Control System
- Engineering Drawings and Methods Sheets
- Materials Data Collection and Serialization
- Equipment Process Control and Monitoring System
- SCADA Notification System
- Plant Wide Environmental Controls System

Raw data can also be made available for manipulation in the Infinity QS SPC platform or can be delivered directly to the customer for analysis. This remote access system is fully integrated and provides the user with the power of information 24/7.

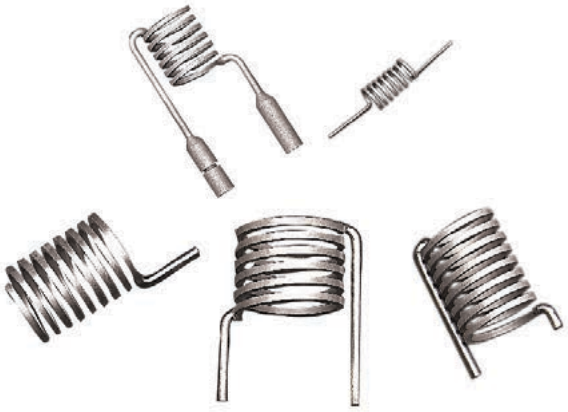
Our capabilities and services

- High Temperature Brazing (hydrogen, DA gas, vacuum furnaces)
- Refractory metals precision machining
- Precision fabrication and assembly
  - Laser cutting and welding
  - Resistance welding
  - Heliarc welding
- Engineering and Analytical Services
  - Mechanical and electrical design
  - FEA
  - SEM/EDX
  - In-process evaluation
  - Failure analysis
  - Thermal management
  - Access to corporate labs
  - Partnership with universities
  - Publications

Dispenser cathodes

Applications

- Traveling wave tubes (TWT)
- Cathode ray tubes (CRT)
- Gyrotrons
- Klystrons
- Magnetrons
- Accelerators
- Ion lasers



3M™ Ion Laser Cathodes

These filaments for ion lasers are available in a variety of custom configuration and processing options. Applications include the printing and entertainment industries and in molecular microscopy research.

- Machined tolerance: ±0.001 in. (±0.0254 mm) or better as required
- Surface finish: 32 microinches or better
- Typical discharge current: 5–50 amps
- Customizable aluminate impregnant mole ratios
- Various surface treatments for uniform thermal emissivity
- Customized lead size and configuration for easy installation

3M™ Tungsten Dispenser Cathodes

These cathodes typically consist of a porous tungsten matrix impregnated with a barium-based emission enhancing material. Depending on the application, this matrix may also be a mixed metal, such as tungsten iridium or tungsten molybdenum. 3M tungsten dispenser cathodes are used in inert and reducing atmospheres and in all types of vacuum devices, most commonly TWTs, klystrons, magnetrons, gyrotrons and plasma devices.

- Machined tolerance: ±0.0002 in. (±0.005 mm)
- Size range: 0.010–8.00 in.
- Life expectancy: 3,000–150,000 hours
- Operating temperature: 910–1200°C
- Emission density: up to 20 A/cm^2 continuous; up to 120 A/cm^2 pulsed
- Various impregnant types, sputter coatings, materials and brazes

Specialty cathodes

Hollow cathodes are used in the ion thruster systems in space vehicles

3M™ Controlled Porosity Reservoir Cathodes

Used in a number of specialized vacuum tube applications, 3M controlled porosity reservoir cathodes provide a virtually unlimited and uniform supply of barium to the cathode surface. They consist of fine tungsten wires sintered in a compact structure with hexagonal patterns of pores. The resulting porous tungsten structure is brazed to a molybdenum cup that forms a cavity. This technology enables the production of smaller and dome-shaped cathodes, and is relatively insensitive to spacing between the cathode and focus electrode.

- 2 to 4 times the life expectancy of conventional cathodes
- Uniform emission throughout the life of the cathode
- High current densities simplify gun design with less beam compression
- Little or no edge emission
- Reduces barium deposition on adjacent critical surfaces

3M™ Hollow Cathodes

These cathodes consist of a porous tungsten matrix impregnated with a barium-based emission enhancing material. Built using the same quality systems that are used for space-qualified microwave cathodes, 3M hollow cathodes are used in mission-critical space applications including ion sources, electric propulsion, plasma contactors, spacecraft neutralization and high intensity discharge lamps.

- Diameter: 0.050–4 in. (1.2–100 mm)
- Length: up to 6 in. (150 mm)
- Discharge current: 2–50 amps
- May include a high-reliability potted heater assembly and additional support structures

Specialty cathodes (cont.)

Features

- High reliability
- Fast warm-up
- High current density
- Controlled porosity

Did you know?

3M™ Space Qualified Dispenser Cathodes can boost a radio signal up to one million times! That's enough power for a spacecraft to send data and images from the edge of the solar system all the way back to Earth.

3M™ Space Qualified Dispenser Cathodes

3M is the only independent supplier of space qualified dispenser cathodes. Homogenously processed to meet rigid civilian and military specifications, they offer extraordinary reliability for demanding applications such as high power/high bandwidth TWTs, ion neutralizers and ion electric propulsion systems.

3M space qualified dispenser cathodes are certified with a full documentation package that includes:

- Full material and process traceability (forwards and backwards)
- Certified dimensional data
- Certified chemical and physical analysis of all involved materials
- 100% double inspection
- Destructive metallurgical analysis of potting and brazing samples

Electron guns

Building an electron gun is a highly technical and time-consuming process; we offer our expertise and our manufacturing services to help free up your technical resources. With over sixty years of experience in this field, we have the technical expertise and precision manufacturing capacity required to support the accelerated development of custom-designed electron guns, built to your most exacting requirements.

Components

- Cathodes
- Mounting structures
- Ceramic high voltage standoffs
- Focus electrodes
- Grids
- Complete assemblies

3M cathodes and electron guns can be used in molecular analysis equipment such as spectrometers.

3M™ Electron Guns

We manufacture a wide range of custom electron gun components, partial and complete assemblies for a variety of communications, aviation and defense applications. 3M electron guns are machined and assembled with precision for high mechanical and vacuum integrity. Our pre-tested, measured assemblies and easy, next-step installation can help speed production and minimize device failures.

- Precision machining and assembly
- Controlled induction and furnace brazing
- Resistance and laser welding
- High vacuum leak checking
- Customized gun designs, geometries, sizes, structural materials and braze materials

Product is manufactured and sold by 3M Technical Ceramics Inc.

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