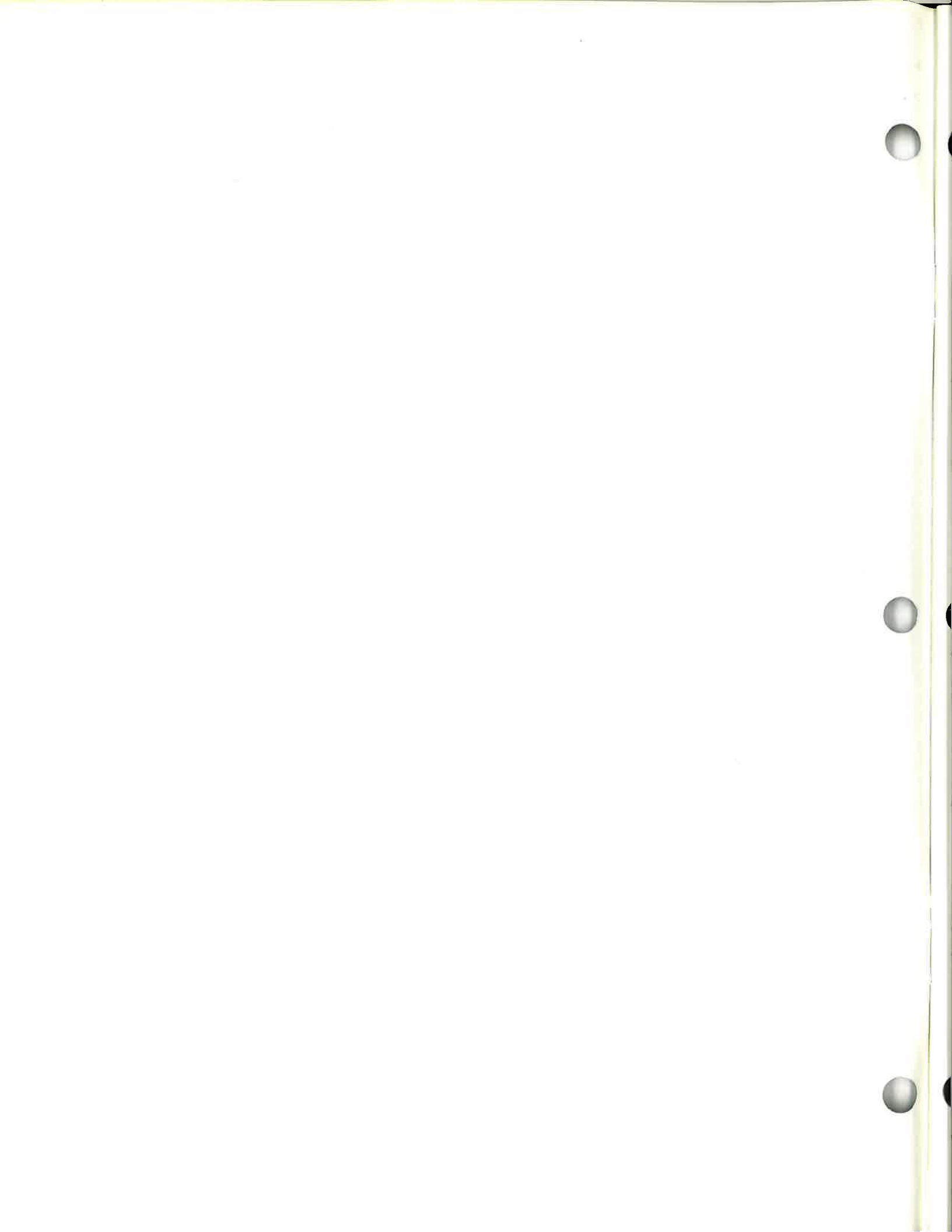


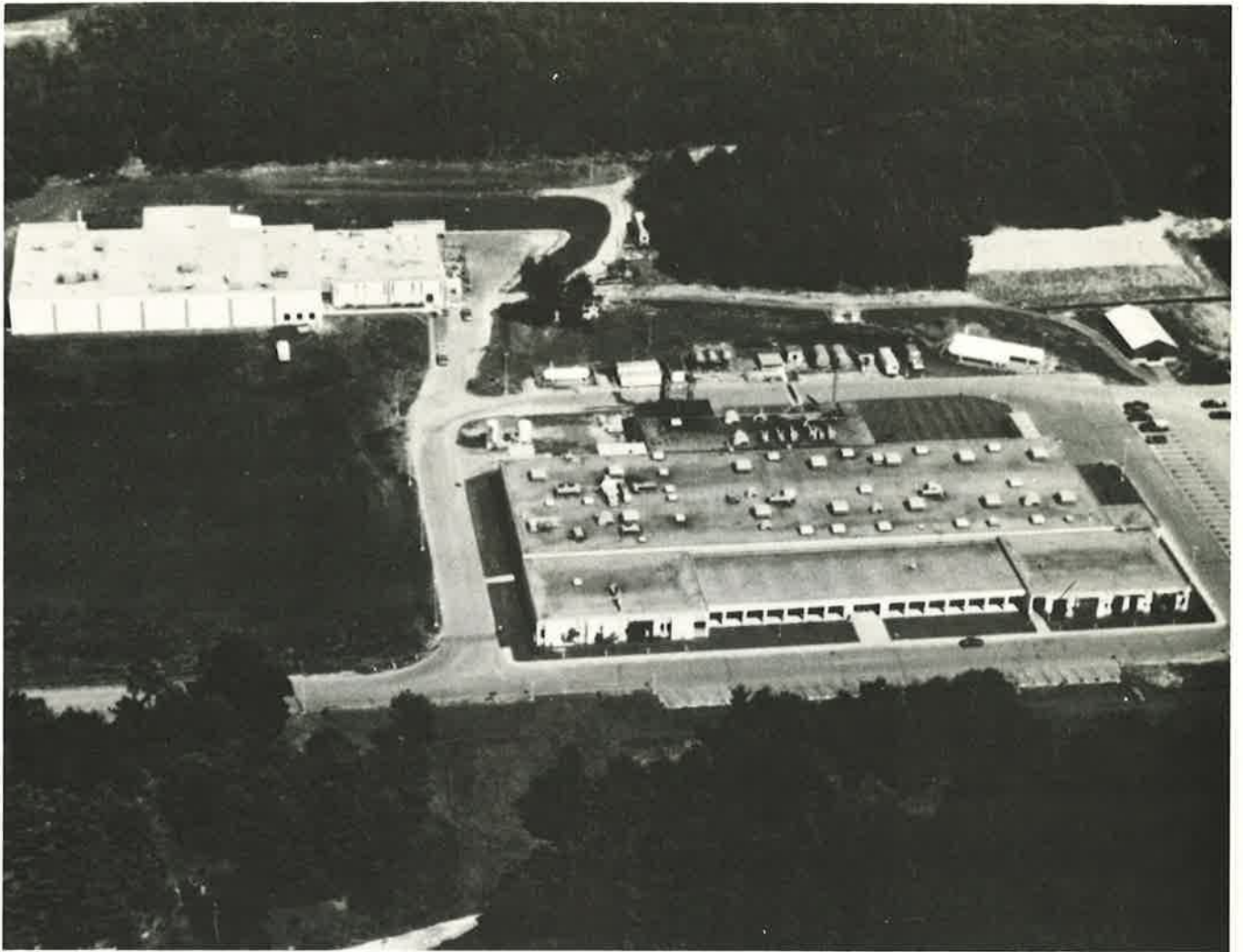
**Catalog
of
Materials
&
Sources**

SYLVANIA

**Emissive
Products**







Sylvania Emissive Products is headquartered at this 120,000 square foot facility in Exeter, New Hampshire. Other production locations bring our combined size to over 220,000 square feet. Field sales engineers are conveniently located in the U.S. and overseas.

Catalog of Materials & Sources

GTE Products Corporation
Portsmouth Avenue
Exeter NH 03833
800 258 8290
(In New Hampshire call 603 772 4331)

SYLVANIA

Emissive
Products

GTE



Table of Contents

Introduction	2
Metallizing Coils	3
Functional	3
Decorative	6
Refractory Metal Boats	7
Intermetallic Boats	9
Electron Beam Filaments	11
Silicon Monoxide (SiO)	12
Aluminum Clips	12
Chrome Rods	13
Bulk Chrome	14
Chrome Hearth Slugs	14
Sputtering Targets	15-16
Quartz Crucibles	17
CS Crucibles	18
Composite Hearth Liners	19
Pyrolytic Boron Nitride Materials (PBN)	20
Boron Nitride Release Agent	20
General Information and Technical Data	21-24

Sylvania Emissive Products General Terms & Conditions of Sale

- Prices and specifications are subject to change without notice
- All shipments are F.O.B. Exeter, NH 03833
- Terms are available on approved credit
- Minimum order requirements:
 - \$25 on any item
 - \$100 on an order
- International Orders: Contact sales office for information

Materials and Sources for Thin Film Vacuum Deposition

Introduction

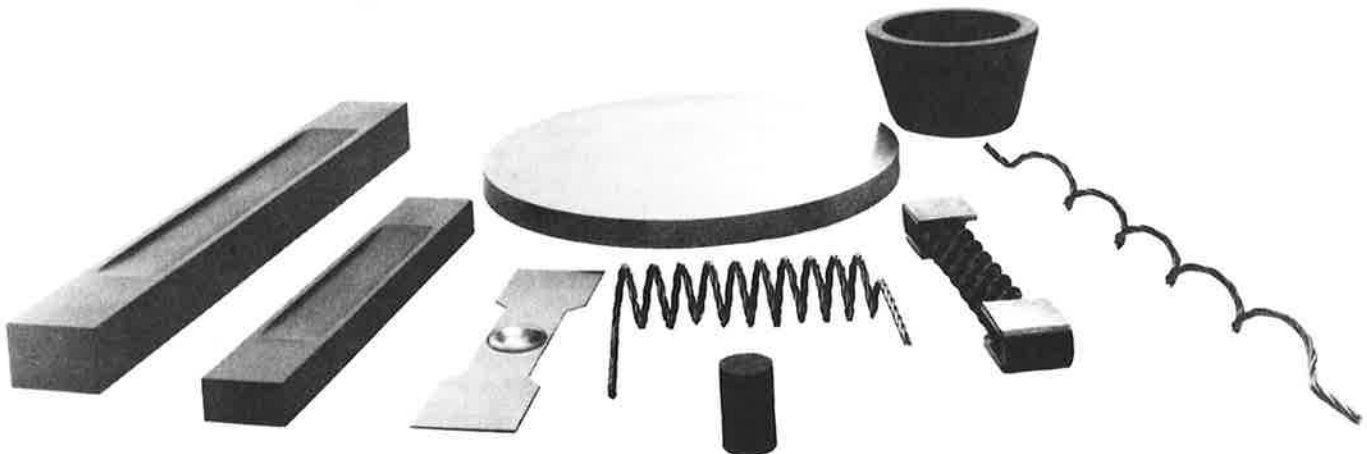
Sylvania's role in vacuum-deposition technology is an outgrowth of the extensive research and development activities that support its position as a major manufacturer of lamps. Sylvania has been working in the field of high temperature metallurgy since 1901, and has pioneered in the development of the tungsten filament for incandescent lamps. Since 1930, when it first employed its capabilities in the development of evaporation sources for thin-film coatings, Sylvania has maintained a continuing research program in the evolution of new materials and processes for vacuum deposition.

Sylvania has been at the forefront of development activity in the new applications of functional vacuum deposition, especially in the fields of electronics, electro-optics and decorative films. For the manufacturers of components and devices in those fields, Sylvania has made available an ever-increasing number of exotic vacuum-deposition materials, at purity levels that were heretofore unattainable. It has also made significant contributions to vacuum-deposition technology, not only in the thermal-evaporation processes, but also in the electron-beam and sputtering techniques. Sylvania thus maintains its leadership in the rapidly evolving field of vacuum deposition by supplying a vital flow of new and improved sources, materials, and processes required for the most advanced applications. In electronics, for example, Sylvania materials and sources have been key factors in the development of CMOS, MSI, LSI, and LED devices.

Sylvania's technological leadership is strengthened by its close affiliation with the industry's best equipped and most advanced analytical laboratory – the world renowned GTE Sylvania Analytical Services Facility, which contains virtually every type of analytical instruments obtainable for determining chemical composition, purity, structure, and properties of materials. The Facility is operated by a distinguished scientific and engineering staff that has not only a strong theoretical background in the physical sciences, but also the extensive practical experience required to select and design the types of experimental analysis best suited to each problem.

Many exclusive and/or proprietary processes are employed in the manufacture of Sylvania vacuum deposition products. These include methods of producing:

- evaporant chemicals of ultimate purity;
- non-contaminating evaporation sources;
- alkali-free tungsten and tantalum sources;
- vacuum hot-pressed sources of great density and homogeneity.



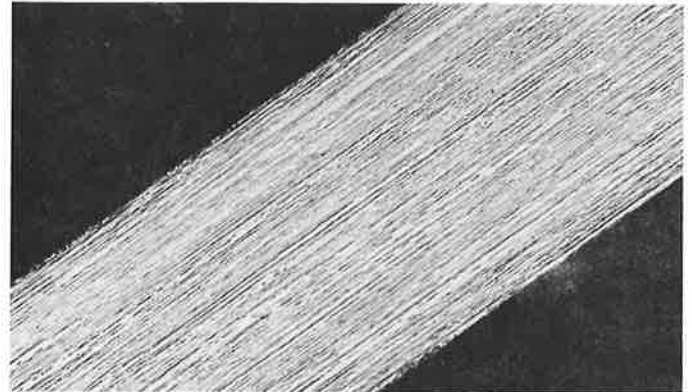
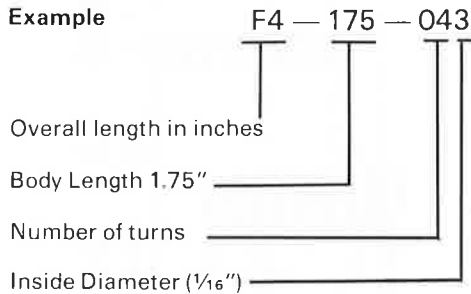
Coils

Sylvania stranded-tungsten-wire coils and baskets provide stable, long-life resistance-heated sources for consistent, dependable, smooth evaporation of aluminum and other metals, in batch vacuum-deposition processes. All of these coils and baskets are made of stranded tungsten wire, the individual strands of which have been recrystallized after drawing to increase the homogeneity, density, and grain size. The process minimizes the number of grain boundaries available for corrosive attack by active evaporants such as aluminum, and thus extends the source life. These coils and baskets are available not only in a large number of standard configurations and sizes, but in any special construction, configuration, and size required by your equipment and process. They may be ordered with pre-treatments such as chemical cleaning or thermal cleaning in a reducing atmosphere for outgassing. They are also available pre-loaded with evaporant.

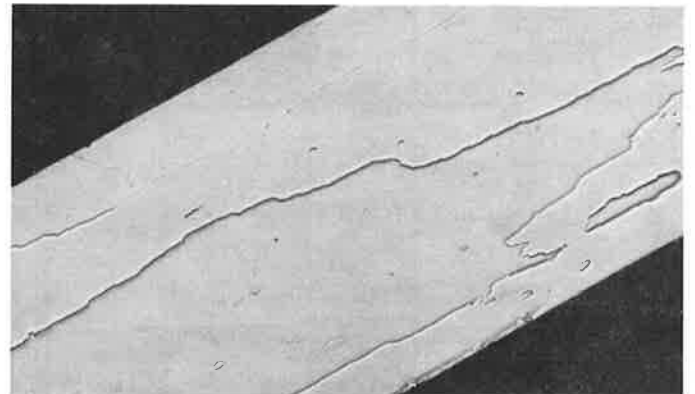
All GTE Sylvania Catalog Tungsten and Tantalum coils and boats are available in the Low Alkali form. We use selected Group I Tungsten and metallurgical grade Tantalum combined with special tools and cleaning processes to fabricate these sources. Contact us for price information.

Ordering Information

Use the example to determine the coil size by ordering abbreviation






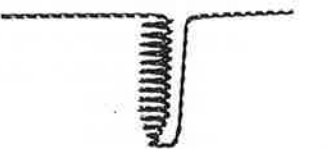
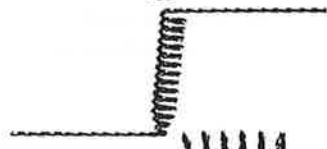

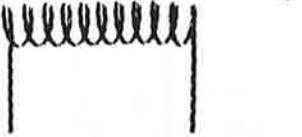
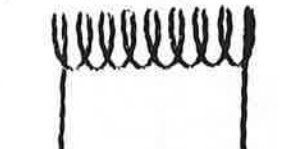






Before: Typical fibrous structure of untreated tungsten strand. Note the large number of grain boundary layers which are subject to corrosive attack.



After: A typical Sylvania tungsten strand after the recrystallization process. Note the dramatic reduction in grain boundary layers. Result: increased coil life and improved operating efficiency.

Ordering Abbreviation	Configuration	Overall Length in inches	Body Length in inches	Number of Turns	Inside Diameter in 1/16 inch	Leg Length	Coil Height	Number of Strands & Wire Sizes
F4-175-043		4	1.75	4	3	—	—	3 x .025 3 x .030
F4-175-063		4	1.75	6	3	—	—	3 x .030 4 x .030
F4-175-064		4	1.75	6	4	—	—	3 x .025 3 x .030 4 x .030
F5-200-054		5	2	5	4	—	—	3 x .025

Ordering Abbreviation	Configuration	Overall Length in inches	Body Length in inches	Number of Turns	Inside Diameter in 1/16 inch	Leg Length	Coil Height	Number of Strands & Wire Sizes
F5-200-065		5	2	5	4	—	—	3 x .025 4 x .030 3 x .040
F5-200-083		5	2	6	5	—	—	3 x .025 3 x .030
F5-200-086		5	2	8	3	—	—	3 x .030 4 x .030 2 x .040 3 x .040
F5-200-104		5	2	8	6	—	—	3 x .025 3 x .030
F5-200-105		5	2	10	5	—	—	4 x .030
F5-200-145		5	2	14	5	—	—	3 x .030 4 x .030
F5-200-146		5	2	14	6	—	—	3 x .030 4 x .030
F6-200-086		6	2	8	6	—	—	3 x .030
F6-500-053		6	5	5	3	—	—	3 x .025 3 x .030 4 x .030
BC-1001		3.5	—	5	4	—	.75	3 x .030
BC-1003		3.5	—	5	3	—	.625	3 x .025
BC-1004		3.5	—	5	12	—	.5	3 x .025 3 x .030 1 x .040
BC-1005		3.5	—	5	8	—	.5	3 x .025 3 x .030
BC-1006		3.5	—	9	8	—	1	3 x .025 3 x .030 4 x .030

Ordering Abbreviation	Configuration	Overall Length in inches	Body Length in inches	Number of Turns	Inside Diameter in 1/16 inch	Leg Length	Coil Height	Number of Strands & Wire Sizes
BC-1007		3	—	5	5	—	.375	3 x .025 3 x .030
BC-1008		4	—	8	4	—	1	3 x .025 3 x .030
BC-1010		3.5	—	5	8	—	.375	3 x .030 1 x .040
CRB-2001		3	—	14	4	—	1.25	1 x .060
CRB-2003		3	—	14	3	—	1.25	1 x .060
FIL-3001		1	1	5	4	1	—	3 x .025 3 x .030
FIL-3002		2	2	10	6	1	—	3 x .030
FIL-3003		2	2	8	8	1	—	3 x .030
HT4-001		4.5	—	5	16	—	.750	3 x .020
HT5-875		5	—	—	14	—	.250	1 x .040 1 x .030
MS-101		1.875	1	6	3	—	—	3 x .025
MS-102		1.875	1	4	3	—	—	3 x .025
MS-111		1.875	—	6	8	—	.500	3 x .025
MS-114		1.875	—	1	—	—	.375	1 x .030

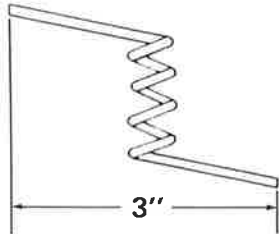
Decorative Metallizing Coils

Coil mountings for decorative applications normally fall into two categories: horizontal and vertical. The installation of the coil itself will generally determine the position of the body, with leg configurations adding to the final solution. Leg forms are normally referred to as U-Leg, Z-Leg, and Straight Leg. Sylvania stocks all standard wire sizes and configurations of the above types and will custom make any form desired.

Inquiries into other types of evaporation sources are welcome. Along with Sylvania's acknowledged leadership in vacuum metallizing is the desire to help you with your problems.

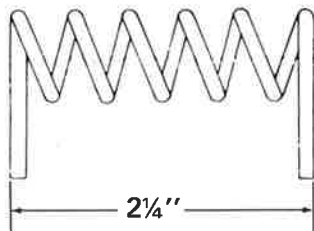
Vertical-Z-Leg (5.0 turns)

Part Number	Code Number
A1563C	8671
A1563CAL	8673
A1563D	8675
A1563DAL	8676
A1563DAWL	8843
A1563DO	8677
A1596C	8845
A1596CAL	8846
A1596D	8848
A1596DAL	8833
A1596DAWL	8849
A1596DO	8850



Vertical-U-Leg (4.5 turns)

Part Number	Code Number
A1524C	8649
A1524CAWL	8650
A1524CAL	8651
A1524CO	8652
A1524D	8653
A1524DAL	8654
A1524DO	8655
A1524DAWL	8656



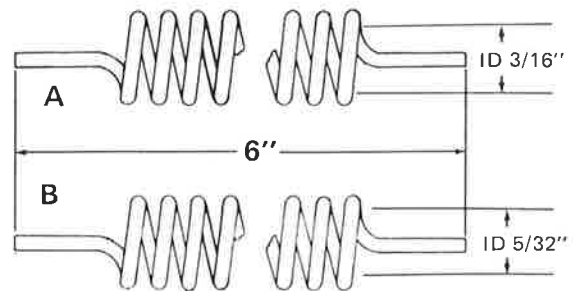
Tungsten Strand Wire

Each coil type is available in the following strand wire sizes. Example: Type A1141DAL would be made of 3 x .030" strand with an .025" aluminum core.

Suffix	Designations
None	Single Strand
B	4 x .015 Tungsten strand
C	3 x .025 Tungsten strand
CAL	3 x .025 with .025 aluminum core even lay strand
CAWL	3 x .025 with .025 aluminum core wide lay strand
CO	3 x .025 with .025 aluminum core treated out
D	3 x .030 Tungsten strand
DAL	3 x .030 with .025 aluminum core even lay strand
DAWL	3 x .030 with .025 aluminum core wide lay strand
DO	3 x .030 with .025 aluminum core treated out
E	3 x .040 Tungsten strand
H	4 x .020 Tungsten strand
K	4 x .030 Tungsten strand
AX	Single Strand alumina coated

Horizontal-Straight Leg (5 turns)

Part Number	Code Number
A1141	8760
A1141B	8774
A1141CAL	8526
A1141CO	8772
A1141D	8768
A1141DAL	8891
A1141DO	8770
A1141E	8769
A1520CAL	8754
A1520CAWL	8753
A1520D	8999
A1520DAL	8756
A1520DAWL	8757
A1520DO	8759

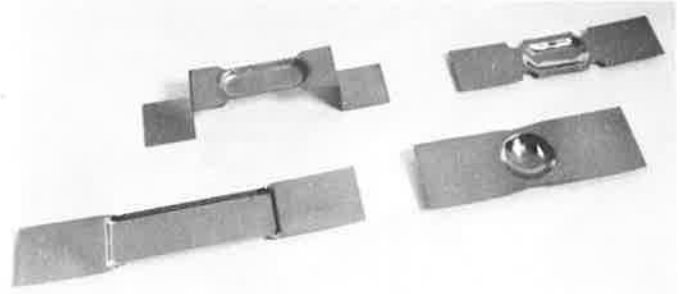


Metallic Boats















Evaporation boats are formed from extremely pure sheet tungsten, tantalum, and molybdenum. They are also available in low-alkali tungsten and in alumina-coated molybdenum, which is especially suitable for evaporating gold or nickel. The large number of standard sizes and shapes include open and closed boats, both flat and bent or folded, and many special configurations. Other sizes and configurations are readily available to suit special requirements. Metallic boats may be ordered with either chemical or thermal cleaning. Chemical cleaning is normally employed since it provides maximum durability; thermal cleaning is desirable when out-gassing must be reduced to the minimum.

All GTE Sylvania Catalog Tungsten and Tantalum coils and boats are available in the Low Alkali form. We use selected

Group I Tungsten and metallurgical grade Tantalum combined with special tools and cleaning processes to fabricate these sources. Contact us for price information.



Part Number	Configuration	Overall Length in Inches	Width or Vertical Fold	Cavity Length or Diameter	Cavity Depth	Material Thickness in Inches
SY-2780 Solid		3.5	.75	1.125	.125	.010W
SY-2781 with Holes		3.5	.75	1.125	.125	.005W .010W
SY-2790 Solid		3.5	.75	.500	.125	.010W
SY-2800 Solid		4.25	.875	2.250	.100	.010W .010Mo
SY-2810 Solid		3	.75	.500	.125	.005W .010W
SY-2820 Solid		4	.5	.500	.125	.010W
SY-2821 with Notches		4	.5	.500	.125	.005W .010W
SY-2830 Solid		3.5	.75	1.250	.125	.010W
SY-2840 Solid		3.5	.75	1.250	.125	.005W .010W
SY-2860 with Notches		4	1	.750	.250	.015Ta .010Mo

Part Number	Configuration	Overall Length in Inches	Width or Vertical Fold	Cavity Length or Diameter	Cavity Depth	Material Thickness in Inches
SY-2870		4	.5	2.50	.500	.010W .015W
SY-2920		3.25	.5	1.00	.100	.005W .010W .010Ta
SY-2950		3.5	.5	1.00	.125	.005W .010W
SY-2970		4	.75	2.00	.125	.005W .010W .005Mo
SY-2980		4	.75	.625	.125	.005W .010W
SY-3090		4	.25	2.00	.250	.010W
SY-3190		3.75	.75	1.50	.125	.010W
MS-005		1.875	.5	.50	.100	.005W
MS-006		1.875	.75	1.00	.125	.005W
MS-007		1.875	.25	.188	.063	.005W .005Mo
SY-2840-A0		3.5	.75	1.250	.125	.010Mo with Al ₂ O ₃ coating
SY-2920-A0		3.25	.5	1.00	.100	.010Mo with Al ₂ O ₃ coating
SY-2950-A0		3.5	.5	1.00	.125	.010Mo with Al ₂ O ₃ coating
MS-008-A0		1.875	.5	1.00	.125	.010Mo with Al ₂ O ₃ coating

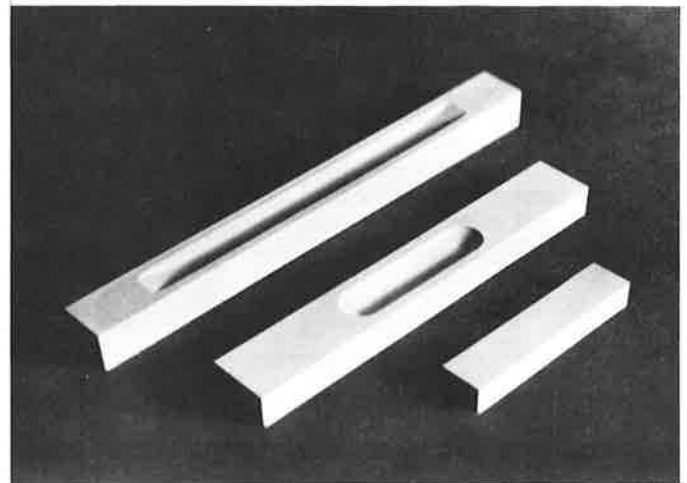
Vacuum-Hot-Pressed Intermetallic Evaporation Sources

Sylvania conductive composite intermetallic evaporation boats are stable, long-life, resistance-heated sources providing consistent, dependable, smooth evaporation of aluminum and a wide range of other metals and alloys. These boats are prepared from proprietary formulations and hot-pressed under vacuum. This results in unusually dense, inert, homogeneous sources free of entrapped gases and contaminants. They exhibit low reactivity at operating temperatures, require minimal break-in, are non-hygroscopic, and have exceptional dimensional stability.

Sylvania intermetallic sources are available in a wide variety of sizes, resistivities, and cavity dimensions to fit the customer's specific application. They are packaged individually, marked with the resistivity value, and are available as matched sets.

Design Features

- **Vacuum-Hot-Pressed Composition.** A combination of evaporation source characteristics unobtainable by other techniques.
- **High Purity.** Absolute minimum contamination of the film.
- **No Outgassing.** Vacuum fabrication drastically reduces entrapment of gases, and minimizes spitting.
- **High Dimensional Stability.** No shrinkage at initial firing, no compression bowing at high temperatures. Thermal Coefficient of Expansion only 7.6 micro-inches/inch/°C.
- **Widest Range of Resistivities.** 50 to 2000 microhm-centimeters.
- **Matched Resistances.** All boats are individually packaged, and marked with resistivity value.
- **Non-Hygroscopic.** No storage problems; no bake-out or break-in periods; no humidity worries.
- **Long Life with Aluminum Evaporant.** Low reactivity assures extended operation with fewer source changes, high-purity deposits, and clean, uniform films.



Applications

Electronic Microcircuit and Thin Film Deposition on glass and metal substrates, featuring high purity and uniformity of films.

Aluminizing of Glass, Metal and Plastic Film in long, continuous runs at high speeds. Low reactivity with aluminum ensures longer life, and fewer boat changes.

Metallizing for Reflective Surfaces, and Decorative Stampings for automotive, appliance, and other consumer and commercial equipment.

Conductive Composite formulations are your best guarantee of high-purity, smooth, homogeneous film deposition.

Sylvania Conductive Composites are custom formulations, each the result of careful research and direct field experience in the vacuum deposition industry. Each of the composites have low, medium or high electrical resistivities as listed below.

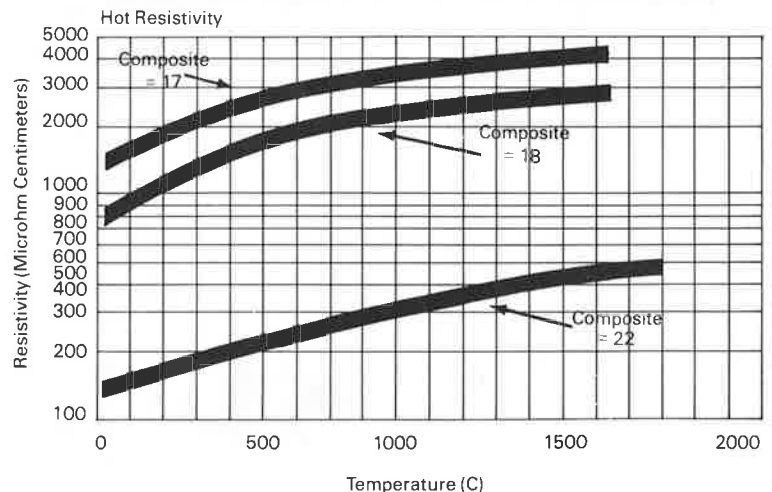
Electrical Characteristics

Resistivity

Composite #17	1000 - 2000 $\mu\Omega$ - cm
Composite #18 .....	.600 - 1400 $\mu\Omega$ - cm
Composite #22	50 - 150 $\mu\Omega$ - cm

Hot Resistivity

The Temperature/Resistivity characteristic curves shown for Sylvania Conductive Composites in this graph are median curves; the available range of practicable resistivities for these materials actually extends well beyond the highest and well below the lowest ranges shown for the standard Composites. By judicious modifications in the compounding of the raw materials and in the fabrication processes, it is possible to control the resistivity, and other parameters as well, over a considerable range of values.

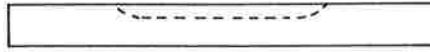
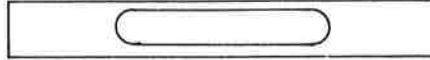


Typical Intermetallic Evaporation Source Types

Cavity Style I



Cavity Style II



Also available with cavities on both sides, and as blanks (without cavity)

Typical Mechanical & Thermal Characteristics

Density: 3.04 g/cm³

Thermal Conductivity: 0.14 Cal/cm²/sec/°C/cm

Moisture Absorption @ 100% R.H.: 0.07% by weight

Compression Strength: 2,390.0 kg/cm²

Flexure Strength: 1406.1 kg/cm

Elastic Modulus: 12-16 x 10⁶ psi at 25°C

Coefficient of Thermal Expansion (20°-900°C):
7.6 x 10⁻⁶ (C°)⁻¹

Resistivity: 50-2000 microhm-centimeters

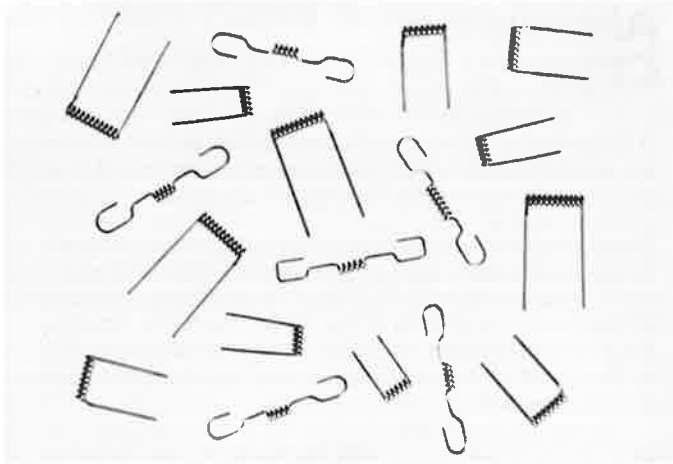
Tolerances

Cavity	- Depth & Width	±.010"
	- Length	±1/16"
Boat	- Thickness & Width	±.010"
	- Length	±1/16"

How to Order

Contact your local Sylvania Emissive Products sales engineer or contact the plant directly for a discussion of your requirements. We will be pleased to quote on your specifications.

Electron Beam Filaments



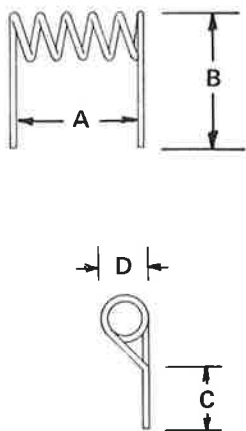
The Electron Beam Technique of vacuum evaporation provides high purity, long duration deposition with minimum generation of radiant heat.

The electron source is a tungsten wire or coil which is electrically heated to extreme temperatures. When the energy levels of the electrons on the hot surface exceed the binding forces which hold them to it, they leave the surface as a beam of energetic, negatively charged particles. This stream of electrons will melt and evaporate any material upon which it is focused.

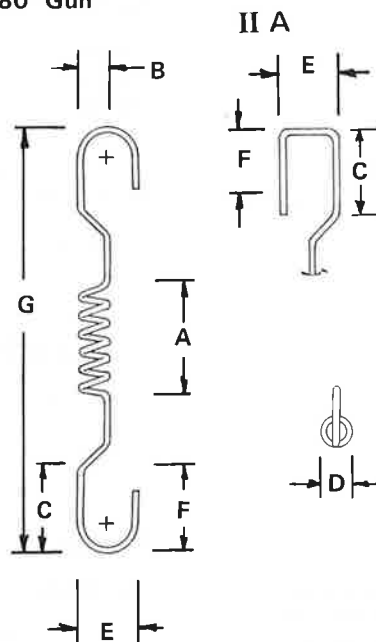
GTE Sylvania makes a variety of filaments for 180° and 270° bent beam guns.

Code Number	Style	Wire Type	Wire Diameter	Number of Turns	Dimensions in Inches						
					A	B	C	D	E	F	G
126931	I	W-LA	.030	7.5	.375	.771	.438	.125	—	—	—
127642	I	W-LA	.040	7.5	.375	.771	.438	.125	—	—	—
129744	I	W-LA	.035	10.5	.500	.750	.438	.125	—	—	—
125844	II	W-LA	.030	5.0	.127	.145	.250	.125	.250	.280	1.40
125845	II	W-LA	.040	7.0	.225	.145	.300	.125	.250	.250	1.40
127909	IIA	W	.030	5.0	.250	.156	.300	.125	.230	.250	1.40
125843	III	W-LA	.030	5.5	.250	.563	.313	.125	—	—	—
127424	III	W	.032	4.5	.236	.620	—	.145	—	—	—

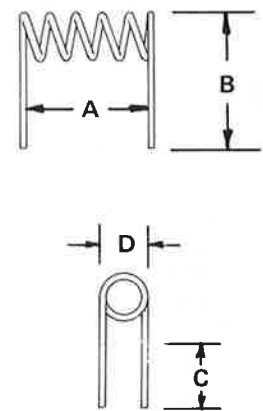
Style I
270° Gun



Style II
180° Gun



Style III
270° Gun



Silicon Monoxide

SiO for Vacuum Thin Film Application

Sylvania offers SiO which is specially processed and sized for use in various evaporation sources. By varying the rate of deposition, the refractive index can vary from 1.95 (infrared transmission) when done quickly at low pressure to 1.7 by a slow deposition and a partial pressure of oxygen.

SiO is also available as vacuum hot pressed pellets. This form provides a convenient system for depositing precise film layers utilizing simplified metal sources, with a minimum of "spitting" problems. Contact your sales representative for application information.

Packaging is in friction seal steel cans with a polyethylene bag inner container. After initial use it should be resealed in the original container to reduce moisture pickup.

SiO Size Ranges Available

Size	Part Number
- 1/2 inch + 8 mesh	146100
- 3/8 inch + 10 mesh	115019
- 10 mesh + 120 mesh	115022
- 120 mesh + 325 mesh	146101
- 325 mesh	115025
- 1 inch + 1/4 inch mesh	146910
3/8 inch dia x 3/8 inch h pellets	145764

Purity

Typical impurities as determined by spectrographic analysis are:

Al	= 200ppm
B	= 5ppm
Ca	= 5ppm
Cu	= 20ppm
Fe	= 150ppm
Mn	= 35ppm
Ti	= 40ppm
Mg	= 30ppm
Ni	= 25ppm
Others	= 5ppm

All material is packaged in friction seal cans with a polyethylene bag inner container to protect the material from moisture and gas. Unused portions should be stored in original containers.

Aluminum Clips

GTE Sylvania's Aluminum Evaporants are 99.99% pure and are available in all commonly acceptable shapes and sizes, including the standard J-Type quick load pieces.

These small pre-formed clips are designed to be hung on tungsten wire coils. As the coil is heated, the aluminum melts, is drawn up to the coil by surface tension, and is distributed over the strands of the coil by capillarity. The clips are a very convenient way of handling small amounts of aluminum, and of controlling the quantity and distribution of the evaporant.

Straight Crimp



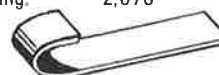
Part Number	Weight	Pcs./Lb.
116229	70 mg.	6,500
114500	105 mg.	4,320
114502	125 mg.	3,640
114504	170 mg.	2,670

V-Crimp



Part Number	Weight	Pcs./Lb.
116230	70 mg.	6,500
114501	105 mg.	4,320
114503	125 mg.	3,630
114505	170 mg.	2,670

J-Type



Part Number	Weight	Pcs./Lb.
118180	165 mg.	2,750
118181	248 mg.	1,820
118182	372 mg.	1,220
137985	500 mg.	910

Staple



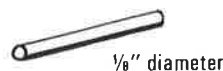
Part Number	Weight	Pcs./Lb.
114498	115 mg.	3,950

Horseshoe



Part Number	Weight	Pcs./Lb.
138833	75 mg.	6,000
114499	155 mg.	2,930

Slug



Part Number	Weight	Pcs./Lb.
127233	135 mg.	3,362
127234	200 mg.	2,270
127235	250 mg.	1,830

Chromium-Plated Tungsten Rods

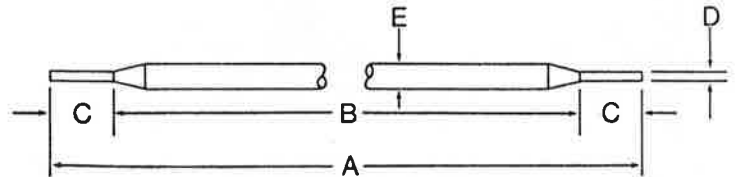
These rods are excellent pre-loaded evaporation sources for vacuum-deposition of thin chromium films. Since chromium sublimates when evaporated at low pressures, lumps or granular chromium exhibit erratic activity during the evaporation cycle, so that the deposited film lacks desired uniformity. The chrome-plated source presents a uniform, cylindrical surface of known dimensions, so that evaporation and the consequent deposition occur at controllable, uniform rates. Film thickness is easily regulated, and imperfections such as spalling and pinholes are virtually eliminated.

GTE Sylvania chromium plated tungsten rods are a superior evaporation source for depositing thin chromium films on mirrors, optics, electronics and decorative applications. In addition, other lengths to 24" of tungsten strand as well as rod can be furnished plated to suit individual applications.

Molybdenum rod and strand can also be furnished in both fabricated shapes and straight pieces with chrome plating.

Major advantages are:

- a. Film thickness easily regulated
- b. Purity of film controllable to a high degree
- c. Spalling of coating eliminated
- d. Relatively small degree of heat radiation
- e. Extremely low pin-hole level



Sylvania Part Number	Rod Material	Plating Material	A	B	C	D	E
110150	W	Cr	2	1	1/2	.050	.065 .080
115364	W	Cr	2	1	1/2	.050	.070 .080
115476	W	Cr	3	2	1/2	.050	.065 .075
140323	W	Cr	3	2	1/2	.050	.080 .090
140322	W	Cr	3	2	1/2	.050	.065 .080
140324	W	Cr	3 1/2	2 1/2	1/2	.050	.080 .090
115657	W	Cr	3 1/2	2 1/2	1/2	.050	.065 .080
116147	W	Cr	4	3	1/2	.050	.080 .090
115365	W	Cr	4	3	1/2	.050	.070 .080
110151	W	Cr	4	3	1/2	.050	.065 .080
110152	W	Cr	6	5	1/2	.050	.065 .080
119518	W	Cr	9	8	1/2	.050	.070 .080
115079	W	Cr	9	8	1/2	.050	.080 .100
110101	W	Cr	9	8	1/2	.050	.065 .080
140325	W	Cr	9	8	1/2	.050	.080 .090

Bulk Chrome

Sylvania chrome is manufactured under tightly controlled specifications suited for the Semiconductor and Optics Industries. The chrome is available in a variety of sizes and purity levels to satisfy a broad spectrum of applications.

Refer to other catalog sections for Boat and Coil Sources suitable for customizing your chrome deposition requirements.



Sylvania Part Number	Purity %	Size or Form
BC138759	99.7	.125" maximum Granules
BC138957	99.9	200 Mesh Nominal
BC145559*	99.99	.125"- .250" Plateletes
BC141126*	99.99	.125-.250 Nodules

*Oxygen Content 9.9 Microliters/Gram ~ 15ppm.

Other Chrome Material is available upon request.

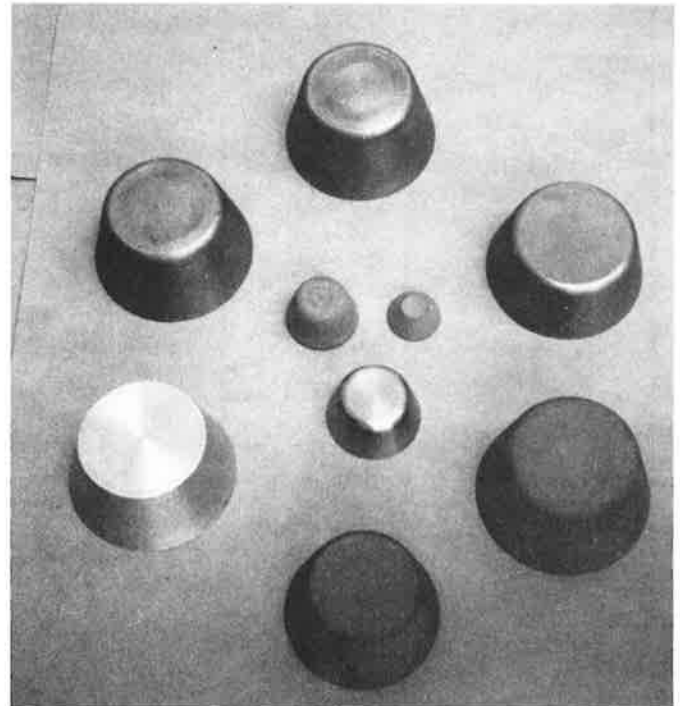
Chrome Hearth Slugs

Sylvania now offers hearth slugs for electron beam evaporation prepared from the highest purity substances.

Many sizes are listed, but other configurations will be quoted upon request.

Should you need assistance with your particular application we suggest contacting our engineers with your specifications.

Typical Purity	Sylvania Part Number	Crucible Diameter
99.99	144684	3/8"
99.99	144685	1 1/8"
99.99	144686	1 1/2"
99.99	144687	2"
99.999	144688	3/8"
99.999	144689	1 1/8"
99.999	144690	1 1/2"
99.999	144691	2"



Hearth slugs are made to fit Airco Temescal 180° and 270° electron beam guns.

High Purity Sputtering Targets

The practical development of the Sputtering technique for vacuum deposition, with its inherent capabilities for application of uniform, homogeneous coatings of virtually any solid material to substrates, films, and objects of many configurations and compositions, has been responsible for a steadily growing demand for target sources with the requisite purity, uniformity and dependability suitable for applications of this process.

Most popular sputtering materials are available from Sylvania Emissive Products. All are available in round disc form, nominal 1/4-inch thickness, in diameters from 2 to 22 inches in 1-inch increments.

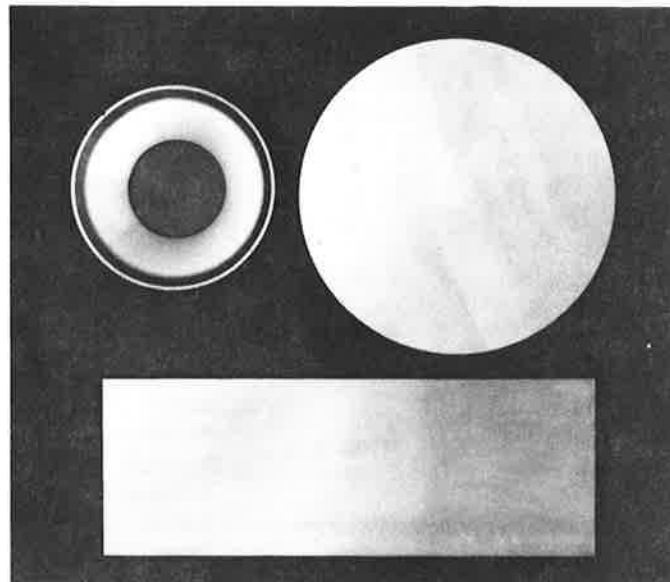
These Sylvania Sources are vacuum-hot-pressed from the highest-purity materials to form sound sputtering targets with clean, smooth surfaces, and densities of 90% or greater. While the standard disc form is the one most commonly employed in this process, other configurations and sizes can be furnished when required. Backing plates of stainless steel, aluminum, or copper, suitable for most sputtering systems, are also available, and bonding of the Source to its support by soldering, brazing, or silver epoxy bonding can be provided.

Design Features

- Hundreds of materials and compositions to choose from:
 - Metals
 - Alloys
 - Cermets
 - Metalloids
 - Chemical Compounds
- Standard disc form, in diameters from 2 to 22 inches.
- Non-standard sizes, rectangular, square, etc. also available.
- Extreme Purity – as high as 99.999%.
- Available with or without backing plates and support-target bonding.
- Special materials, compositions, configurations, and sizes available on request.

Sputtering Target Materials

All of the materials listed in this bulletin are standard items of supply with Sylvania. Many others, not listed here, can be provided, as well as special refinements, combinations, and purity specifications, in the listed materials. Sylvania Applications Engineers will be pleased to discuss your Source material requirements any time a need arises. A toll-free telephone number, 800-258-8290, has been provided for your convenience.



Applications

Micro-Electronics Production – Precision vacuum-deposition of high-purity, controlled-composition alloys, metals, metalloids, and insulators, commercial production of thin-film, discrete, and monolithic integrated-circuit elements and components.

Special Coating Application – Controlled, homogeneous deposition of special alloys, precious metals, rare earths, refractory materials, and materials ordinarily subject to decomposition.

Critical Industrial Coating Requirements – Commercial application of special coatings for end uses such as surface-protection, passivation, masking, bonding sensitizing, electrical or thermal barrier layers, visual effects, and electrostatic shielding.

Decorative Coatings – Specialized alloy targets for decorative brightwork applications to replace conventional electroplating processes in the automotive, appliance, and other consumer products industries.

See following page for list of available materials.

Sputtering Target Materials

Nitrides

Aluminum Nitride
Hafnium Nitride
Niobium Nitride
Silicon Nitride
Tantalum Nitride
Titanium Nitride
Vanadium Nitride
Zirconium Nitride

Oxides

Aluminum Oxide
Silicon Monoxide
Silicon Dioxide
Indium Tin Oxide
Yttrium Oxide

Borides

Chromium Boride CrB_2
Chromium Boride Cr_5B_3
Hafnium Boride
Lanthanum Boride
Molybdenum Boride
Niobium Boride
Tantalum Boride
Titanium Boride
Tungsten Boride WB
Tungsten Boride W_2B
Vanadium Boride
Zirconium Boride

Carbides

Boron Carbide
Chromium Carbide
Hafnium Carbide
Molybdenum Carbide
Niobium Carbide
Silicon Carbide
Tantalum Carbide
Titanium Carbide
Tungsten Carbide
Vanadium Carbide
Zirconium Carbide

Cermets

Silicon Monoxide/Chrome

Metals

Chromium & Alloys
Cobalt
Copper
Germanium
Hafnium
Iron
Molybdenum
Nickel
Nickel Chromium
Niobium
Ruthenium
Silicon
Tantalum
Titanium
Tungsten
Tungsten/Titanium
Zirconium

Disilicides

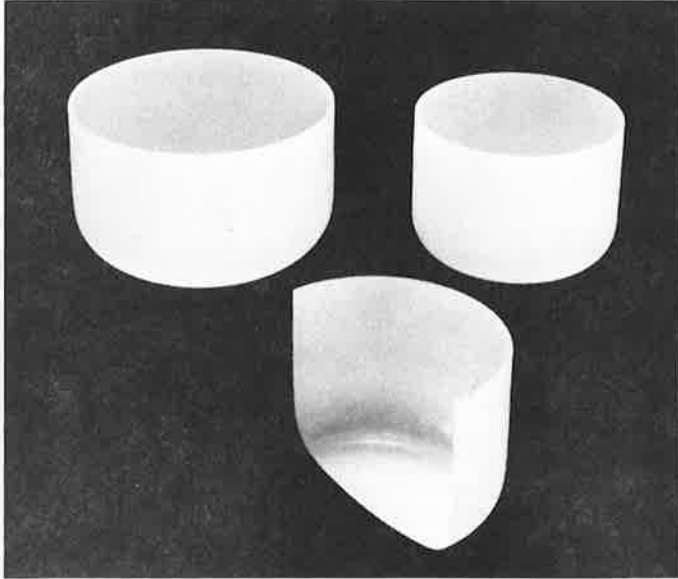
Chromium Silicide
Hafnium Silicide
Iron Silicide
Molybdenum Silicide
Niobium Silicide
Tantalum Silicide
Titanium Silicide
Tungsten Silicide
Vanadium Silicide
Zirconium Silicide

Sulfides

Zinc Sulfide

Other materials are also available. Contact us with your requirements.

High Purity Quartz Crucibles



The semiconductor industry's stringent requirements for crystal-growing crucibles of high purity and tight dimensional tolerances are satisfied by Sylvania's line of arc-fused quartz crucibles. A product of Sylvania's many years of experience in quartz materials processing, these crucibles meet or exceed the most demanding specifications.

Features

- Fabricated from the highest grade pure quartz material available.
- Subjected to strict quality standards, from starting material to finished product.
- Available in a wide variety of configurations and sizes. Round or flat bottomed.
- Custom configurations available.
- Each crucible is thoroughly inspected, cleaned and ready to use. Packed individually in rugged containers.
- Fast, reliable shipment.

Integral Tungsten/Alumina Crucibles

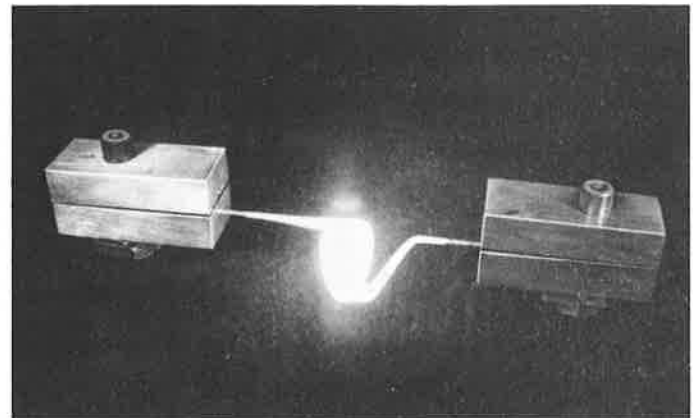
CS Crucibles, for High Purity Evaporation of "Difficult" Alloys

The durability problems that have ruled out such difficult to handle metals as nickel and iron alloys have been solved by Sylvania's development of an integral heater crucible that performs where others fail. This patented fabrication technique greatly increases the useful life of crucible units in applications involving high evaporation point metals. The process employs a densified layer of alumina to coat the tungsten basket heater without oxidizing the wire. Erosion of the crucible by molten metals is retarded by the densified alumina coating adjacent to the heating element.

With lower thermal differential across the crucible, and an evaporation rate consistent with current, the result is far greater control, plus a level of thermal efficiency previously impossible to achieve on such sources.

Providing upward evaporation in the deposition profile, Sylvania's new integral tungsten/alumina crucibles maintain the metal evaporant as a spinning ball within each unit. Flowing, spitting and wetting are significantly reduced. Material efficiency is high, not only for nickel and iron alloys, but also for a broad range that includes gold, lead, manganese, tellurium, selenium, tin, zinc, antimony and silver.

These crucibles have a standard mounting length of 100 mm and capacities from .05 to 5.8 ml. They are designed to fit easily into standard evaporators, with multiple crucible mountings recommended for production applications.



Features:

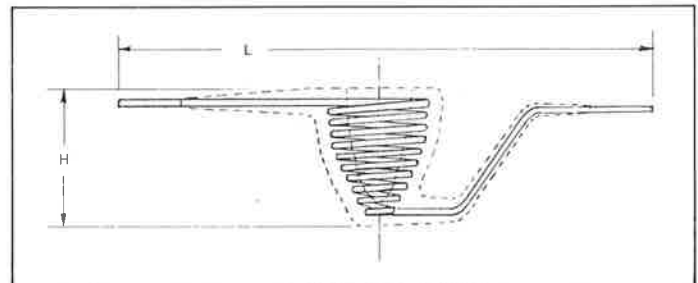
- Ideal upward evaporation characteristics
- Metal evaporants will not flow or wet
- Easily mounted
- High evaporation rate
- High material efficiency
- Rate uniform with current

Ordering Information

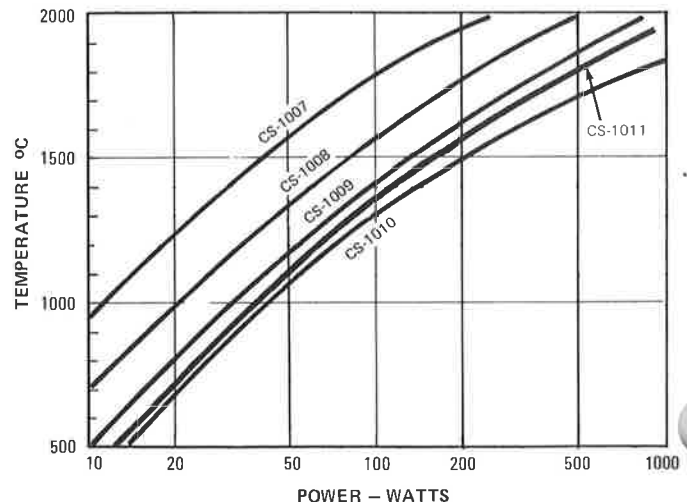
Stock Number	Heater Wire				Cavity		
	Diameter (in.)	L (in.)	Volume (ml.)	H (mm)	Diameter (mm)	Depth (mm)	
CS-1007	0.020	3.75	0.05	10	5	5	
CS-1008	0.040	4.0	0.25	15	10	10	
CS-1009	0.050	4.0	0.85	22	10	20	
CS-1010	0.050	4.0	5.8	25	20	20	
CS-1011	0.040	3.25	2.1	20	18	18	

Typical Chemical Analysis of Coating - Percent by Weight

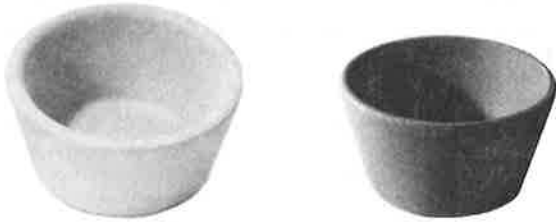
Al ₂ O ₃	SiO ₂	Fe ₂ O ₃	TiO ₂	Na ₂ O	CaO	MgO
98.55	0.58	0.10	0.04	0.31	0.19	0.23



POWER - TEMPERATURE CURVES



Conductive Composite Hearth Liners



Sylvania's Conductive Composite #17 is an ideal active composition of the elements Aluminum, Boron, Nitrogen, and Titanium, for use as Hearth Liners on all electron beam systems.

The material typically exhibits shrinkage of .0002" per inch when initially fired in 1 Torr vacuum at 1600°C for one hour. Composite #17 also has less than 0.12% moisture absorption after 168 hours at 25°C and 80-100% humidity.

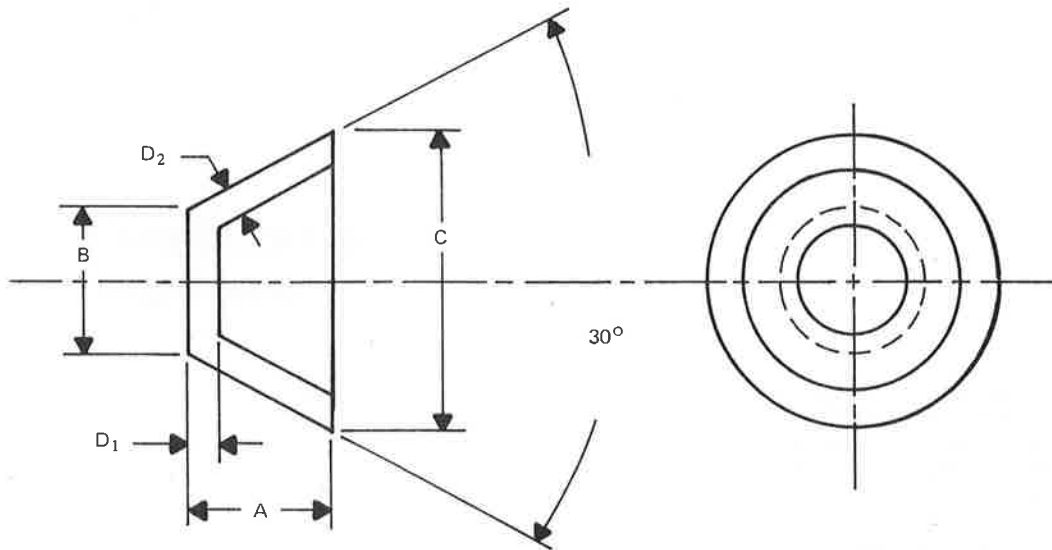
Typical electrical resistivity is 1400-1900 micro ohms at room temperature.

Configurations and materials other than specified are available on request.

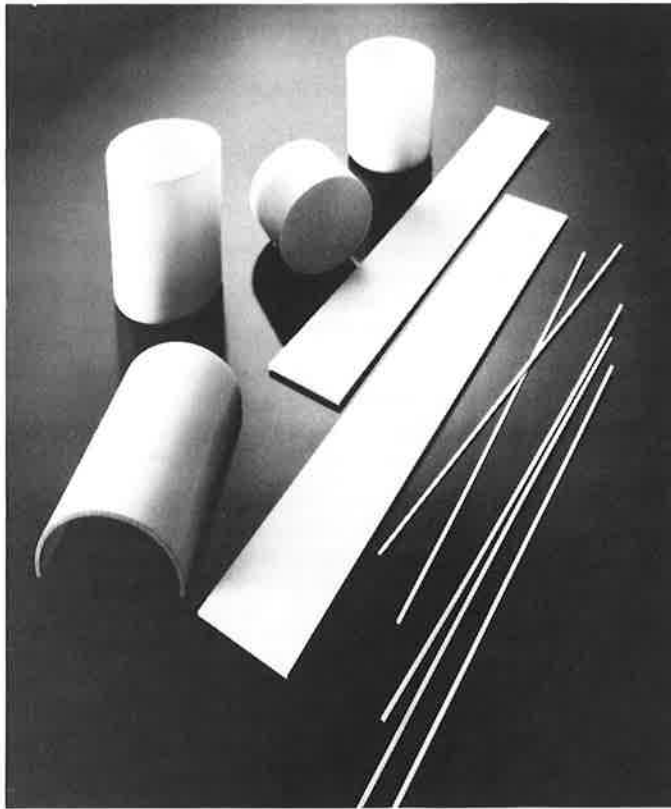
Dimensions (in Inches)

Crucible Number	A	B	C	D ₁	D ₂
117924	0.593	0.620	0.935	0.093	0.093
117925	1.000	1.250	1.786	0.183	0.183
117926	0.563	0.563	0.865	0.100	0.100
117927	0.563	0.865	1.167	0.093	0.093
118861	0.234	0.165	1.030	0.041	0.041
141359	1.109	1.440	2.020	0.175	0.175
141174	0.781	1.112	1.530	0.108	0.108
129817	1.625	2.861	3.297	0.375	Special 30° Taper Inside Wall

Inside Bottom Radius - 0.093" Typical
 Outside Bottom Radius - 0.125" Minimum
 0.156" Maximum
 Tolerances ±0.010"



Pyrolytic Boron Nitride



This "space age" material possesses a unique combination of thermal-electrical properties, typical of products made by the high-temperature chemical vapor deposition process. Sylvania's PBN materials feature:

- High Purity** - less than 10ppm metallic impurities
- Mechanical Strength** - tensile strength increases from 41 MPa (6,000 psi) at ambient temperatures to 103 MPa (15,000 psi) at 2200°C
- High Resistivity** - approximately 10^4 ohm/cm at 1600°C
- High Dielectric** - highest of any known material
- Good Thermal Conductivity** - 40:1 in the planar direction
- Good Chemical Compatibility** - compatible with a broad range of materials; highly resistant to oxidation

Pyrolytic Boron Nitride is increasingly finding applications in areas such as:

- Materials Evaporation (CVD, MBE)
- Crystal Growing
- Zone Refining
- Electronic Insulators

Sylvania offers PBN in both flat plate and specific shapes. Contact us for information and a quotation on your requirements.

Boron Nitride Release Agent

A real time and money saver in many production vacuum deposition installations, Sylvania's BN Release agent comes in a convenient liquid form which can be brushed on the inside of vacuum chamber walls as well as on clamps, fixtures, and other surfaces.

When it's time to remove the evaporant build-up from these surfaces, the BN Release Agent allows even heavy build-ups to be scraped off with a minimum of time and effort. Effects on pumpdown cycle are minimal.

Sylvania's BN Release Agent is available in three convenient sizes:

Size	Order Number
Pint (metric .48 liter)	151395
Quart (metric .95 liter)	151396
Gallon (metric 3.8 liter)	151397

Evaporation Rate of Selected Materials in a Vacuum

To determine the evaporation rate:

1. Select the material from among the material points, the temperature at right, connect to intersect an index point.
2. Select the material on the material line. Connect with the index point to intersect the evaporation.

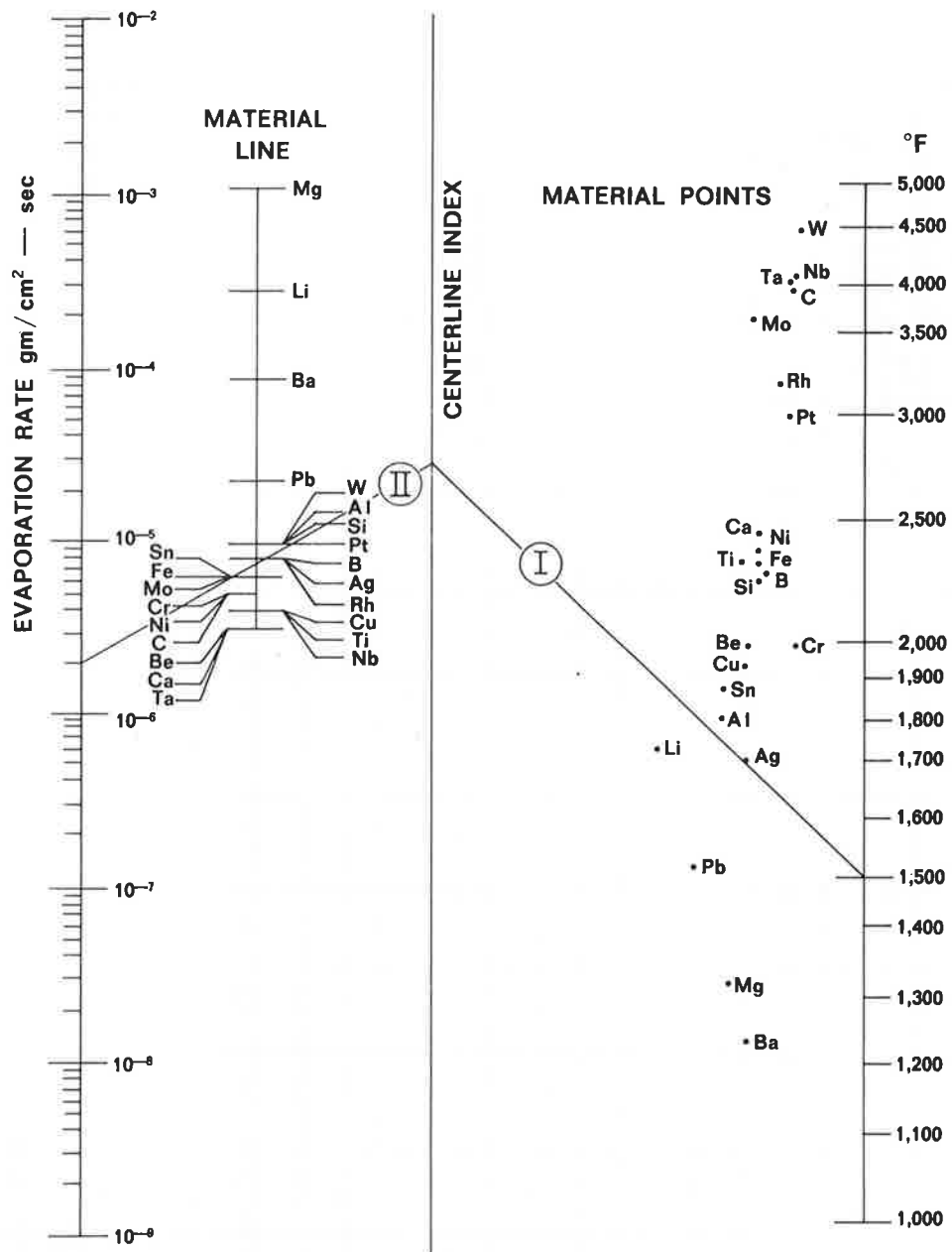


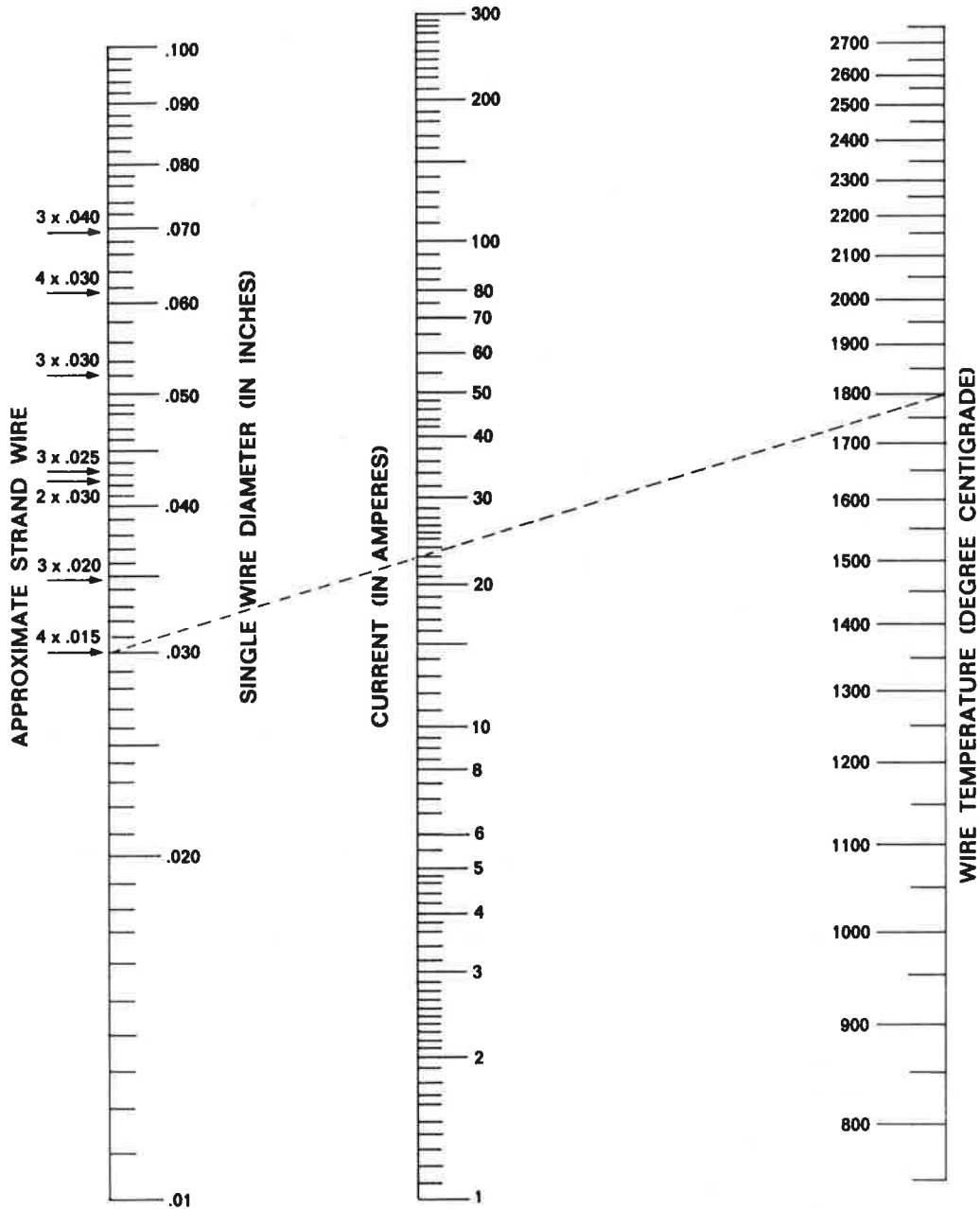
Table of Evaporation Sources

EVAPORATION MATERIAL	M.P. °C	TEMP °C AT 10 ⁻¹ VAP. PR.	BOATS	COILS	BASKETS	CRUCIBLES	OTHER	SPUTTER RATE RELATIVE	SPUTTER TECHNIQUE	E-BEAM SUITABILITY	REMARKS & TECHNIQUES	TYPICAL APPLICATIONS
ALUMINUM (Al)	660	1010	I	W, WS	W	BN, I, W		0.35	RF	Exel.	Wets & alloys readily with tungsten, stranded wire preferred. High rate evaporation uses I Boat or MP.	Mirrors, semiconductor gates, interconnections on IC's decorative, toys, trophies, decals, reflectors, TV screens
ALUMINUM SILICON ALLOY			I	W	W	BN, I, W					Wets & alloys readily with tungsten, stranded wire preferred	Semiconductor MOS devices, prevents electromigration
ALUMINUM OXIDE (Al ₂ O ₃)	2050	1325							RF reactive	Exel.		Dielectric applications
ANTIMONY (Sb)	630	425	Mo, W		Mo, W	BN, W, AO	WAO		RF	Poor	Evaporates readily, toxic chromel boats suitable.	Resistive thin films, semi-metal
ARSENIC (As)	814(S)	210	VC			AO, VC	WAO		RF	Poor	Sublimes rapidly at low temp. Toxic.	
BARIUM (Ba)	710	735	W, Ta		W, Mo				RF	Fair	Wets refractory metals without alloying, reacts with oxides.	
BARIUM TITANATE (BaTiO ₃)									RF	2 Source		High dielectric, constant in thin film capacitors
BERYLLIUM (Be)	1284	1000	Ta	W	W	C, BO			RF	Exel.	Wets refractory metals, extremely toxic.	Semiconductor junctions
BISMUTH (Bi)	271	520	Ta	W	W	AO	WAO		DC, RF	Good	Use external heater on crucible, vapors are toxic.	Ferromagnetic films, resistive thin films
BORON (B)	2000	1797	C			C, WC			RF	Exel.	Carbon resistance heated boat or strips.	Diffusion layer, semiconductor
CADMIUM (Cd)	321	180	Ta, SS		W	AO, P, O	WAO MS		DC, RF	Poor	Heat crucible with external basket heater. Evaporate rapidly to insure condensation on substrate.	Metallizing paper, capacitor dielectrics
CADMIUM OXIDE (CdO)	1430	530							RF reactive		Films are electrically conducting, decomposes.	Electrically conducting films
CADMIUM SELENIDE (CdSe)	1264	540	Mo, Ta			AO, O	MS		RF	Good	Evaporates easily.	Optical films
CADMIUM SULFIDE (CdS)	1750	250	Mo			C	MS		RF	Fair	Substrate should be heated for good adherence.	IR filters, color filters, transistors, photoconductor diodes
CALCIUM (Ca)	810	459			W	AO	WAO			Poor	Use external heater with crucible. Corrodes in air.	
CARBON (C)	3650	2137								Exel.	Ion plating used for hard surfacing.	Semiconductor resistance films
CERIUM DIOXIDE (CeO ₂)	2395	2310	W (heavy)						RF reactive	OK	Reacts with refractory source.	
CHROMIUM (Cr)	1900(S)	1157	W Plated	W	W	W	Cr Plated W rods	0.7	RF, DC	OK	Use chips in tapered baskets. Films very adherent. High rates possible.	Mirrors, decorative glassware, semiconductor adhesive layer
COBALT (Co)	1478	1200	W			AO, BO	WAO	0.6	DC, RF	Exel.	Alloys readily with refractory metals.	Ferromagnetic thin films
COPPER (Cu)	1083	1017	W, Mo, Ta	W	W		WAO, MP	1.1	DC, RF	Exel.	Dimple boat used. Evaporates well from all refractory sources. Films do not adhere well.	Decorative metallizing, conductors in thin film circuits
GALLIUM (Ga)	30	907				AO, O, BO, VC	WAO			Good	Reacts with metals and will attack crucibles above 1000°C. Heat crucible with external heater.	
GALLIUM ARSENIDE (GaAs)			W						RF	Fair	Flash evaporation, decomposes.	LED
GALLIUM PHOSPHIDE (GaP)	1348	920	W, Ta		W				RF	Exel.	Evaporates well with little decomposition. Rate control important.	LED
GERMANIUM (Ge)	959	1167	W, Ta, Mo	W	W	C	WAO	0.5	DC, RF	Exel.	Wets refractory metals, extremely densified graphite resistance source recommended. Excellent films from EB guns.	Substrate material
GERMANIUM OXIDE (GeO ₂)	1115		W, Ta, Mo	W	W	VC			RF reactive	Good	Similar to SiO ₂ film predominately GeO ₂ .	
GOLD (Au)	1063	1132	W, Mo	W, WS	W	AO, VC, BN	WAO	1.1	DC, RF	Exel.	Wets W & Mo wrap. Coil with fine Au wire. Canos boat used. Films soft, not very adherent.	Semiconductor bonding, capacitor electrodes, protective layers
INDIUM (In)	157	742	Mo, W		W	AO	WAO		DC, RF	Exel.	Wets W & Cu. Use Ta liner in guns.	Transistor contacts, diodes
INDIUM OXIDE (In ₂ O ₃)	1565	200	PL W		W				RF, RF-reactive	Poor	Sputter Pt onto W sources, decomposes.	Transparent heating elements on glass
IRON (Fe)	1535	1180	W	W	W	AO, BO	WAO	0.5	DC, RF	Exel.	Fe must not exceed 30% of the W source. Use embedded W heater with crucible.	Ferromagnetic thin films

Wire Diameter-Current-Temperature-Nomograph

Example:

Find the current of 4 x .015" strand wire operating at 1800°C.
Answer: 23 amperes.



Conversion Factors

Area – Length – Power – Energy – Miscellaneous

To Convert	Multiply By
Area	
Circular Mils to Square Inches . . . . .	.0000007854
Circular Mils to Square Mils . . . . .	.7854
Circular Mils to Square Millimeters . . . . .	.0005066
Square Centimeters to Square Inches . . . . .	.155
Square Feet to Square Meters . . . . .	.0929
Square Inches to Circular Mils	1,273,240.
Square Inches to Square Centimeters	6.4516
Square Inches to Square Millimeters	645.16
Square Inches to Square Mils	1,000,000.
Square Meters to Square Feet	10.764
Square Millimeters to Square Inches . . . . .	.00155
Square Millimeters to Circular Mils	1,973.51
Square Mils to Circular Mils	1.2732
Square Mils to Square Inches . . . . .	.000001
Length	
Centimeters to Inches . . . . .	.3937
Centimeters to Feet . . . . .	.03281
Feet to Centimeters	30.48
Feet to Meters . . . . .	.3048
Inches to Centimeters	2.54
Inches to Meters . . . . .	.0254
Inches to Millimeters	25.4
Inches to Mils	1,000.
Kilometers to Miles . . . . .	.6214
Meters to Feet	3.2808
Meters to Inches	39.3701
Meters to Yards	1.0936
Miles to Kilometers	1.6093
Millimeters to Inches . . . . .	.03937
Millimeters to Mils	39.3701
Mils to Inches . . . . .	.001
Mils to Millimeters . . . . .	.0254
Yards to Meters . . . . .	.9144
Power	
Foot-Pounds per Minute to Horsepower . . . . .	.0000303
Foot-Pounds per Minute to Watts . . . . .	.0226
Foot-Pounds per Second to Horsepower . . . . .	.001818
Foot-Pounds per Second to Watts	1.356
Horsepower to Foot-Pounds per Minute	33,000.
Horsepower to Foot-Pounds per Second	550.
Horsepower to Watts	746.
Kilogram-Meters per Second to Watts	9.807
Watts to Foot-Pounds per Minute	44.25
Watts to Foot-Pounds per Second . . . . .	.7375
Watts to Horsepower . . . . .	.001341
Watts to Kilogram-Meters per Second . . . . .	.1020

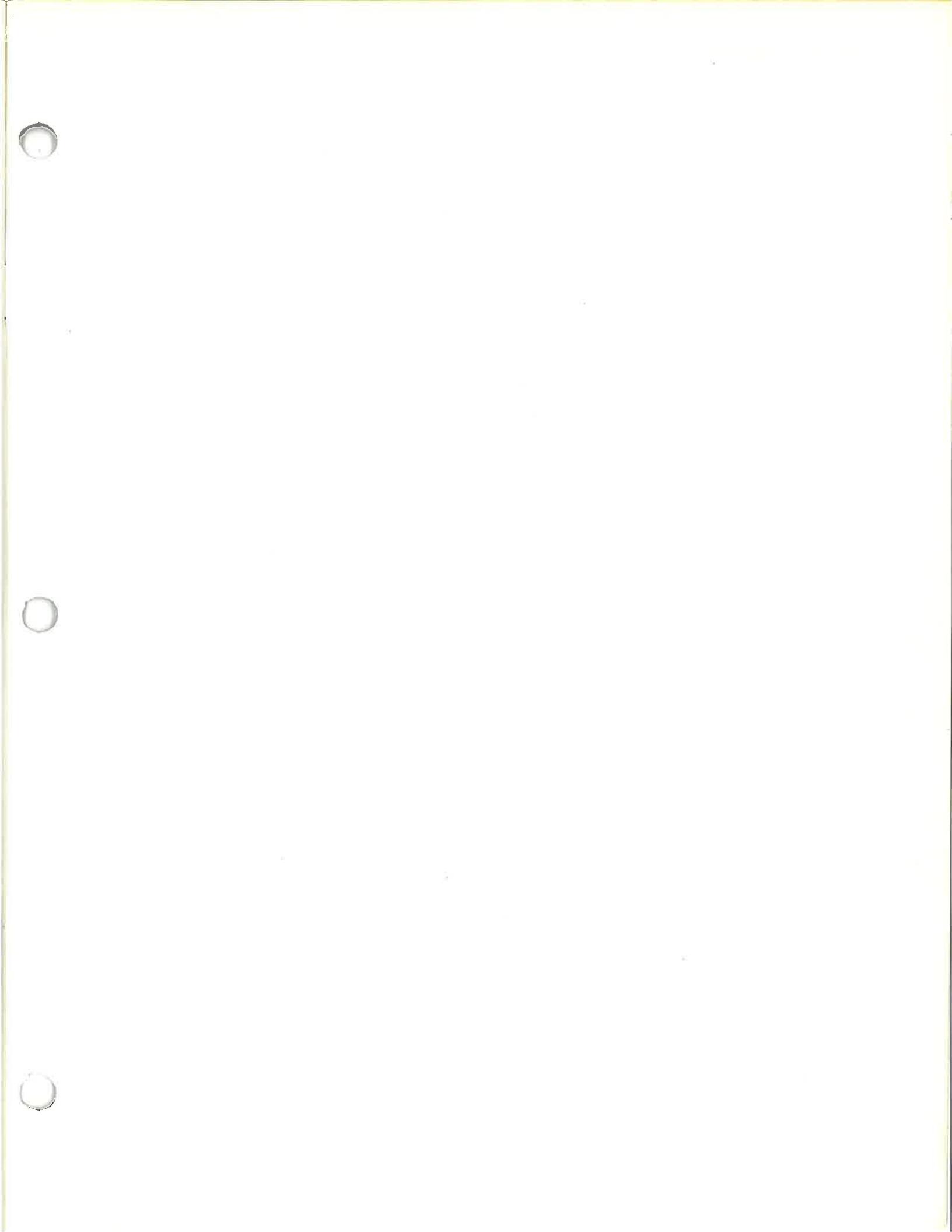
To Convert	Multiply By
Energy	
British Thermal Units to Foot-Pounds	778.
British Thermal Units to Joules	1,055.
British Thermal Units to Watt-Hours . . . . .	.293
Foot-Pounds to British Thermal Units . . . . .	.001285
Foot-Pounds to Joules	1.356
Foot-Pounds to Kilogram-Meters . . . . .	.1383
Gram Calories to Joules	4.186
Joules to British Thermal Units . . . . .	.000947
Joules to Ergs	10 ⁷
Joules to Foot-Pounds . . . . .	.7375
Joules to Gram-Calories . . . . .	.2388
Joules to Kilogram-Meters . . . . .	.10198
Kilogram-Meters to Foot-Pounds	7.233
Kilogram-Meters to Joules	9.8117
Watt-Hours to British Thermal Units	3.4126
Miscellaneous	
Kilogram to Pounds	2.205
Kilograms per Kilometer to Pounds per 1000 Feet . . . . .	.6719
Ohms per Kilometer to Ohms per 1000 Feet . . . . .	.3048
Ohms per 1000 Feet to Ohms per Kilometer	3.2808
Ohms per 1000 Yards to Ohms per Kilometer	1.0936
Pounds to Kilograms . . . . .	.4536
Pounds per 1000 Feet to Kilograms per Kilometer	1.488
Pounds per 1000 Yards to Kilograms per Kilometer . . . . .	.4960
Pounds per 1000 Yards to Pounds per Kilometer	1.0936
Resistivity in Microhm Cent. to Ohms CMF	6.0153
Resistivity in Ohms CMF to Microhm Centimeters . . . . .	.166
Specific Gravity to Pounds per Cubic Inch . . . . .	.0361

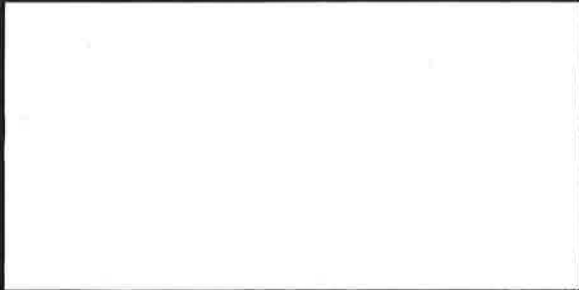
Millimeter Equivalents

In Inches					
mm	Inches	mm	Inches	mm	Inches
.01	.0004	.45	.0177	.89	.0350
.02	.0008	.46	.0181	.90	.0354
.03	.0012	.47	.0185	.91	.0358
.04	.0016	.48	.0189	.92	.0362
.05	.0020	.49	.0193	.93	.0366
.06	.0024	.50	.0197	.94	.0370
.07	.0028	.51	.0201	.95	.0374
.08	.0031	.52	.0205	.96	.0378
.09	.0035	.53	.0209	.97	.0382
.10	.0039	.54	.0213	.98	.0386
.11	.0043	.55	.0217	.99	.0390
.12	.0047	.56	.0221	1.00	.0394
.13	.0051	.57	.0224	2.00	.0787
.14	.0055	.58	.0228	3.00	.1181
.15	.0059	.59	.0232	4.00	.1575
.16	.0063	.60	.0236	5.00	.1969
.17	.0067	.61	.0240	6.00	.2362
.18	.0071	.62	.0244	7.00	.2756
.19	.0075	.63	.0248	8.00	.3150
.20	.0079	.64	.0252	9.00	.3543
.21	.0083	.65	.0256	10.00	.3937
.22	.0087	.66	.0260	11.00	.4331
.23	.0091	.67	.0264	12.00	.4724
.24	.0094	.68	.0268	13.00	.5118
.25	.0098	.69	.0272	14.00	.5512
.26	.0102	.70	.0276	15.00	.5906
.27	.0106	.71	.0280	16.00	.6299
.28	.0110	.72	.0284	17.00	.6693
.29	.0114	.73	.0287	18.00	.7087
.30	.0118	.74	.0291	19.00	.7480
.31	.0122	.75	.0295	20.00	.7874
.32	.0126	.76	.0299	21.00	.8268
.33	.0130	.77	.0303	22.00	.8661
.34	.0134	.78	.0307	23.00	.9055
.35	.0138	.79	.0311	24.00	.9449
.36	.0142	.80	.0315	25.00	.9843
.37	.0146	.81	.0319	26.00	1.0236
.38	.0150	.82	.0323	27.00	1.0630
.39	.0154	.83	.0327	28.00	1.1024
.40	.0158	.84	.0331	29.00	1.1417
.41	.0161	.85	.0335	30.00	1.1811
.42	.0165	.86	.0339	31.00	1.2205
.43	.0169	.87	.0343	32.00	1.2598
.44	.0173	.88	.0347	33.00	1.2992

Decimals of an Inch

For Each 64th							
Fraction	1/64ths	Decimal	mm	Fraction	1/64ths	Decimal	mm
	1	.015625	.0397		33	.515625	13.097
1/32	2	.03125	.794	17/32	34	.53125	13.494
	3	.046875	1.191		35	.546875	13.891
1/16	4	.0625	1.588	9/16	36	.5625	14.288
	5	.078125	1.984		37	.578125	14.684
3/32	6	.09375	2.381	19/32	38	.59375	15.081
	7	.109375	2.778		39	.609375	15.478
1/8	8	.125	3.175	5/8	40	.625	15.875
	9	.140625	3.572		41	.640625	16.272
5/32	10	.15625	3.969	21/32	42	.65625	16.669
	11	.171875	4.366		43	.671875	17.066
3/16	12	.1875	4.763	11/16	44	.6875	17.463
	13	.203125	5.159		45	.703125	17.859
7/32	14	.21875	5.556	23/32	46	.71875	18.256
	15	.234375	5.953		47	.734375	18.653
1/4	16	.250	6.350	3/4	48	.750	19.050
	17	.265625	6.747		49	.765625	19.447
9/32	18	.28125	7.144	25/32	50	.78125	19.844
	19	.296875	7.541		51	.796875	20.241
5/16	20	.3125	7.938	13/16	52	.8125	20.638
	21	.328125	8.334		53	.828125	21.034
11/32	22	.34375	8.731	27/32	54	.84375	21.431
	23	.359375	9.128		55	.859375	21.828
3/8	24	.375	9.525	7/8	56	.875	22.225
	25	.390625	9.922		57	.890625	22.622
13/32	26	.40625	10.319	29/32	58	.90625	23.019
	27	.421875	10.716		59	.921875	23.416
7/16	28	.4375	11.113	15/16	60	.9375	23.813
	29	.453125	11.509		61	.953125	24.209
15/32	30	.46875	11.906	31/32	62	.96875	24.606
	31	.484375	12.303		63	.984375	25.003
1/2	32	.500	12.700	1	64	1.000	25.400





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