GE Components
Marketing & Sales Operation

Dumet and Cumet Wire

Dumet and Cumet:

Clad Wires Designed To Meet Specific Expansion/Contraction Coefficients

Achieving a vacuum tight seal between the lead wires and the glass envelope is one of the most critical operations in lamp manufacture.

Today this procedure is handled with a high degree of reliability by utilizing a specially tailored wire material known throughout the lighting industry as Dumet.

Since it was first formulated by GE over 60 years ago, nothing has come along to match the excellent glass sealing properties of this material.

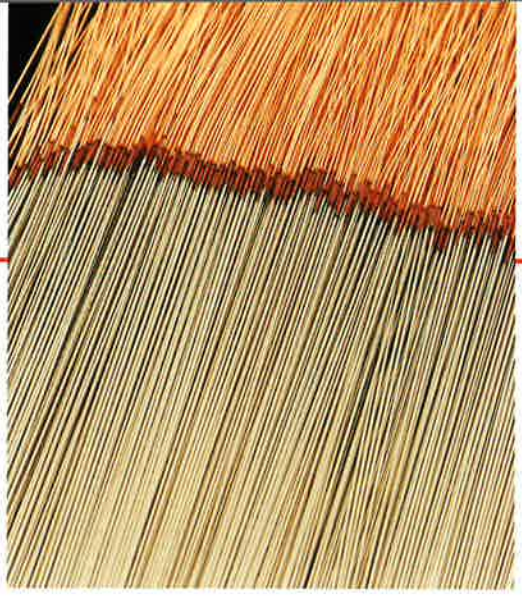
Today, there are different varieties of the Dumet, each designed to meet special lamp making requirements. There are also special grades for sealing television picture tubes, cathode ray tubes and certain types of semiconductors.

In some of these applications, Dumet has replaced such high cost materials as platinum.

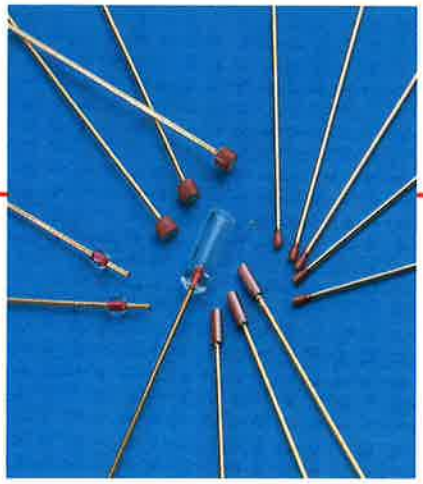
Dumet wire consists of a nickel iron core onto which a precise thickness of copper is metallurgically bonded. This combination of materials creates a radial coefficient of expansion that closely resembles that of a soft glass. With the Dumet portion of a lead wire embedded in molten glass, the two materials form a tight bond as the seal cools down.

Cumet

Like Dumet, Cumet is a clad wire that meets specific engineering parameters. It consists of a copper-sheath metallurgically bonded to a low-carbon steel core. Cumet thus combines the good electrical conductivity of copper and the strength of steel.



Lamp Leads



Semiconductor Slug Leads

Dumet Wire

Dumet is made to exacting specifications in order to meet the sealing requirements of a wide range of glass products, foreign or domestic. Once the glass expansion rate is known, such variables as nickel content of the core wire (42% and 47% are standard), type of coating, cladding thickness, and other factors can be controlled to meet the specification.

Borate and other coatings are applied to the wire surface to enhance sealability.

In addition to defect free glass sealing, this GE product has the electrical and thermal conductivity that is well suited for the application.

Dumet also provides the electrical resistivity desirable in a wide range of lamp and electronic applications, a high melting point, and good corrosion resistance.

Dumet is generally specified as either Lamp Grade or Semiconductor Slug Grade.

Lamp Grade Dumet

Lamp Grade Dumet is used for the seal section of two, three and four part leads for incandescent lamps. Lamp Grade Dumet is normally ordered with either a borated or nickel-plated surface, depending on the application, in the diameter range of 10 to 30 mils. (.254 to .762mm.)

For sealing with higher expansion glasses (Corning, Schott, NGK); high lead glass, or for applications with longer seals, GE recommends a slight variation called Dumet II. This material has a thinner copper cladding and a heavier core wire, providing 47% nickel as opposed to the 42% in regular Dumet. This composition provides a better thermal expansion match for sealing the materials described above.

The wide range of surface finishes now available has made it more important than ever to accurately specify the desired oxide thickness for a given surface condition. GE has developed an oxide thickness tester in order to quantify this critical Dumet property.

Semiconductor Slug Grade Dumet

Another major application of Dumet is for two-piece slug leads for glass encapsulated diodes and capacitors. Semiconductor slug grade Dumet is available with the tensile strength and oxide thickness values required for these discrete electronic devices.

Because deformation of the two-piece slug lead can occur during manufacture, GE now provides a high tensile strength Dumet. This material provides a circular slug on a more consistent basis.

For applications such as capacitor lead wires, a thicker oxide is usually required for hermetic glass sealing. In these cases, high tensile properties may be sacrificed to attain greater oxide thickness.

Semiconductor slug grade Dumet comes in standard diameters ranging from 30 to 68 mils. (.762 to 1.727mm.) and is ordered with either a leach-resistant borated coating or an oxidized surface.

Expansion/Contraction of Dumet

Because its radial coefficient of thermal expansion so closely matches that of soft glasses, Dumet wire effectively seals with soda lime glass as well as high and low lead glasses.

In Figure 1, expansion curves of Dumet and high lead glass are compared.

Because Dumet is a composite material, its axial and radial thermal expansions are different. For this reason the optimum seal length depends on the diameter of the Dumet used. Figure 2 illustrates this relationship.

Dumet II, which is used for sealing with higher expansion glasses and when longer seals are required, has radial and axial coefficients of thermal expansion that are even closer to glass than standard Dumet.

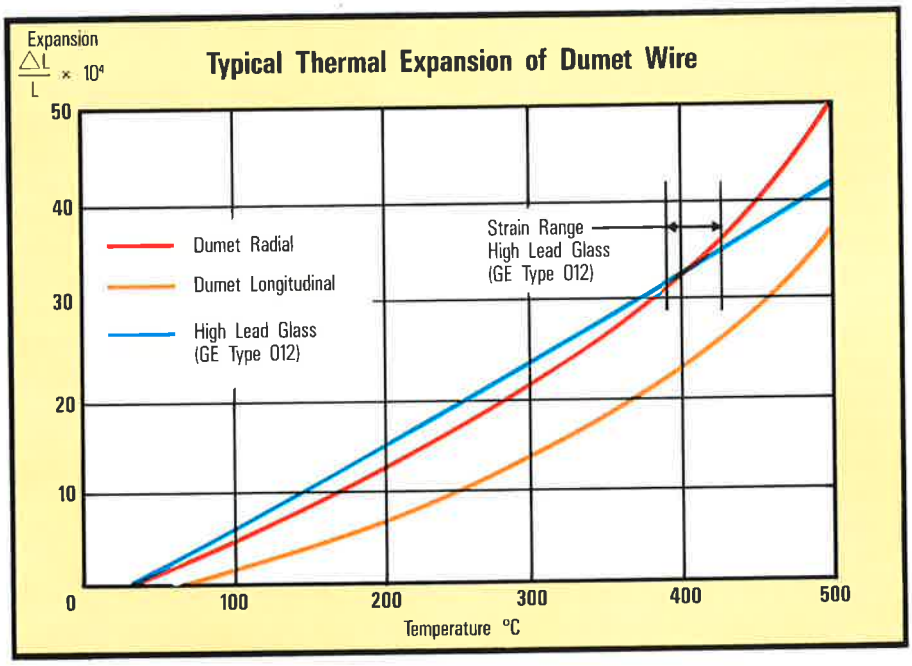


Figure 1 · Dumet Expansion

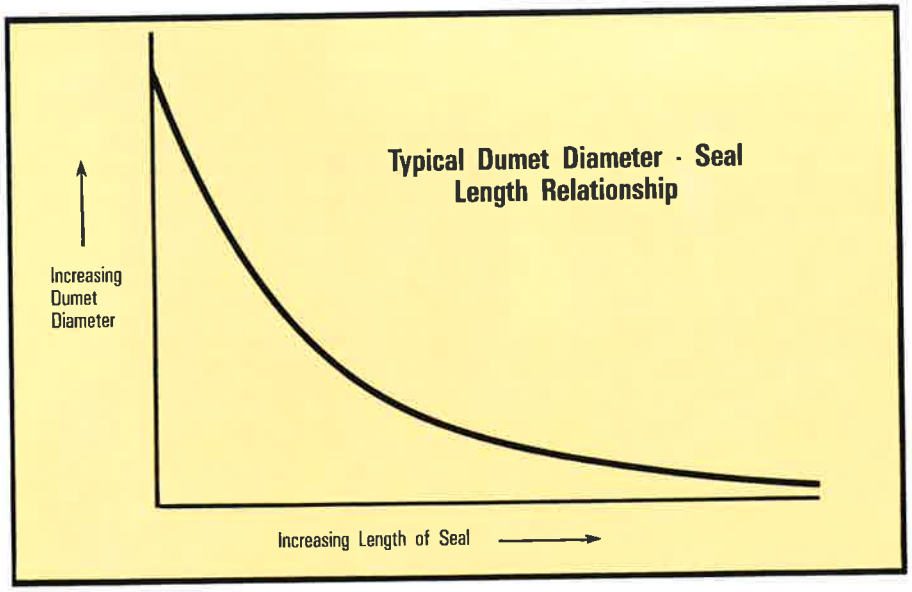


Figure 2 · Diameter/Seal Length Relationships

Cumet Wire

The major use of Cumet wire is the pigtail portion of two part leads for capacitors, rectifiers, diodes, and other electronic devices. It is also used for formed wire parts for electronic components, and in lead wires for electronic tubes and incandescent lamps.

Uniformity of this cladding thickness and the circular cross section of the steel core wire are important design factors. Both affect the performance of Cumet.

Cumet's steel core permits the use of magnetic sorting and handling equipment in the manufacture of pins, lead wires and other small pieces.

Redraw Dumet and Cumet

For the more vertically integrated customers, GE now offers both Dumet and Cumet for redrawing to smaller diameters. This material is available in diameters up to 0.250 mils. (6.35mm.)

Properties and Characteristics of Dumet and Cumet Wire

	Dumet	Dumet II	Cumet C-1006		Cumet C-1018	
			30%	40%	30%	40%
Cladding Material						
Copper, Min. Percent	99.90	99.90	99.90		99.90	
Cladding Weight %						
Copper, Cladding	18-26 (22 Nom.)	14-20 (17 Nom.)	22	34	24	36
Cladding Thickness Ratio						
Copper, Cladding Max: Min	2.0:1.0	2.5-1.0	2.0:1.0		2.0:1.0	
Physical Properties						
Tensile Strength, KPSI Yield Strength, KPSI % Elongation (10 in.)	100 Max. 80 Max. 10 Min.	100 Max. 80 Max. 10 Min.	65 Max. 50 Max. 16 Min.	60 Max. 45 Max. 16 Min.	65 Max. 50 Max. 16 Min.	60 Max. 45 Max. 16 Min.
Thermal Properties						
Coeff. Expansion, 25-400 °C, $\mu l/\mu l$ °C×10^{-7} Axial Radial Conductivity, 20-200 °C Cal/cm/sec/cm^2,°C	 50-65 80-100 0.2-0.3	 76-85 96-105 N.D.	 Not Determined Not Determined 0.38	 0.46	 Not Determined Not Determined 0.38	 0.46
Electrical Properties						
Resistivity: m_Ω-cm Circ. Mil-ohms/ft. Conductivity %IACS	 7.3-12.0 44-72 24-14	 7.0-15.0 42-90 25-12	 5.9 34.6 30	 4.4 25.9 40	 5.9 34.6 30	 4.4 25.9 40
Density						
lb/in^3 gm/cm^3	0.298-0.301 8.26-8.32	0.299-0.301 8.29-8.32	0.292 8.10	0.297 8.23	0.294 8.13	0.298 8.26
Chemical Composition of Core by Weight %						
Nickel Cobalt Manganese Carbon Silicon Chromium Sulfur Copper Phosphorus Molybdenum Titanium Iron & Residuals	41.00-43.00 0.50 Max. 0.75-1.25 0.10 Max. 0.25 Max. 0.20 Max. 0.015 Max. 0.15 Max. 0.02 Max. 0.15 Max. 0.08 Max. Remainder	46.50-48.00 0.50 Max. 0.50 Max. 0.06 Max. 0.35 Max. 0.25 Max. 0.015 Max. 0.15 Max. 0.02 Max. 0.15 Max. 0.08 Max. Remainder	0.25-0.40 0.08 Max. 0.05 Max. 0.04 Max. Remainder		0.60-0.90 0.15-0.20 0.05 Max. 0.04 Max. Remainder	

Weldability

Dumet and Cumet wire can be welded to a wide range of ferrous, non-ferrous, and refractory metals and alloys.

In welding these wires, the uniform concentricity of the clad wires provides good alignment of the cores. This results in consistently strong and reliable welds.

Dumet Surface Coatings

Borated Dumet

In lamp making, glass sealing is sensitive to a number of variables. To enhance sealing, the Dumet wire is produced to achieve a precise oxide thickness on its surface and is subsequently coated with layers of borate.

A new borating line at GE's Carolina Welds plant features power assisted payoff, preoxidation burners, acid clean and rinse cycles, atmospheric cooling tubes, and tension reels to control the wire speed through the heating zones and borate quench tank.

In the borating process, oxidized wire is passed through a solution of borax and then heated to produce a coating of anhydrous sodium tetraborate.

The borate coating serves two functions:

1. In flame sealing, it helps prevent excessive oxidation of the Dumet surface in the early "sealing fires," the time before it is protected by the glass envelope.
2. It acts as a flux, accelerating the dissolution of the copper oxide in the surrounding glass envelope. This provides a "wetting action" which aids in sealing.

The thickness of the coating is critical and is related to the oxide color, from pale copper to a dark, dusty red. The color can be converted to a number using ASTM color chart F29.

In order to quantify oxide thickness and eliminate the subjectivity of visual color matching, GE has developed a reliable oxide thickness tester. Once the color/oxide thickness relationship has been established, GE can vary the manufacturing process to meet requirements for specific applications.

Nickel-Plated Dumet

Used primarily in the lamp industry, nickel-plated Dumet wire can provide better protection from sealing fires and reduce oxidation inside a sealed glass envelope. Nickel-plated Dumet has the added advantage of not requiring a cleanup operation after stem-making.

Oxidized Dumet

Oxidized Dumet is used in diode and capacitor slug lead applications where glass sealing is done in a furnace.

The color range of oxidized Dumet is similar to the color standards of borated Dumet, but not exactly, and does not conform to ASTM color chart F29. GE's oxide thickness tester is especially useful for specifying this grade of Dumet.

Leach Resistant Borated Dumet

For flame sealing applications, a leach-resistant borated Dumet is preferred over grades with an oxidized surface.

LR Dumet is used primarily for slug leads and is designed to withstand chemical and thermal cleaning of the oxide after sealing. These cleaning processes are intended to remove extraneous oxides formed in flame sealing, but leaching of the seal oxides frequently occurs. By modifying the borated Dumet chemistry, the sealed oxide can be protected from leaching.

LR Dumet is used exclusively for flame sealing, not furnace sealing, and is available only with a borated surface.

Unborated Dumet

For applications in which a clean copper finish is desired, unborated Dumet can be specified.

This material is used for pigtails for certain classes of electronic slug leads.

GE uses a number of test instruments to look for possible defects in the oxidized or coated surface.

Quality Control

Because slight variations in cladding thickness and surface coatings can have a noticeable effect on its sealing properties, Dumet wire is produced under very tight quality control conditions.

Core rod composition is double-checked on each heat. Metal bonding, core wire concentricity and copper weight percent are monitored from as-cast to finished product for every lot. Tensile strength, surface finish and oxide-thickness are checked on every spool as the wire is produced.

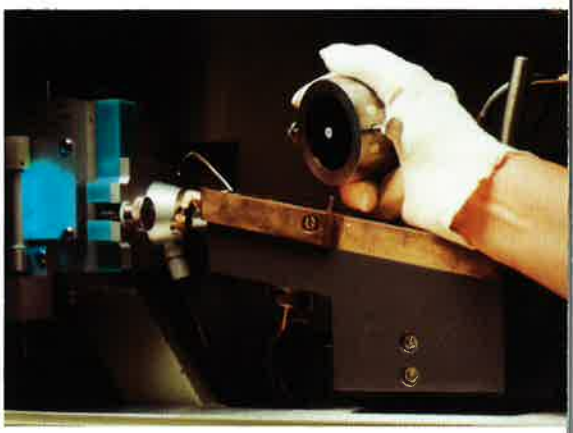
GE also insures quality in the product by closely controlling the process. In dipforming, for instance, a multiple closed loop process is employed to control cladding thickness.

Testing Oxide Thickness

The sealability of glass to Dumet is determined by the thickness of the oxide layer. The color of the wire is a relative indication of this thickness, but it is a highly subjective measure that is open to interpretation. An oxide tester developed by GE removes the guesswork, providing quantitative data on the thickness of cuprous oxide on the surface of borated or oxidized Dumet wire. This data also validates the thickness uniformity of the oxide layer.

The oxide thickness tester handles a wide range of wire diameters and lengths, including finished slug leads. Readings are obtained in less than three minutes for most oxide thickness levels and with minimal sample preparation.

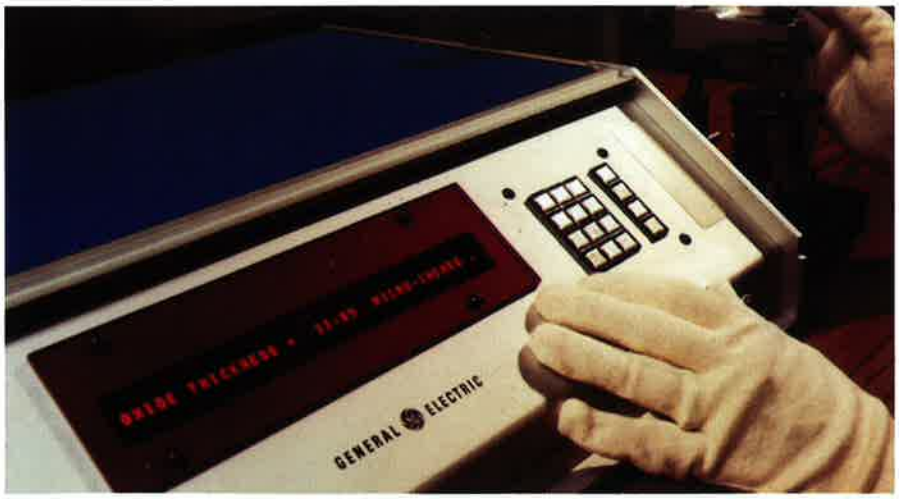
Before GE wire is shipped to the customer, it is thoroughly analyzed for surface defects.



The chemistry on each heat of core rod is verified for conformance to specification.

The oxide thickness tester is used to set up the oxidizing and borating processes, providing the data that permits the use of process control charts. These not only assure specifications are being met, but help identify future process improvement. The tester is also used for inspection procedures.

An oxide thickness tester developed by GE is used for setting up processes in the wire plant and assuring that customer specifications are being met.

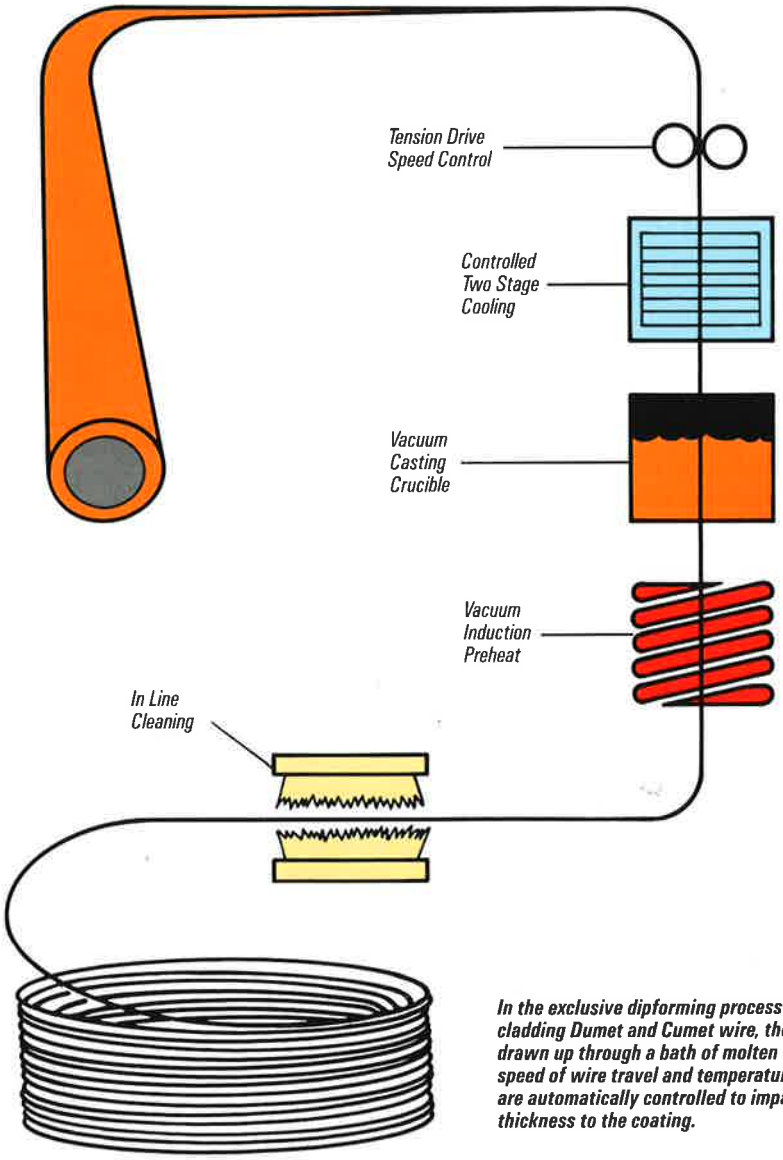


Manufacturing

The sheath of copper on both Dumet and Cumet wire is created in a patented dipform process developed by GE specifically for these materials.

In this process, the core wire is cleaned and fed through a bath of low oxygen, high purity copper. The copper adheres to the surface of the core rod much as tallow freezes onto a candle. A uniform thickness of copper builds up naturally, forming a metallurgical bond as the molten copper solidifies onto the core. The thickness of the sheath is controlled by the speed at which the wire is traveling through the molten bath.

The advantage of the dipform process is a highly uniform copper thickness ratio and a very effective copper-to-core interface. This, in turn, results in a more uniform coefficient of thermal expansion and hence a better glass to metal seal.



In the exclusive dipforming process GE uses for cladding Dumet and Cumet wire, the core wire is drawn up through a bath of molten copper. The speed of wire travel and temperature of the bath are automatically controlled to impart a precise thickness to the coating.

In the crucible, copper is metallurgically bonded to the core rod.

In-process and end product quality control studies are conducted in GE's well equipped QC laboratory.

The dimensions of redressed wire dies are checked on several instruments before the tooling is reinserted into the drawing equipment.

The wire rolling mill is used for sizing large diameter clad wire. It creates less work hardening than drawing, therefore reducing the number of anneals. Rolling also provides an excellent metallurgical bond between the core wire and the copper cladding.

Wire is kept under tension through the annealing furnace so its speed can be carefully controlled. This enables operators to achieve more exact properties in the final product.

Because of the sensitivity of borated Dumet to moisture, packaging and record keeping are given a high priority in the shipping department.

Packaging

GE packages Dumet and Cumet wire according to the diameter of the wire and the size of the order. However, customers have a number of options to accommodate their own requirements.

In the size range of 10 to 30 mil. (.254 to .762mm.) diameters, Dumet is shipped on 3 to 15 pound (1.3 to 6.8kg.) spools contained in heat sealed foil or clear plastic bags with a desiccant. In the 25 to 90 mil. (.635 to 2.300mm.) range, Dumet is wound into self-contained coils on large plastic spools that are shipped in sealed foil bags, also with a desiccant.

Cumet, the copper colored wire in the smaller photo, is available in 200 pound (90kg.) spools packaged in clear plastic, as well as in pail packs.

Pail packs are flat drums in which the wire is wound around a central core so that it can be continuously fed into automatic processing or assembly machinery.

Storage and Handling

Because the coating on borated Dumet is anhydrous and tends to pick up moisture from the air, special procedures in storage and handling should be followed. Too much moisture causes some of the fused borax in the borate coating to devitrify producing a whitish cast on the wire.

This condition, referred to as "blooming," causes scattered bubbles in the glass seal.

To minimize this problem during shipment, GE Borated Dumet is packaged in a sealed plastic bag which includes a desiccant to help maintain the required atmospheric condition.

Once the material has been received by the user, the following procedures should be followed:

- Dumet should be kept in its sealed bag and stored in cabinets maintained at a relative humidity of less than 50%.
- Prolonged storage should be avoided. The oldest stock should always be used first.
- For maximum performance Dumet should be used within 30 days from the date of shipment.
- The material should not be touched with bare hands and should be kept free from contact with grease.
- Any mechanical damage to Dumet's surface should also be avoided since a broken surface may cause sealing problems.
- If borated Dumet is exposed to light, the color may darken somewhat because the borate coating is photo-sensitive; however, the sealing qualities will not be affected.

GE recommends the above procedures be followed in order to minimize the possibility of deterioration.

CAUTION

DETERIORATION OF THE DUMET SURFACE AFTER DELIVERY IS NOT CONSIDERED A DEFECT IN MATERIAL OR WORKMANSHIP, NOR A FAILURE TO CONFORM TO SPECIFICATIONS.

Shipping Information

Dumet and Cumet wire are packaged for shipping on either self contained coils or standard spools or reels.

The materials are shipped in one continuous length per container or coil, as indicated in the chart below.

Any deposit charge made for shipping containers is refunded when containers are returned prepaid and in good condition.

Cumet Wire

Resistance annealed Cumet is supplied on returnable plastic spools.				
Nominal Wire Weight/Spool	Spool Dimensions			
	Flange O.D.	Traverse	Bore	Approx Tare Wt.
200 lbs.	18″	9½″	5.0″	17.5 lbs.
90 kgs.	457.2 mm	241.3 mm	127.0 mm	8 kgs.
Strand annealed Cumet is supplied in disposable pail packs.				
Nominal Wire Weight/Pail	Pail Dimensions			
	O.D.	I.D.	Height	Approx Tare Wt.
80 lbs.	21″	12″	11″	10 lbs.
36 kgs.	533.4 mm	304.8 mm	279.4 mm	4.5 kgs.

Dumet Wire

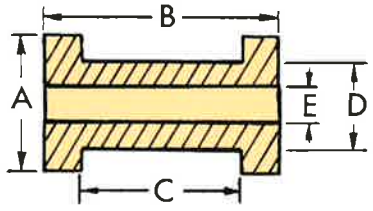
Type of Dumet	Wire Diameter	Max Wire Wt Per Spool	Flange OD (A)	Width (B)	Traverse (C)	Barrel Diameter (D)	Hole Diameter (E)	Approx. Spool Tare Wt	Spool Name
Lamp Grade *(Borated, Oxidized, Nickel Plated and Unborated)*	≤0.16″ ≤0.4mm	3.3 lbs 1.5 kgs	4.500″ 114.30mm	2.750″ 69.85mm	2.250″ 57.15mm	2.000″ 50.80mm	1.750″ 44.45mm	0.30 lbs. 0.14 kgs	1.5 KG Spool
	≤.020″ ≤0.5mm	4.4 lbs 2.0 kgs	4.375″ 111.13mm	3.500″ 88.90mm	2.875″ 73.03mm	2.500″ 63.50mm	0.625″ 15.88mm	0.30 lbs 0.14 kgs	2.0 KG Spool
	.014-.030″ .35-.75mm	10.0 lbs 4.5 kgs	6.000″ 152.40mm	4.312″ 109.54mm	3.500″ 88.90mm	3.375″ 85.73mm	0.625″ 15.88mm	1.10 lbs 0.50 kgs	4.5 KG Spool
Semi-Conductor Grade *(Oxidized Only)*	.0253-.059″ .65-1.50mm	15.4 lbs 7.0 kgs	13.625″ 346.08mm	2.813″ 71.45mm	2.500″ 63.50mm	10.875″ 276.23mm	1.875″ 47.63mm	1.75 lbs 0.80 kgs	7.0 KG Spool
Semi-Conductor Grade *(Oxidized and Leach Resistant Borated)*	.0253-.090″ .65-2.30mm	Coil Weight 12.1 lbs 5.5 kgs	Coil ID 13-15″ 330-381mm	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A	Self Contained Coils

PACKAGE IDENTIFICATION

The following identification and descriptive information, where applicable, is put on each label: type of wire, standard process designation, quantity of meters or kilograms, size in milligrams per 200 millimeters or in mils, metal lot number, designation of ingot from which wire was drawn, date of packaging, and code number of operator who packaged wire. Information such as this is backed by records of a rigid quality control system and makes possible positive identification of wire made by GE.

It is recommended that labels and tags be kept with the wire so that identification can be made at any time.

Small corks are used to secure wire to spools or bands. A red cork signifies the outer end.



Designation of Container Dimensions

Dumet and Cumet Wire: Two of GE's Many Special Engineering Materials

Dumet and Cumet wire are among the many innovations that GE has made in the lighting industry. Today, we produce literally hundreds of special products like these, and their applications are much broader than the lamp industry.

In addition to Dumet and Cumet wire, we manufacture lead wires and lead wire assemblies . . . tungsten wire, tungsten wire filaments, and tungsten and tungsten carbide powders, molybdenum wire and molybdenum wire lamp supports, lamp bases and formed and fabricated parts.

We manufacture glass in the form of bulb blanks, tubing and pressed ware, and fused quartz in the form of tubing, rod, ingots and crucibles. Lucalox® ceramics, luminescent phosphors, and inorganic chemicals are some of our other special materials.

The uses of these products and materials include semiconductor processing, electronic packaging and testing, cutting tools, electrodischarge machining, ceramics, vacuum metallizing and many others.

Every product we produce is subject to stringent quality control procedures, whether it is destined for our product line or yours. Some of these products may be available from our inventory, while others will be custom made to your specifications.

Because of the unique character of many of these products, GE stands ready to provide product development or application engineering assistance to its customers.

For more information, contact your regional sales representative or the nearest sales office indicated below.

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