TRANSENE COMPANY, INC.
DANVERS INDUSTRIAL PARK
10 ELECTRONICS AVE.
DANVERS, MA 01923
TEL: (978) 777-7860
FAX: (978) 739-5640

PACKING SLIP

078963

Order Date
06/09/99

SOLD TO: OBRIEN SCIENTIFIC SYSTEMS
55 CRYSTAL AVENUE PMB324
DERRY NH 03038-1725

SHIP TO: OBRIEN SCIENTIFIC SYSTEMS
55 CRYSTAL AVENUE PMB324
DERRY NH 03038-1725

ACCOUNT NO.	SALESPERSON NUMBER	PURCHASE ORDER NO.	SHIP VIA	DATE SHIPPED	TERMS	INVOICE DATE	PAGE
OBRIEN		68994	RPS		Net 30 Days		1

QTY. ORDERED	QTY. SHIPPED	QTY. BACK ORDERED	ITEM NO.	DESCRIPTION	UNIT PRICE	EXTENDED PRICE
2	2	0	050-005T33C-1PT	CATHODE COATINGS TYPE T33C-133 DC CERTIFICATE OF COMPLIANCE MSDS INCLUDED		

COMMENTS:

Thank You

TRANSENE COMPANY, INC.
DANVERS INDUSTRIAL PARK
10 ELECTRONICS AVENUE
DANVERS, MA 01923
TEL: (978)777-7860

TO: OBRIEN SCIENTIFIC SYSTEMS
55 CRYSTAL AVENUE PMB 324
DERRY NH 03038-1725

PO# 68994
INV# 078963
DATE: 6/15/99

This is to certify that this material meets the manufacturer's specification as to material, fabrication, inspection and lot identification.

PRODUCT	QUANTITY	LOT NUMBER	DATE OF MFG.	SHELF LIFE/EXP.
CATHODE COATING T-33C-133 DC	2 X 1 PINT	069909	6/99	1 YEAR

Martin E Hecht
MARTIN E. HECHT, PRESIDENT

CERTIFICATE OF COMPLIANCE

MATERIAL SAFETY DATA SHEET

CATHODE COATING T33-C-133
N/A = not available

MANUFACTURER: TRANSENE COMPANY, INC.
ADDRESS: ROUTE ONE
ROWLEY, MA 01969
PHONE: 508-948-2811
EMERGENCY NO. 508-948-2501 TELEX

NO._____

SECTION I. MATERIAL IDENTIFICATION

Reviewed:

MATERIAL NAME: CATHODE COATING T33-C-133
OTHER DESIGNATIONS
EMMISSION CARBONATE MIXTURE

CHEMICAL FAMILY ALKALINE EARTH CARBONATE MIX TRADE NAME T33C-133

SECTION II. INGREDIENTS AND HAZARDS

			%	HAZARD DATA
				Toxicity (mg/M^3)
Barium, Strontium Carbonate	CAS# 32915-78-9	w/v	35	nuisance dust
N-Butyl Acetate	123-86-4	v/v	55	100 ppm
Diethyl Oxalate	95-92-1	v/v	25	0.4mg/Kg LD_{50}:orl-rat

SECTION III. PHYSICAL DATA

Boiling point at 1 atm, deg C	N/A	Specific gravity, 20/4 °C	N/A
Vapor pressure at 15 °C, mm Hg	N/A	Evap. Rate (BuAc = 1)	N/A
Vapor density (Air = 1)	N/A	Volatiles, %	N/A
Water solubility at 20 °C	Insoluble	Molecular weight	N/A

Appearance & Odor:

Shiny white paint-like viscosity

SECTION IV. FIRE AND EXPLOSION DATA for AMYL ACETATE

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air % by volume	LOWER	UPPER
98.0 TagCC	714°F approx.		1.1	7.5

Extinguishing media:

Carbon dioxide, dry chemical, Foam or water spray.

Special fire fighting procedures: Wear NIOSH MSHA approved self-contained breathing apparatus.

SECTION V. REACTIVITY DATA

Stability		Conditions to avoid:
	Stable XXX	flame, sparks, elevated temperatures
	Unstable	

Incompatible with: avoid strong alkalies or acids

Hazardous decomposition products: Oxalic acid, ethanol, CO, and CO_2. At elevated temperatures toxic concentrations of diethyl oxalate may be produced.

Hazardous polymerization:		Conditions to avoid:
	May occur	
	Will not occur XXXXX	

Material Safety Data :

ROUTE ONE, ROWLEY, MASS. 01969
Tel. (617) 948-2501, 948-2811

TRANSENE COMPANY, INC.

Addendum to Material Safety Data Sheet

REGULATORY STATUS

This Addendum Must Not Be Detached from the MSDS

Identifies SARA 313 substance(s)

Any copying or redistribution of the MSDS must include a copy of this addendum

Hazard Categories for SARA Section 311/312 Reporting

Acute	Chronic	Fire	Pressure	Reactive
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Product or Components of Product:	SARA EHS Sect. 302 RQ (lbs.)	SARA EHS Sect. 302 TPQ (lbs.)	SARA Section 313 Chemicals Name List	SARA Section 313 Chemicals Chemical Category	CERCLA Sec.103 RQ (lbs.)	RCRA Sec. 261.33
Barium Carbonate (Barium Compounds) (513-77-9)	No	No	No	Yes	No	No

Applicable Products:
Cathode Coatings(100-700, T33C118-T33C921), Emmission Carbonates Powder

SARA Section 302 EHS RQ: Reportable Quantity of Extremely Hazardous Substance, listed at 40 CFR 355.
SARA Section 302 EHS TPQ: Threshold Planning Quantity of Extremely Hazardous Substance. An asterisk (*) following a Threshold Planning Quantity signifies that if the material is a solid and has a particle size equal to or larger than 100 micrometers, the Threshold Planning Quantity = 10,000 LBS.
SARA Section 313 Chemicals: Toxic Substances subject to annual release reporting requirements listed at 40 CFR 372.65.
CERCLA Sec. 103: Comprehensive Enviromental Response, Compensation and Liability Act (Superfund). Releases to air, land or water of these hazardous substances which exceed the Reportable Quantity (RQ) must be reported to the National Response Center, (800-424-8802); Listed at 40 CFR 302.4
RCRA: Resource Conservation and Reclamation Act. Commercial chemical product wastes designated as acute hazards and toxic under 40 CFR 261.33

CATHODE COATINGS For Thermal Electronic Emission

Lacquer spray and electrophotoretic coatings of emission carbonates (Ba-Sr-Ca) – for oxide coated cathodes in electronic tube applications.

SPECIAL FEATURES

- Spray and electrophoretic coating applications.
- High purity carbonates with isomorphous crystal structure.
- Controlled viscosity, uniformity, and particle size.
- Excellent emission characteristics.
- Long term stability

Cathode Coatings prepared to customer specifications are also offered.

Transene Co. Inc. 10 Electronics Ave, Danvers, MA 01923 Tel: 978-777-7860 Fax: 739-5640

CATHODE COATINGS

DESCRIPTION

Transene double and triple carbonates are specially prepared electronic materials used for efficient thermal electron emission of cathode structures. These carbonates are compounds of Ba, Sr, and Ca, occurring as homogenous crystallites with an isomorphous crystal structure, carefully dispersed in a lacquer vehicle. Furthermore, the vehicle contains an improved ethyl cellulose binder to create a highly stable lacquer spray coating. An electrophoretic cathode coating is also offered. These coatings can be applied to various geometric hot cathode structures

- Filamentary, cylindrical, disk, hollow, etc.

Upon heating (breakdown), the carbonate coatings are converted to semiconductor oxides of Ba, Sr, and Ca. These oxides are characteristically N-type and exhibit high electron conductivity paralleling the high functional activity of the hot cathodes. In addition, the pore structures produced from these carbonate coatings are optimized to augment emission and conductivity.

Cathode Coating Types

CATHODE COATING –100 High calcium triple carbonate spray coating	(Ba-Sr-Ca) CO_3 56-31-13%
CATHODE COATING –200 High calcium, high density, triple carbonate spray coating	(Ba-Sr-Ca) CO_3 56-31-13%
CATHODE COATING – 300 Low calcium, triple carbonate spray coating	(Ba-Sr-Ca) CO_3 56-39-4%
CATHODE COATING –400 Low calcium, high density, triple carbonate spray coating.	(Ba-Sr-Ca) CO_3 56-39-4%
CATHODE COATING – 500 High density, barium and strontium carbonate s spray coating	Equimolar $BaCo_3.SrCO_3$
CATHODE COATING – 600 High density, barium and strontium carbonate electrophoretic coating.	Equimolar $BaCo_3.SrCO_3$
CATHODE COATING – 700 High density, triple carbonate	(Ba-Sr-Ca) 57-39-4%

APPLICATIONS

Transene Cathode Coatings offer selection of materials to best satisfy requirements for electron emissive surface in radio tubes, TV and cathode raytubes, power tubes, thyratrons, and other electron devices. Cathode Coating – 100 is for general-purpose applications. Cathode Coating – 200 and -400 are recommended where grid-to-cathode spacing must be held very closely. Cathode Coating –300 and –400 permit cathodes to be operated at elevated temperatures; while tube transconductance shows excellent stability during life. Cathode Coating –500 is useful when arc prevention is essential. Cathode coatings –600 and –700 are electrophoretic types designed to achieve very high packing density of emission carbonates.

Special emission coating are also available or can be developed for particular applications and requirements. These special products include coating for cataphoresis, dip, and automatic or hand spray methods.

ELECTROPHORETIC CATHODE COATING – TYPE 600 INSTRUCTIONS

DESCRIPTION:

This product contains double carbonates of barium and strontium suspended in an organic vehicle. The product includes an activator (part B) which is added to Part A, containing the suspension of double carbonates.

This mixture is suitable for electrophoretic coating after the addition of the activator (Part B). The suspended double carbonate particles carry a negative charge. The charge is developed when the activator is added as a result of adsorption of hydroxl ions.

As a result, the double carbonate particle will migrate to the positive terminal of the cell.

PROCEDURE FOR ELECTROPHORETIC COATING

1. Equipment needed: (See Figure 1)
   A. Stainless steel beaker
   B. Stirrer
   C. High voltage DC supply 0 to 400 volts and 0 to 200 ma

2. Room Temperature 25°C

3. Voltage 200 to 400 volts

4. Polarity work – Positive

5. Mild agitation or stirring recommended.

The electrophoretic coat thickness is a function of temperature, time, voltage, and inter-electrode distance. Relationship of coating thickness to time and voltage shown in Figure 2.

ELECTROPHORETIC CATHODE COATING – TYPE 700 INSTRUCTIONS

DESCRIPTION:

This product contains triple carbonates of barium and strontium suspended in an organic vehicle. The product includes an activator (part B) which is added to Part A, containing the suspension of double carbonates.

This mixture is suitable for electrophoretic coating after the addition of the activator (Part B). The suspended triple carbonate particles carry a negative charge. The charge is developed when the activator is added as a result of adsorption of hydroxl ions.

As a result, the double carbonate particle will migrate to the positive terminal of the cell.

PROCEDURE FOR ELECTROPHORETIC COATING

2. Equipment needed: (See Figure 1)
   D. Stainless steel beaker
   E. Stirrer
   F. High voltage DC supply 0 to 400 volts and 0 to 200 ma

2. Room Temperature 25°C

3. Voltage 200 to 400 volts

4. Polarity work – Positive

6. Mild agitation or stirring recommended.

The electrophoretic coat thickness is a function of temperature, time, voltage, and inter-electrode distance. Relationship of coating thickness to time and voltage shown in Figure 2.

CHARACTERISTICS OF SPRAY CATHODE COATINGS
TRANSENE COMPANY INC.

TYPE	PRODUCT DESCRIPTION	SOLIDS AS CARBONATES	PERCENT COMPOSITION OF CARBONATES	VEHICLE BINDER	DILUENT	ZAHN VISCSITY #1(SEC)
CATHODE COATING-100	HIGH CALCIUM TRIPLE CARBONATE SPRAY COATING	44% W/V	56% $BaCO_3$ 31% $SrCO_3$ 13% $CaCO_3$	Ethyl Cellulose	85% Xylol-15% Butanol Mixture	32
CATHODE COATING-200	HIGH CALCIUM HIGH DENSITY TRIPLE CARBONATE SPRAY COATING	22% W/V	56% $BaCO_3$ 31% $SrCO_3$ 13% $CaCO_3$	Ethyl Cellulose	85% Xylol-15% Butanol Mixture	32
CATHODE COATING-300	LOW CALCIUM TRIPLE CARBONATE SPRAY COATING	44% W/V	57% $BaCO_3$ 39% $SrCO_3$ 13% $CaCO_3$	Ethyl Cellulose	85% Xylol-15% Butanol Mixture	32
CATHODE COATING-400	LOW CALCIUM HIGH DENSITY TRIPLE CARBONATE SPRAY COATING	22% W/V	57% $BaCO_3$ 39% $SrCO_3$ 4% $CaCO_3$	Ethyl Cellulose	85% Xylol-15% Butanol Mixture	32
CATHODE COATING-500	HIGH DENSITY BARIUM & STRONTIUM CARBONATES SPRAY COATING	44% W/V	57.5% $BaCO_3$ 42% $SrCO_3$	Ethyl Cellulose	85% Xylol-15% Butanol Mixture	32

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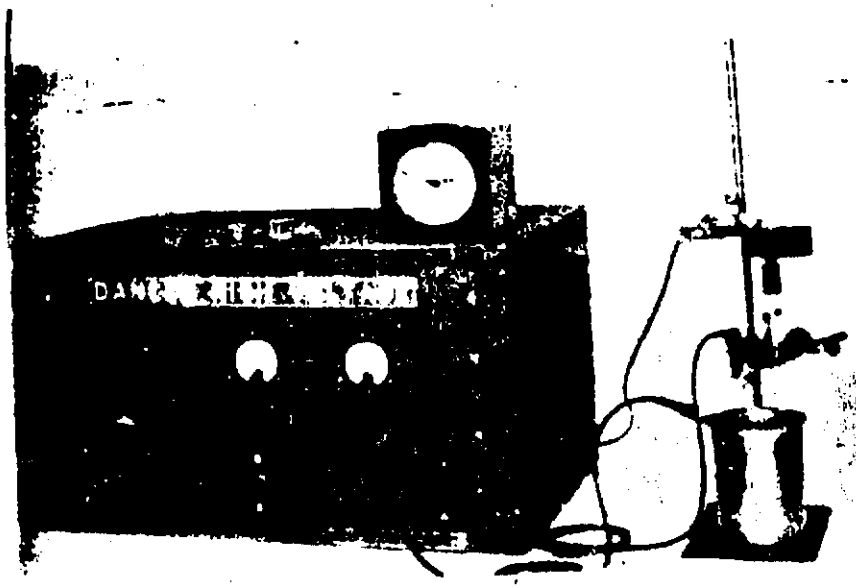

Fig.1 Electrophoretic power supply and deposition cell.

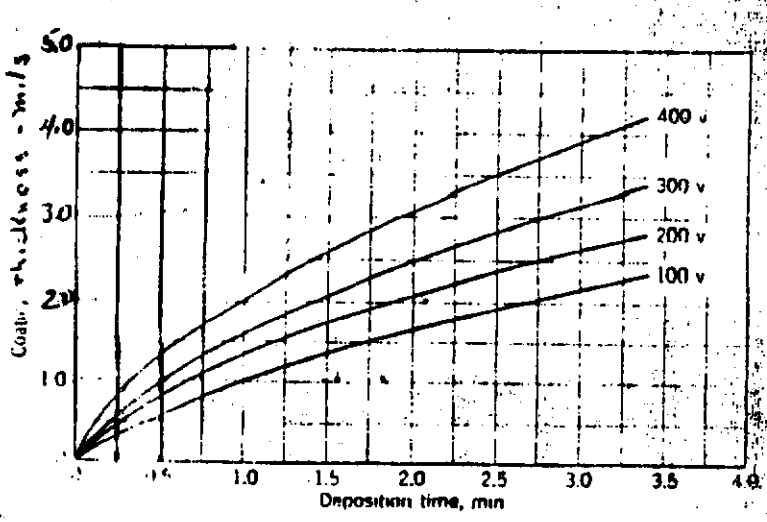

Fig.2 Coating thickness versus deposition time for various cell voltages.

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(617) 948-2811

PROCESS FOR ACTIVATION OF CATHODES (Double and Triple Carbonates Cathode Coatings)

The activation process described herein pertains to Transene Cathode Coatings, Types-100,-200,-300,-400, and –500. The basic process is quite conventional and involves heating in vacuum to obtain the essential "breakdown" of cathodes. The process involves four operational steps as follows:

1. Dissipation and removal of ethyl cellulose binder as volatile products.
2. Conversion of the carbonates into the corresponding oxides by thermal degradation.
3. Partial reduction of oxides by dissociation at the metal-coating interface to form free barium, with uniform dispersion of free barium resulting.
4. Cathode stabilization.

The activation process begins by cathode heating to about 500°C for a few minutes under vacuum (at least 10^{-5}mm Hg.). The heat input is increased to raise the temperature close to 600°C. The cathode coating will change in color during the heating process becoming gray or black and finally pure white.

The temperature of the heated cathodes should then be increased to control of the heater wattage. The temperature should rise to approximately 900°C, to obtain complete conversion of the carbonates to oxide, e.g.:

$$BaCO_3 \rightarrow BaO + CO_2 \qquad (1)$$
$$CaCO_3 \rightarrow CaO + CO_x \qquad (2)$$
$$SrCO_3 \rightarrow SrO + CO_2 \qquad (3)$$

Complete conversion of the carbonates to oxides will be indicated by the sharp drop in pressure to 10^{-6} mm. Of Hg.

Final activation is then carried out by raising the cathode temperature up to 1200°C, but not higher. At this high temperature some barium is produced forming active cathode structures.

Stabilization is generally obtained by applying a de voltage to draw a cathode current of 25-50 ma/cm^2 for a short time. The temperature is then reduced at 800°C.

CATHODE COATINGS RCA EQUIVALENT

CATHODE COATING NO:	CARBONATES	VEHICLE	METHOD OF APPLICATION	COATING DENSITY
T-33C-118	BaSrCa 56/31/13% Ammonium. Carb, Spherulite Form	Nitrocellulose	Hand Spray	Very High
T-33C-131	BaSrCa 57/39/4% Sodium carb. Ppted. Needle Form	Nitrocellulose	Hand Spray	Medium to High
T-33C-132	BaSrCa 57/39/4% Sodium carb.ppted. Needle Form	Nitrocellulose	Hand Spray	Medium
T-33C-133	$BaCO_3$ $SrCO_3$ Single Crystal Sodium carb. Ppted. Needle Form	Nitrocellulose	Hand Spray	Very High
T-33C-138	BaSrCa 57/39/4% Sodium carb. Ppted. Needle Form	Nitrocellulose	Machine or Hand Spray	Low to Medium
T-33C-144	$BaCO_3$ $SrCO_3$ Single Crystal Sodium carb. Ppted. Needle Form	Nitrocellulose	Spray	Medium
T-33C-185A	BaSrCa 57/39/4% Sodium carb. Ppted. Needle Form Low water solubles	Nitrocellulose	Hand Spray	Medium to High
T-33C-304	BaSrCa 57/39/4% Sodium carb. Ppted. Needle Form	Methyl Methacrylate	Cataphoretic ctg. Filamentary wires	High
T-33C-326	BaSrCa 57/39/4% Nickel-carb. Type Needle Form	Nitrocellulose	Hand Spray	Medium to High
T-33C-326A	BaSrCa 57/39/4% Nickel-carb. Type Needle Form	Nitrocellulose	Machine or Hand Spray	High
T-33C-334	BaSrCa 56/31/13% Ammonium. Carb, Spherulite Form	Methyl Methacrylate	Cataphoretic ctg. Filamentary wires	High
T-33C-337	BaSrCa 57/39/4% Amm carb, ppted. Spherulite Form	Nitrocellulose	Hand Spray	Medium to High
T-33C-338*	BaSrCa 57/39/4% Amm carb, ppted. Spherulite Form	Butyl Methacrylate	Spray	Medium o High
T-33C-339*	$BaSrCO_3$ 57/43% Amm carb, ppted. Spherulite Form	Butyl Methacrylate	Spray	Medium o High
T-33C-921	BaSrCa 57/39/4% Sodium car. Ppted. Needle Form/low water solubles	Nitrocellulose	Spray	Medium o High
T-33C-340	$BaSrCO_3$ 57/43% Ammonium. Carb, Spherulite Form	Nitrocellulose	Spray	Medium

RCA EQUIVALENT MATERIALS

EMMISSION CARBONATES POWDER

PRODUCT #	CARBONATE	COMPOSITION	FORM
T-33-B-1A	$BaCO_3$	100%	Needle Form
T-33-S-1A	$SrCO_3$	100%	Needle Form
T-33-C-42	$(BaSrCa)CO_3$	56/31/13%	Spherulite Form
T-33-C-106	$(BaSr)CO_3$	57/43%	Needle Form
T-33-C-120	$(BaSr)CO_3$	57/43%	Needle Form
T-33-C-125	$(BaSr)CO_3$	57/43%	Spherulite Form
T-33-C-130	$(BaSrCo)CO_3$	57/39/4%	Needle Form
T-33-C-175A	$(BaSrCa)CO_3$	57/39/4%	High Purity
T-33-C-335	$(BaSrCa)CO_3$	57/39/4%	Needle Form
T-33-C-813	$(BaSrCa)CO_3$	49/44/7%	Spherulite

BINDERS FOR CATHODE COATINGS

Nitrocellulose Binder	Methacrylate Binders
T-33-B-10	T-33-B-207
T-33-B-109	T-33-B-209
T-33-B-110	T-33-B-610F
T-33-B-114	
T-33-B-608	
T-33-B-902	

HEATER COIL COATINGS

For Coating Heater Wires in Electron Tubes.

ALUNDUM COATING – T33C-220
ALUNDUM COATING – T33C-255L
HEATER COIL COATING – T-100

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