Sealing Glasses

Materials Business

CORNING

Sealing Glasses: Product & Application Information

Product Information

Corning offers many glasses specifically for hermetic sealing applications such as:

- Display sealing
- IC packages
- Mechanical seals
- Coatings
- Wire feedthroughs
- Ferrite sealing

Sealing glasses are available in two types: vitreous and devitrifying. Vitreous sealing glasses are thermoplastic materials which melt and flow at the same temperature each time they are thermally processed. Devitrifying sealing glasses are thermosetting materials which crystallize by surface nucleation in a time-temperature relationship. Due to the crystalline nature of the material, a devitrified sealing glass has thermal stability which is greater than that of the original glass.

Application Information

The recommended difference between the coefficient of thermal expansion of the sealing glass and the material to be sealed should be less than 5×10^{-7}/°C. In the case of special geometries, seals can be made with larger differences.

Application Methods - Powdered glasses

Spraying

Satisfactory spray suspensions can be obtained by suspending glass powders in a volatile solvent such as amyl acetate or denatured alcohol. In the case of most volatile vehicles, small amounts of organic binders may improve the suspension characteristics and "green" strength of the sprayed glass. It is critical in spray applications to maintain a well agitated slurry reservoir and to minimize the distance from the reservoir to the spray nozzle to minimize sedimentation.

Screening

Selection of a vehicle for this method of application depends upon particle size, screen dimensions, application speeds, drying characteristics of the suspension vehicles and the final seal configuration. A typical slurry system is comprised of pine oil (carrier), and ethyl cellulose (binder). The important factors to consider when selecting a vehicle are screenability and thoroughness of binder burn-out.

Extrusion

For consistent seals using the extrusion method, proper mixing and application techniques are very important. Both the glass-to-vehicle ratio and the mixing technique must be held constant. Assuming the use of a typical vehicle (amyl acetate with 1.2 weight % nitrocellulose as a binder), the glass-to-vehicle ratio should be between 8:1 and 14:1 with 12:1 ratio being optimum under most conditions. Due to the thixotropic rheology of the slurry, the slurry must be homogenized and blended at a constant rate when the mixture is used in a continuous production process. To prevent evaporation, the slurry should be dispensed directly from an air-tight mixing chamber. When used in small quantities, the slurry can be mixed in a small container and applied through a syringe-type device.

Storage Recommendation

The glass powders should be stored in their original airtight containers. These glasses are hygroscopic and prolonged exposure to air may result in a change in handling and application characteristics. When properly sealed and stored, these glasses should have an unlimited shelf life.

Sealing Parameters - Powdered glasses

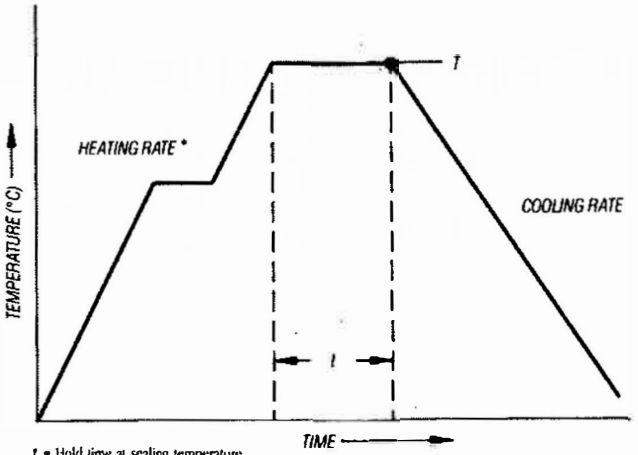
Binder burnout

Binder burnout of the sealing glasses is essential to drive off organic residues produced by vehicle and binder decomposition. This decomposition determines the time and temperature required for burnout. The burnout temperature should not exceed 350°C and the time must be sufficient to allow for complete outgassing. Heating the glass too rapidly may tend to glaze the surface and preclude escape of the carbonaceous products of burnout. Burnout may take place during a separate operation or it may be included as a part of the sealing cycle. Insufficient burnout will cause increased porosity in the seal due to outgassing of trapped organics from the vehicle. Insufficient burnout may cause high lead oxide glasses to darken due to a reduction of the lead oxide to metallic lead.

Pre-glazing

When the "green" strength of a seal needs to be increased for handling and sub-assembly, the glass can be pre-glazed. Pre-glazing can be accomplished by heating the part (as rapidly as its size will allow after burnout) to the softening point of the glass, holding for approximately 10 minutes, then cooling.

Sealing Cycle



t = Hold time at sealing temperature
T = sealing temperature

* Hold for binder burnout not to exceed 350° C

Sealing

Sealing operations should be done in an oxidizing atmosphere to prevent the reduction of lead oxide in the glass. An oxygen rich air atmosphere is recommended. Seals can also be made in a nitrogen atmosphere. Lead oxide containing sealing glasses should not be fired in a reducing atmosphere.

A recommended heating rate for a particular glass can be found in the properties table. The size, geometry, and thermal mass of a part (as well as any fixturing) will determine the optimal sealing cycle. For example, large glass parts generally require very slow heating and cooling rates on the order of 10°C /minute or less with peak temperature hold times to reach thermal equilibrium to minimize residual stress. Small integrated circuit packages may require heating rates in excess of 100°C /minute with rather short hold times. The sealing cycle can be varied to achieve optimum results. Devitrifying sealing glasses are surface nucleating. Changes in final properties can be dependent upon variations in the thermal processing of the seal.

Sealing Glasses

Glass Code	Type	Forms Usually Available[1]	Glass Type[2]	Thermal Expansion x 10⁷ cm/cm/°C 0 - 300°C	Thermal Expansion x 10⁷ cm/cm/°C 25°C to Set Point	Sealing Cycle: Sealing Temp. °C	Sealing Cycle: Hold Time min.	Sealing Cycle: Heating Rate °C / min.	Max. Service Temp. °C	Strain Point, °C 10^{14} poise	Annealing Point, °C 10^{13} poise	Softening Point, °C $10^{7.6}$ poise	Density g/cc	Log_{10} Volume Resistivity ohm-cm 250°C	Dielectric Constant 1 MHz, 20°C	Loss Tangent % 1 MHz, 20°C	Typical Application	Glass Code
0120	Potash Soda Lead	P,T,M	V	89.5	99.0	980	5	50 – 100	370	395	435	630	3.05	10.10	6.700	0.1200	Glass-to-Metal Sealing	0120
1415	Barium Borosilicate	K,P	V	79.0	96.7	850	15	50 – 100	595	620	654	776	3.64				Ferrite Sealing	1415
1416	Lead Aluminosilicate	K,P	V	81.0	90.8	513	15	50 – 100	339	364	389	463	5.26				Ferrite Sealing	1416
1417	Lead Aluminosilicate	K,P	V	89.0	96.1	487	15	50 – 100	311	336	356	427	5.60				Ferrite Sealing	1417
1724	Aluminosilicate	P,T,M	V	44.0	50.0	1175	5	50 – 100	649	674	726	926	2.64	13.80	6.600	0.0010	Glass-to-Metal Sealing	1724
1990	Potash Soda Lead	P	V	124.0	131.0	560	15	20 – 50	315	340	370	500	3.50	10.10	8.300	0.0500	Iron Sealing	1990
7046	Alkali Borosilicate	P,M	V	50.0		1000	5	50 – 100	427	452	495	702	2.27	10.40	5.350	0.2000	Glass-to-Metal Sealing	7046
7052	Alkali Barium Borosilicate	P,T,M,C	V	47.0	53.1	1000	5	50 – 100	415	440	484	712	2.27	9.20	5.100	0.1500	Sealing to Kovar	7052
7056	Alkali Borosilicate	P,T,M	V	51.5	54.5	1000	5	50 – 100	447	472	512	718	2.29	10.30	5.700	0.2700	Glass-to-Metal Sealing	7056
7070	Lithia Potash Borosilicate	P,M	V	32.0	39.0	1025	5	50 – 100	431	456	496		2.13	11.20	4.100	0.0600	Glass-to-Metal Sealing	7070
7555	Lead Borate	P	V	88.0	99.3	450	15	50 – 100	301	326	370	415	5.70	10.50	13.740		Flat Panel Display Sealing	7555
7556	Lead Borate	P	V	67.0	67.0	450	12	50 – 100	209	234	269	330	4.68				Alumina Sealing	7556
7567	Lead Zinc Borate	K,P	V	120.0	120.0	415	10	20 – 50	258	283	303	358	6.61				Ferrite Sealing	7567
7568	Lead Zinc Borate	P	D	89.0	100.0	425	30	5 – 20	400			320	5.97				Color CRT Sealing	7568
7570	Lead Borosilicate	K,P	V	83.0	93.5	470	25	20 – 50	333	358	376	447	5.46	10.60	15.000	0.2200	Ferrite Sealing	7570
7572	Lead Zinc Borosilicate	P	D	95.0	95.0	450	60	5 – 20	425	294	313	370	6.30	8.60	20.000	0.8700	Glass-to-Metal Sealing	7572
7574	Zinc Borosilicate	P	D	34.0	46.0	750	60	5 – 20	725	537	560	644	3.78	13.70	6.100	0.2000	Glass-to-Metal Sealing	7574
7575	Lead Zinc Borosilicate	P	D	89.0	89.0	450	60	5 – 20	425			380	6.30	8.60	20.400	0.9100	Glass-to-Metal Sealing	7575
7576	Zinc Boric Lead	P	D	100.0[3]	100.0	460	20	5 – 20	435	292	311	372	6.47				Color CRT Sealing	7576
7578	Lead Zinc Borosilicate	P	D	65.0	68.0	530	60	5 – 20	460			445	5.82				Fiber Optics Sealing	7578
7580	Lead Barium Borosilicate	P	D	100.0[3]	96.0	450	30	5 – 20	425	293	311	374	6.47	8.20			Color CRT Sealing	7580
7583	Lead Zinc Borosilicate	P	D	84.0	83.0	480	5	5 – 20	455			370	6.00	8.50	18.900	0.7100	Alumina Sealing	7583
7585	Lead Zinc Borate	P	V	68.0	67.5	415	10	50 – 100	390		309	365	5.10	9.55	12.380	0.2500	Alumina Sealing	7585
7586	Lead Zinc Borosilicate	P	V	66.5	67.0	600	30	50 – 100	379	404	427	513	5.04	8.00	12.000		Silicon Passivation	7586
7589	Lead Zinc Borosilicate	P	D	80.0	78.0	480	15	5 – 20	455			335	6.00	8.50	18.900		IC Packages	7589
7590	Lead Zinc Borate	P	D	97.0	103.7	440	35	5 – 20	415			374	6.45	13.60			Color CRT Sealing	7590
7595	Lead Zinc Borate	P	D	97.0	110.0	415	45	5 – 20	390			362	6.45	13.60			Color CRT Sealing	7595
7597	Lead Zinc Borate	P	D	100.0	105.0	440	30	5 – 20	415			374	6.40				Color CRT Sealing	7597
7598	Lead Zinc Borate	P	D	100.0	103.0	440	30	5 – 20	415			374	6.40				Color CRT Sealing	7598
7599	Lead Zinc Borate	P	D	89.0	98.8	425	45	> 5	400			320	5.78	9.30	17.700	1.1000	Soda Lime Sealing	7599
7723	Lead Borosilicate	P	V	35.0	45.0	810	15	50 – 100	455	480	522	770	2.90	12.10	5.730	0.0500	Silicon Sealing	7723
7732	Lead Zinc Borate	P	D	91.6	82.0	450	12	5 – 50	425			315	5.80			0.5000	Alumina Sealing	7732
7761	Potash Borosilicate	P,M,C	V	28.0	31.0	1300	5	50 – 100	433	458	510	820	2.16	12.30	4.000	0.1400	Electrical Insulator	7761
8161	Potash Rubidium Lead	K,P,T	V	90.3	95.0	660	10	20 – 50	375	400	435	600	3.97	12.00	8.300	0.0500	Ferrite Sealing	8161
8445	Lanthanum Barium	K,P	V	80.0	95.0	850	20	50 – 100	599	624	652	759	3.98				Ferrite Sealing	8445
8463	Lead Borate	K,P	V	102.0	108.0	425	15	20 – 50	294	319	333	388	6.22				Ferrite Sealing	8463
9010	Alkali Barium	P,M	V	89.0	99.2	1000	5	50 – 100	380	405	445	646	2.64	8.90	6.300	0.1700	Compression Sealing	9010
9013	Alkali Barium (no PbO)	P,M,C	V	88.5	99.2	1000	5	50 – 100	398	423	462	656	2.64	8.90	6.700	0.2000	Compression Sealing	9013
9108	Alumina Loaded 7056	M	V	53.2		950	5	50 – 100	471	496	538	742	2.40	9.70	6.430	0.6100	Glass-to-Metal Sealing	9108
9119	Alumina Loaded 7052	M	V	53.0		950	5	50 – 100	440	465	512	754	2.35	8.70	4.360		Glass-to-Metal Sealing	9119

[1] Forms usually available: C = Clearform® K = Cane M = Multiform & Spray Dried P = Powdered & Frit Glass T = Tubing

[2] V = Vitreous D = Devitrifying

[3] 0 - 200°C

Note: Contact Corning if you would like additional information or if you have a sealing application that is not addressed by one of these sealing glass products.

Corning's sealing glasses are normally available as 100 U.S. standard mesh (less than 149 microns) powder; *other mesh sizes are available upon request.* Since devitrifying glasses are surface nucleated and will vary with particle size, the properties and characteristics are based on standard 100 mesh material.

Multiform, Clearform® Glasses

These intricately-shaped and close-toletanced glass parts are typically used as preforms for hermetic insulating seals and as substrates, spacers, headers, frames and bases. Multiform and Clearform parts are made by the "powder processing" of glass. Granulated (spray dried) glass particles are dry-pressed into shape and sintered in order to fuse them into a vacuum-tight structure. Multiform parts are available in a variety of shapes and opaque colors such as: black, blue, brown, green, yellow, gray and turquoise. Clearform products differ from Multiform in that they are partly transparent allowing for visual inspection of the completed seal. The maximum outside dimension of a Multiform or Clearform part is 63.5 mm (2.5"). Minimum hole diameter is .38 mm (0.015"). Tolerances will vary depending on the dimensions.

Spray Dried Glasses

Spray dried glasses are powdered glasses whose particles have been coated with an organic binder. The binder coating increases the flowability and adhesion for dry pressing and sintering. Spray dried glasses are also available with sodium stearate which acts as mold lubricant. The binder and sodium stearate burn off during sintering, leaving a finished part with 92-99% of the density of the original glass. Spray dried glasses are available in a variety of colors.

Sealing Glasses

Glass Code	Forms Usually Available [1]	Thermal Expansion x 10^{-7} cm/cm/°C 25°C to Set Point	Sealing Temp. °C	Hold Time min.	Density g/cc	Transition Point, °C $10^{13.2}$ Poise	Softening Point, °C $10^{7.6}$ Poise	Working Point, °C 10^{4} Poise	Dielectric Constant 1MHz, 20°C	Log_{10} Volume Resistivity ohm-cm, 250°C	Typical Application
9901 (T436)	P	60	450	10	7.2	308	348	450	40.1	9.8	Kovar Sealing
9902 (CT420)	P	65	420	10	5.6	298	339	425	12.3	9.6	IC Ceramic Package Sealing
9903 (CT480D)	P	66	480	10	5.2	304	346	450	12.2	9.7	IC Ceramic Package Sealing
9904 (T187)	P	68	430	10	5.6	308	342	442	12.8	9.4	IC Ceramic Package Sealing
9905 (T191)	P	69	430	10	5.2	312	351	438	12.3	9.4	IC Ceramic Package Sealing
9906 (CT410)	P	69	410	10	5.6	298	337	420	12.7	9.5	IC Ceramic Package Sealing
9907 (T072)	P	70	575	5	4.4	445	525	625	18.3	11.5	Thick Film Material
9908 (DT430)	P	72	430	10	7.2	310	355	435	35.0	9.6	Display Panel Sealing
9911 (T077)	P	74	530	5	5.0	408	480	575	20.1	10.6	Insulating Overcoat Sealing
9912 (T029)	P	78	450	15	6.0	316	365	435	20.0	7.8	Display Tube Sealing
9913 (T015)	P	110	425	5	6.4	316	365	435	22.2	7.6	Sheathed Heater Sealing
9914 (T214)	P	125	500	10	4.7	356	435	548	15.6	10.3	Sheathed Heater Sealing
9915 (KF882)	K	73	730			462	560				Ferrite Sealing
9916 (KF1479)	K	83	730			462	567				Ferrite Sealing
9917 (KF1730)	K	99	530			358	408				Ferrite Sealing
9918 (KF1732)	K	99	730			539	626				Ferrite Sealing
9919 (KF1709)	K	100	730			467	595				Ferrite Sealing
9920 (KF1729	K	100	680			417	538				Ferrite Sealing
9921 (KF261)	K	101	520			354	411				Ferrite Sealing
9922 (KF1694)	K	114	600			386	473				Ferrite Sealing
9923 (K7006AE)	S	50	845				655	1000			Kovar Pin Sealing
9924 (K7006B)	S	50	925				710	1080			Kovar Pin Sealing
9926 (K2001D)	S	54	875				675	1060			Kovar Pin - Ceramic Sealing
9927 (K801B)	S	63	830				640	930			Kovar Pin - Ceramic Sealing
9928 (K2005F)	S	63	835				645	960			Kovar Pin - Ceramic Sealing
9929 (K6011C)	S	91	845				650				Kovar Pin - FeNi Sealing
9930 (KF79B)	S	106	820				630				FeNi Pin - Fe Sealing

[1] Forms usually available:
P = Powdered & Frit Glass
K = Cane
S = MicroSleeves™

* These sealing glasses are made in Japan by Iwaki Glass Company, Ltd., and are available from Corning Incorporated.

Powdered glasses are available in one or more of the following mesh sizes:

Mesh Sizes	Maximum Particle Size
100 mesh	149 microns
150 mesh	104 microns
200 mesh	77 microns
250 mesh	62 microns
300 mesh	43 microns

Pin Seal MicroSleeves™

Pin Seal MicroSleeves are tiny flat glass rings that slide over an electrical pin, and when fired, form hermetic and electrically insulating seals between the pin and the package. Typical applications include sealing Kovar pins into hermetic semiconductor packages and connectors.

	Range of Sizes Available	Most Common Size
OD	0.8 - 4.0 mm	1.0 mm
ID	0.4 - 3.0 mm	0.6 mm
Length	0.15 - 25.0 mm	0.2 mm

Note:
Contact Corning if you would like additional information or if you have a sealing application that is not addressed by one of these sealing glass products.

Sealing Glasses

Safety Precautions

These precautions apply to glass powders which contain lead oxide. The level of lead oxide may be as high as 80%.

Employees should be familiar with the hazards of inorganic lead as directed by the Hazard Communication Standard.

Lead can be an acute (short term) or chronic (long term) poison if too much is inhaled or ingested. To understand the hazards and symptoms of lead poisoning, the material safety data sheet (MSDS) for each applicable product should be reviewed carefully.

Other sources should also be reviewed. For example, the Occupational Safety and Health Administration (OSHA) has a specific standard concerning occupational exposures to inorganic lead. This standard, found at 29 CFR 1910.1025, sets forth specific controls, air and medical monitoring, work practices (such as the use of respirators, protective clothing, shower rooms, etc.) and training for employees exposed above certain airborne concentrations of lead. The appendices also contain useful information concerning lead hazards.

It is recommended that good personal hygiene practices be maintained when working around lead material, even when the lead is not in the air. Employees working with a lead-containing material should wash their hands and face before eating, drinking or using any tobacco product. Also, care should be used to assure that the lead-containing material is not carried home incidentally, for example, on work clothing.

MSDS and other information can be obtained through your customer service representative, the Corning Safety and Health Department or the Materials Business Product Engineering Department.

Customer's Responsibility

The information provided in this brochure is for reference purposes only and does not constitute a warranty with respect to any material, product, or application. The actual performance of any material may be affected by factors specific to a customer's application. Customers are responsible for selecting and determining the suitability of materials for their intended applications.

For warranty information specific to any materials or products described in this brochure, write to:

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