<u>SURFACE ENGINEERING BULLETIN</u>
<u>PBX/P-1 CEMENT</u>

GENERAL DESCRIPTION

SermaBond P-1 and SermaBond PBX are ceramic cements which are Used in high temperature instrumentation such as strain gages, thermocouples and transducers, where the cements maintain their electrical insulating properties and mechanical strength at elevated temperatures. The cements are supplied in two parts which require mixing just before use. They are easily applied and form strongly adherent bonds with many metals, including aluminum, Inconel, Stainless, low carbon steel and titanium, as well as non-metallic ceramic surfaces. The bond is air-setting, and requires a final cure at 600°F (315°C). The cements are completely inorganic and have no flash point.

APPLICATION OF THE CEMENTS

In order to form a strong bond, the surface to be coated must be absolutely clean. It should be free of scale, film, grease, oil and fingerprints. Better adhesion will be obtained if the surface is slightly roughened, (grit blasting or grit paper is excellent).

MIXING PROCEDURE

The recommended method for mixing SermaBond ceramic cements is as follows:

<u>PBX:</u> Add the powder to the activating solvent in the ratio of 2.25 grams of powder to 1.0 mL of solvent liquid, mixing thoroughly. Allow the mixture to stand for 30 minutes to one hour. If the mixture seems too thin or too thick, the ratio of powder to liquid may be varied.
<u>P-1:</u> Follow the same procedure as with PBX, but start with a ratio for 2.0 grams of powder to 1.0 mL of liquid.

GENERAL APPLICATION AND CURING PROCEDURE

The mixed cements may be applied by means of a brush, spatula, spraying or dipping. Allow the coated part to air-dry in a clean, dry atmosphere for 30 minutes to one hour. If external heating is used, it is suggested whenever possible to apply heat under the coated surface in order to prevent skinning of the cement. If a comparatively thick application is required (on the order of 5 mils), several thin coats are preferable to one thick coat, allowing time to air-dry and cure briefly between applications of cement.
After completion of air-set heat the coated part to 200°F (93°C) for one hour, followed by heating to 600°F (315°C) for one hour. Allow to cool at a normal rate.

COATING ELECTRONIC COMPONENTS

In most cases spraying or dipping may be accomplished with a single coating. Dip coating is more rapid and economical and eliminates spray equipment. For thicknesses beyond 5 mils, it is recommended that multiple coats be applied, allowing time for slow and complete air-drying and brief curing between coats.

If aditional sealing properties are needed a cot of SermeTel 883 can be applied to the cured cement to fill in surface porosity.

POTTING ELEMENTS

Painstaking cleanliness is a major factor in successful potting of elements. Parts should be cleaned by procedures best suited. PBX is the preferred cement for potting applications although P-1 is also used.

1) Remove all foreign matter from object to be filled.
2) Fill tube or cavity with cement; gentle agitation will aid in eliminating air bubbles.
3) Air dry slowly under infra-red lamp or in air circulating oven. Volume of cement used will govern drying time.
4) Cure slowly at 200^{o}F; set oven at 600^{o}F and allow oven to reach this temperature at a normal rate.
5) Cure for 1 hour at 600^{o}F, longer if possible. Cements will become water insoluble at this temperature. Allow oven to cool before removing specimens.

CURED CEMENT PROPERTIES

RESISTIVITY METHOD

Samples approximately 4 cm. by 5 mm. by 1 mm. were prepared with two platinum wires embedded in the cement. Wet strength was provided by pressing lightly between two sheets of paper which subsequently burned off. Samples were dried at 110^{o}C, then placed in furnace and heated slowly to 400^{o}C for curing. The furnace power was then increased and measurements of resistance made as the temperature increased. A Chromel-alumel thermocouple in the close proximity to the samples was used to indicate temperature.

RESULTS

Some cracking parallel to the direction of current flow occurred in the P-1. The PBX appeared still in good condition after heating to 975^{o}C. The resistances as functions of temperature are shown graphically on the attached sheet and tabulated above. These values should be considered as qualitive only, as variations in preparation of samples may be expected to lead to variations in the exact resistivity.

RESISTIVITY VALUES

T^{o}C	P-1	PBX
625	3.6×10^{7}	
650	2.4×10^{7}	
700	1.2×10^{7}	
750	5.8×10^{6}	
800	2.4×10^{6}	5×10^{7}
825	1.8×10^{6}	

BREAKDOWN VOLTAGE

Electrodes: Steel, one inch diameter, one inch long with edges rounded.

Tested in chamber containing silica gel (indicating) for humidity control.

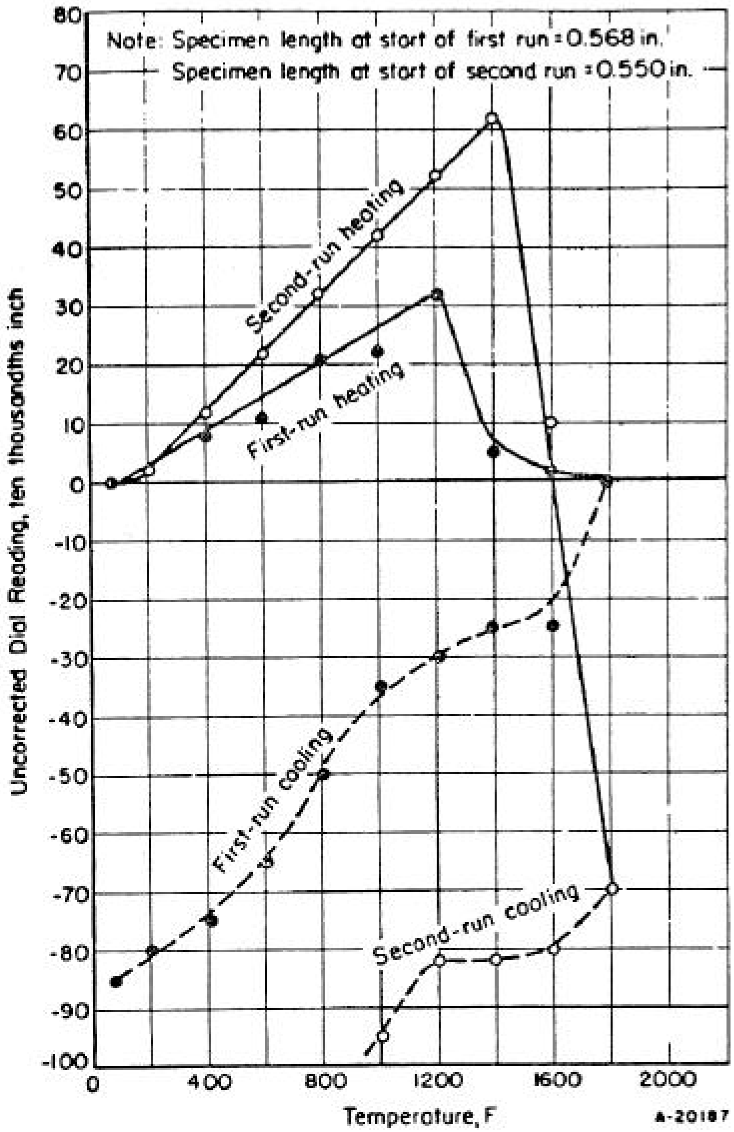
All tested short-time, zero to breakdown voltage at rate of approximately 0.5 Kv/sec.

Ave. Thickness of sample	Breakdown voltage at puncture	Volts/Mil	Deviation from mean
I. PBX fired to 300°C, ambient temperature 25.8°C.			
0.061	5550	98.1	+7.6%
0.050	4150	83.0	-2.7%
0.053	4500	84.9	-0.5%
0.054	4400	81.5	-4.5%
0.055 mean		mean = 85.3	ave dev. = 3.8%
II. PBX fired to 600°C, ambient temperature 22.4°C			
0.069	5750	83.4	-3.2%
0.077	6600	85.7	-0.6%
0.067	6000	89.6	+3.9%
0.071 mean		mean = 86.2	ave dev. = 2.6%
III. P-1 fired to 300°C, ambient temperature 23.8°C.			
0.062	5750	92.7	-5.8%
0.069	7250	105.0	+6.7%
0.050	4600	92.0	-6.5%
0.089	9000	101.0	+2.6%
0.064	6500	101.5	+3.0%
0.067 mean		mean = 98.4	ave dev. = 4.9%
IV. P-1 fired to 600°C, ambient temperature 27.5°C.			
0.069	6850	99.3	+5.1%
0.072	6600	91.6	-4.0%
0.068	6650	97.8	+2.5%
0.057	5300	93.0	-2.5%
0.067 mean		mean = 95.4	ave dev. =3.5%

V. P-1 fired to 600°C, ambient temperature 27.5°C.

0.102	8250	81.0	-0.4%
0.109	8900	81.6	+0.4%
0.106 mean		mean = 81.3	ave dev. =0.4%

THERMAL EXPANSION



<u>Mean Thermal Expansion</u>

<u>First Cycle</u>

70	-	1200°F	…………..	5.0 x 10^{-6} in./in./°F
1200	-	1800°F	…………..	Shrinkage
1800	-	70°F	…………..	8.8 x 10^{-6}

<u>Second Cycle</u>

70	-	1400°F	…………..	8.7 x 10^{-6}
1400	-	1800°F	…………..	Shrinkage
1800	-	70°F	…………..	7.8 x 10^{-6}

PHYSICAL PROPERTIES OF SERMABOND PBX AND P-1 CEMENTS

Cross-bending Strength

Cement	Curing Temperature °C	Strength, p.s.i.
P-1	300	900
P-1	600	1100
PBX	300	2565
PBX	600	3360

Shear Strength of PBX Metal Bond - 390 p.s.i.

Measured on sand blasted Stellite 25. Considerable variation found, depending on thickness and perfection of joints. Values up to 390 p.s.i. were found for best joints.

Hardness

Both P-1 and PBX have hardness between 2 and 3 on Moh's scale.

SHELF LIFE

When stored between 40-90°F in original sealed containers the shelf life for the unmixed PBX, P-1 and P-Solvent components is one (1) year.

TOXICITY AND SAFETY DATA

SermaBond PBX and P-1 cements contain ceramic oxides and chromium oxide. Long term respiratory irritation may occur if powder is inhaled over an extended period of time. Avoid contact with skin, eyes and mucous membranes. In case of contact, immediately irrigate affected area with running water. If ingested or if contact is severe - obtain medical attention.

The SermaBond P-Solvent is an acidic material containing chromates and phosphates requires care in handling. Avoid contact of P-Solvent or mixed cements with skin or eyes. In case of contact immediately irrigate affected area with running water.

For complete health and safety information consult the appropriate Material Safety Data Sheet.

1/03 KBE