

## Encapsulant and Adhesive Study

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### ABSTRACT

We describe a series of exercises performed with epoxy and RTV candidates for use on the straw drift chambers for E871. We find that the Dow 3110 RTV is a good choice for gas-sealing around the pins. Either of the two Tra-Con epoxies TRA-DUCT FS317 or TRA-DUCT 2143D would serve to seal around the ultem-manifold seam without invading the manifold itself. The FS317 is not fluid enough to seal around the pin.

### 1. Tests to be performed

- |               |  |
|---------------|--|
| Encapsulation | A test of the gas-sealing ability of each glue using a mock-up of our manifold cover to simulate any leakage of the encapsulant into the manifold region. Requires construction of a manifold cover and support and use of existing ultem and brass pieces. Will try out MH's new pin/collar installation device as a side effect.                         |
| Fluidity      | We need to be sure the epoxy does not penetrate the gas manifold or the ultem, loosening the wire and impeding gas flow. A mock manifold cover plate will be constructed of .125-in aluminum plate with #19 holes for the ultem. The degree of penetration may then be observed by installing an ultem in the plate and sealing around it with the sample. |
| Reactivity    | Candidates will be enclosed along with our brass pins and straw fragments in gas-tight containers during cure to discover any corrosive catalysts or cure by-products.   |

Resistivity            The chosen encapsulant must be a good insulator. This will be tested by gluing cable ends together as before.

## 2. Observations

### 2.1. 7 May 93

This initial set of tests involved the four RTV/encapsulants on hand and a 5-g sample of the 301-2 epoxy from Epoxy Technologies. The 301-2 was tested at various stages in its cure cycle from 3 hrs. to 8 hrs.

EPO-TEK 301-2 3-hr cure	.1665 $\phi$ hole. Very fluid; epoxy seeped through plate and extends below gas hole in Ultem. Resistivity is off scale.
EPO-TEK 301-2 4-hr cure	.1655 $\phi$ hole. No discernible change.
EPO-TEK 301-2 5-hr cure	.1665 $\phi$ hole. More viscous than the less-cured samples. This state forms a nice bead extending from the brass-pin OD to the Ultem ring. The epoxy still seeps through the plate but extends only $\sim$ .5 mm toward gas hole.
EPO-TEK 301-2 6-hr cure	.1655 $\phi$ hole. The pin/Ultem bead is smaller and thus must depend on how much epoxy is applied. Extension below plate is still $\sim$ .5 mm.
EPO-TEK 301-2 7-hr cure	.1665 $\phi$ hole. With more epoxy applied we're back to a large pin/ultem bead. In this case it even spills down around the ring. More epoxy applied at the Ultem/plate and a larger clearance hole apparently allow the epoxy to reach the gas hole. It seems pre-curing has little effect on wicking.
EPO-TEK 301-2 8-hr cure	.1665 $\phi$ hole. No discernible change.

EPO-TEK 301-2 15-hr cure	This sample was left overnight and was too cured to apply. It was stiff and tacky.
RTV-162	.1665 $\phi$ hole. This stuff does not self-level. Absolutely nothing appears below plate. May be able to learn a good application technique for the pin/Ultem joint but not suited for the plate seal. Resistivity is off scale.
3110	.1665 $\phi$ hole. The initial 5-g mix of this whitish two-part encapsulant failed to cure. The viscosity is very nice, however, so we shall try again. CH has not had any problems with small mixes like this. Resistivity is off scale.
RTV-118	.1665 $\phi$ hole. A good non-wicking bead and easy preparation make this encapsulant hard to reject because of its acetic-acid-based cure.
93-500	.1660 $\phi$ hole. This “space-grade encapsulant” is too fluid for our purposes.

The RTVs are good candidates for the pin/Ultem seal if we decide to use a removable system here. The disadvantage is their lack of strength; they cannot be trusted to hold the wire in place. The manifold seal will take a more permanent, stiffer bond and for this we shall test some microbead-filled epoxies.

## 2.2. 11 May 93

87/88	Too fluid.
87/88 50- $\mu$ m microballs 1:1 by weight	This mix produces a beautiful conical bead at the pin and is very promising. The dusty behaviour of the smaller beads during mixing is annoying. They form a dry layer on the inside of the mixing cup.
87/88 100- $\mu$ m microballs 1:1 by weight	The larger filler produced a somewhat smaller bead but less manifold penetration.

3110 RTV

A second mixing of this sealant proved quite effective. A mixture of 10g : 1g using our 0.1-g balance provided a good, removable seal around the pin.

### 2.3. 17 May 93

The handling of the microbeads and the outgassing of the 87/88 has made it difficult to recommend this mixture. Some recently-received epoxies from Tra-Con may be the answer:

TRA-DUCT 2143D

This sample comes in the dual-compartment premixed packages and is thus simple to prepare and load into a syringe barrel. The 2143D may have penetrated the plate slightly but certainly less than .5 mm. It leaves a very good bead around the pin.

TRA-DUCT FS317

The FS317 also comes premixed. It left no trace of penetration below the plate and a good bead in both application sites. Though it is described by the maker as thixotropic it did flow enough to seal at the plate. It did not form a good seal at the pin; the N<sub>2</sub> test produced bubbles above and below the collar at 2 psig.

### 3. Summary

**Table 3.1:** Products considered in this study. Instances where no samples were available were disregarded because we felt there was sufficient coverage from those suppliers able to provide samples.

## Epoxies

		Nominal Characteristics					Observations				
		Pot Life	Cure Time	Viscosity (cps)	Dispenser pressure (psi)	Penetration		Resistivity	Test Pressure (psig)	Corrosion	Comments
						Plate	Pin				
Epoxy Technologies	EPO-TEK 301-2; 3	24 hr	48 hr	260	5	below		∞		none	room-temperature precured 3 hrs
	EPO-TEK 301-2; 4	24 hr	48 hr		5	below		∞		(none)	4 hrs; penetrated to below gas inlet hole
	EPO-TEK 301-2; 5	24 hr	48 hr		5	0.5		∞		(none)	5 hrs
	EPO-TEK 301-2; 6	24 hr	48 hr		5	0.5		∞		(none)	6 hrs
	EPO-TEK 301-2; 7	24 hr	48 hr		15	1		∞		(none)	7 hrs
	EPO-TEK 301-2; 8	24 hr	48 hr		15	1		∞		(none)	8 hrs still not enough
Tra-Con	TRA-BOND FS317	25 min	24 hr	paste	30	0		∞	2 -- bubble	none	thixotropic
	TRA-BOND 2143D	75 min	18 hr	30,000	30	0		∞	28	none	
FibreGlast	87/88	20 min	24 hr	1000	5	*		∞		none	
	87/88 + 50 micron	20 min	24 hr		25	0.5		(∞)		(none)	glass-filled 1:1 by weight; conical bead
	87/88 + 100 micron	20 min	24 hr		25	0.3		(∞)		(none)	glass-filled 1:1 by weight; conical bead

## Encapsulants

		Nominal Characteristics					Observations					
		Pot Life	Cure Time	Viscosity (cps)	Dispenser Pressure (psi)	Penetration (mm)		Resistivity	Test Pressure (psig)	Corrosion	Comments	
						Plate	Pin					
Dow Corning	DOW 93-500	1 hr	24 hr	7500	5			∞		28	none	too fluid
	DOW 3110	165 min	6.5 hr		15	1		∞		28	none	very smooth application
GE Silicone	RTV-118	20 min	12 hr	paste	15			∞	8 -- bubbles	none	smooth application	
	RTV-162	4 hr	48 hr	spread	25	0		∞	1.4 -- bubbles	none	does not flow at all	
Tra-Con	TRA-CAST 3011	2 hr	72 hr	870	5						none	DID NOT CURE

## Fillers

		Availability			Composition	Size (micron)	Density (g/cc)	Comments
		Unit	Price	Status				
ECCOSPHERES IG25		lb	\$21.00	tech. info on hand; 5-lb min	SiO2 70%, Na2O 25, B2O3 5	5-100+	0.26	hollow; used by AMY
Grade V Microbeads	-270+325	lb	\$30.00	on hand; \$50 min	SiO2 71%, Na2O 12, CaO 8,...	53-44	~ 1.5	
	-140+170	lb	\$17.50	on hand; \$50 min	same	105-88	~ 1.5	

#### 4. Notes on the Tables

Nominal Characteristics	These are the values stated in the product technical information sheets.
Dispenser Pressure	All samples were dispensed from 3-cc syringes equipped with blue plastic conical tips. This column indicates the pressure setting required for smooth application of the sample.
Penetration	Estimated distance along the ultem the sample extends below the mock manifold plate. The gas inlet holes in the ultem are approximately 1 mm below the plate. An entry of 'below' indicates that the sample reached the gas inlets. In no cases were the holes clogged in this exercise.
Resistivity	This was measured in one of two ways: either the shield and central conductor of a coaxial cable were attached via the sample — leaving about 1 mm of sample between the conductors — or a pair of sharp probes penetrated the sample's surface separated by about 1 mm.
Test Pressure	Gas-tightness was measured by attaching a piece of tubing to the straw end of an ultem-pin assembly, submerging the assembly in about 100 mm of water and pressurizing the tubing with N <sub>2</sub> .
Corrosion	To observe corrosion we enclosed in a rubber-stoppered test tube a bit of aluminum foil, a brass-ultem assembly and a bit of straw all dabbed with a sample. In some cases a bit of gold-plated tungsten wire dabbed with sample was included, but this proved inconclusive since the wire is so hard to see. We have seen no discoloration or any other visible evidence of corrosive action for any of the samples tested.

## 5. Conclusion

We have two applications and they shall be considered individually:

**Pin**            The pin/ultem joint at the very least requires gas tightness. The DOW 3110 RTV serves as a good sealant and has been used by SU for this purpose. An RTV has the advantage of being removable, so that a single wire may be dismantled and replaced. The 3110's pot life and cure schedule are also reasonably short.

**Manifold**     A sealant must be applied around the ultems protruding from the gas manifold to prevent gas leakage. As we do not foresee removing the manifold plate — it will be affixed permanently to the main endplate — a stiff, permanent epoxy may be used here. The main requirement is that the epoxy not flow into the manifold while spreading enough to form an effective gas seal. There are two solutions: microsphere-filled 87/88 or the more viscous TRA-BOND 2143D. Both of these flow enough to form a nice bead about the pin/ultem joint yet are presumably viscous enough to avoid penetrating to the wire. They could be used if a stronger, more permanent pin sealant is desired.

The 2143D is attractive for several reasons. It requires less preparation since there is no filler and comes in pre-measured bi-packs. It does not emit the fumes that the 87/88 does. Most importantly, it penetrates the manifold cover even less than the filled 87/88.

Another Tra-Con product, TRA-BOND FS317, looks good as well. It is a thixotropic paste so it will not flow without being handled. Since the FS317 spreads enough to form an effective seal while remaining more viscous than the 2143D it is the best choice for the manifold-ultem seal.

## A. Tabulation of some available products

**Table A.1: Epoxies**

		Availability			Pot Life	Cure Time	Viscosity (cps)	Comments
		Unit	Price	Status				
Emerson & Cuming	ECCOBOND 45	quart	83.33	samples not available	2-3 hr	8 hr	37000	3 quart minimum
	ECCOBOND 45LV	quart	83.33	samples not available	2-3 hr	24 hr	25000	3 quart minimum
	ECCOBOND 27	quart	83.33	samples not available	2-3 hr	24 hr	400	3 quart minimum
	ECCOBOND 91	quart	83.33	samples not available			9400	3 quart minimum
Epoxy Technologies	EPO-TEK 301-2			on hand	24 hr	48 hr	260	try room-temp pre-curing
	EPO-TEK 370G			obsolete				not recommended
	EPO-TEK 730			sample requested 4/29	3 hr	12 hr	150,000	recommended by Epoxy Tech.
Magnolia Plastics	Magnolia 3071			sample requested 4/30	2 hrs	24 hrs/7	1500	film-capacitor epoxy; black
Tra-Con	TRA-BOND FS317			sample on hand	25 min	24 hr	paste	no sag; thixotropic
	TRA-BOND 2143D			sample on hand	75 min	18 hr	30,000	polyamide; recommended by Tra-Con
FibreGlast	87/88			on hand	20 min	24 hr	1000	used by AMY for ultem/pin seal

**Table A.2: Encapsulants**

		Availability			Pot Life	Cure Time	Viscosity (cps)	Comments
		Unit	Price	Status				
Emerson & Cuming	ECCOSIL 5019	quart	96.53	samples not available				3 quart minimum
	primer S-11			samples not available				recommended for adhesion to ULTEM
Dow Corning	DOW 93-500	100 g	253.2	sample on hand	1 hr	24 hr	7500	Space-grade encapsulant
	DOW 3110	1 lb.	30	sample on hand	165 min	6.5 hr		2-component RTV --- used by SU
GE Silicone	RTV-108			sample on hand	20 min	12 hr	paste	outgasses acetic acid during cure
	RTV-162			sample on hand	4 hr	48 hr	spread	alcohol based (no acetic acid)
Dexter Corp.	Urethanes us28,32							
Tra-Con	TRA-CAST 3002			samples req. 4/30	1 hr	48 hr	440	
	TRA-CAST 3010			samples req. 4/30	24 hr	96 hr	500	repottable (self-sealing)
	TRA-CAST 3011			sample on hand	2 hr	72 hr	870	flexible, self-sealing epoxy

**Table A.3: Fillers.** The ECCOSPHERES have been ordered.

		Availability			Composition	Size (micron)	Density (g/cc)	Comments
		Unit	Price	Status				
ECCOSPHERES IG25		lb	\$21.00	tech. info on hand; 5-lb min	SiO2 70%, Na2O 25, B2O3 5	5-100+	0.26	hollow; used by AMY
Grade V Microbeads	-270+325	lb	\$30.00	on hand; \$50 min	SiO2 71%, Na2O 12, CaO 8,...	53-44	~ 1.5	
	-140+170	lb	\$17.50	on hand; \$50 min	same	105-88	~ 1.5	

Table A.4: Sources

		Addresses1
Dexter Corp.	Name	Hysol Electronics Chemicals Division
	Street	
	City & State	NY
	Phone	716-372-6300
	VID	
	Contact	Randy McClain
Cataphote, Inc	Name	Cataphote, Inc.
	Street	P. O. Box 2369
	City & State	Jackson, MI 39225-2369
	Phone	800-221-2574
	VID	34-15-67848
	Contact	
Dow Corning	Name	Dow Corning Corp.
	Street	
	City & State	Midland, MI 48640
	Phone	800-248-2481
	VID	71984
	Contact	
Duke Scientific Corp. (spheres)	Name	Duke Scientific
	Street	1135 D San Anotonio Road
	City & State	Palo Alto, CA 94303
	Phone	800-334-3883
	VID	
	Contact	
Emerson & Cuming	Name	RSI Inc.
	Street	1701 Dalshank Street
	City & State	Pflugerville, TX 78660
	Phone	512-251-1161/800-225-9936
	VID	
	Contact	
Grace Syntactics	Name	Grace Syntactics
	Street	59 Walpole Street
	City & State	Canton, MA
	Phone	617-821-4250
	VID	
	Contact	Ed Decastro
Epoxy Tech.	Name	Wadsworth/Pacific
	Street	5800 E. Thomas Road #115
	City & State	Scottsdale, AZ 85251-7510
	Phone	602-994-4840
	VID	
	Contact	Bill Shanahan
GE Silicone	Name	Hisco
	Street	
	City & State	Houston, TX
	Phone	713-683-0311
	VID	
	Contact	
Magnolia Plastics	Name	Magnolia Plastics Inc.
	Street	5547 Peachtree Industrial Boulevard
	City & State	Chamblee, GE 30341-2296
	Phone	404-451-2777
	VID	
	Contact	Greg Bunn
Tra-Con	Name	TRA-CON, INC
	Street	55 North Street
	City & State	Medford, MA 02155
	Phone	800-872-2661
	VID	04-22-33985
	Contact	Jim Reid