Solithane® S113
A versatile liquid urethane prepolymer

DESCRIPTION

Solithane® S113 prepolymer is an extremely versatile liquid urethane prepolymer which can be cured with a variety of polyol and/or amine curing agents. Processing temperatures can range from 80°F to 300°F (27°C to 149°C) permitting low temperature, non-exothermic cure systems for temperature-sensitive parts. Depending upon the selection and amount of curative employed, the cured compounds can display hardness ranging from 15 shore a to 80 shore D.

APPLICATIONS

The processing versatility of Solithane® S113 prepolymer permits it to be cast into intricate, void-free shapes for a variety of applications. Although cure temperatures as high as 300°F (149°C) are generally recommended for rapid mold turnover, longer cure cycles at lower temperatures can be utilized for potting temperature sensitive parts or sophisticated electric hardware. The outstanding electrical properties inherent in every product derived from Solithane® S113 prepolymer designate it as an ideal prepolymer for electric potting, encapsulation and conformal coating applications. Protective coatings formulated from Solithane® S113 prepolymer can be applied by spraying, dipping or brushing techniques to metallic and non-metallic surfaces.

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In addition, Solithane® S113 prepolymer can be used for photo-elastic stress analysis. Cured compounds, when placed under stress, rotate the plane of polarized light along the principal stress axis. By bonding films of Solithane® S113 prepolymer to complex objects, or by molding prototype parts from this urethane rubber, the strain areas can be observed visually (using polarized light as an analyzer) when the object is placed under stress. Several publication described characterization of Solithane® S113 prepolymer compounds for photo-elastic stress analysis.

1. "The Mechanical and Optical Characteristics of Solithane® S113 Prepolymer and Investigation of Optical Lag in Photoviscoelastic Analysis", California Institute of Technology, Technical Report No. WLTR-64-15;
2. "Make Strain Visible", Product Engineering, November 8, 1965, pp. 98-101;
3. "New Method to Determine Restrained-Shrinkage Stresses in Propellant-Grain Models", A.J. Durelli and V.J. Parks, Prof. And Asst. Prof., respectively, Catholic University of America, Washington, DC;
4. "Some Low-modulus Birefringent Resins", A. San Miguel and E.N. Duran, Senior Research Engineer and Assistant Engineer, respectively, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California.

PREPOLYMER PROPERTIES	
Appearance	Pale Yellow Liquid
Isocyanate (NCO)%	10.6 + 0.2
Average Viscosity, poise **@80°F (27°C)** **@140°F (60°C)** **@212°F (100°C)**	 200 –300 10 – 20 2 – 3
Average Specific Gravity	1.073
Flash Point (ASTM D97-66)	430°F (221°C)
Storage Stability	3 months after shipping date

PHYSICAL PROPERTIES

The physical properties of cured Solithane® S113 prepolymer compounds are controlled by the type and amount of curative or combination of curing agents used. Two typical curing agents are Solithane® C113-300 curing agent supplied by LANXESS and TIPA (triisopropanolamine)*. By varying the quantity of Solithane® C113-300 curing agent, materials within a hardness range of 15 Shore A to 60 Shore A can be formed. Blending Solithane® C113-300 curing agent with TIPA in varying proportions, makes it possible to produce cured compounds within the 40 Shore A to 75 Shore D hardness range. (Refer to Table IV for properties obtained with Solithane compounds cured with Solithane® C113-300 curing agent and/or TIPA).

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All cured compounds of Solithane® S113 prepolymer exhibit excellent electrical properties throughout the broad range of hardness values. (Typical electrical properties of cured compounds listed in Table IV are shown in Table V).

The chemical resistance of two compounds taken from Table I, which represent opposite extremes in the range of hardness, indicates an excellent resistance to water, oils, dilute acids and bases. (Refer to Table VI).

Cured Solithane® S113 prepolymer compounds also show exceptional hydrolytic stability (as indicated in Table VII).

For special applications such as potting, coating and encapsulation of electronic circuits in rocket guidance systems, Solithane® S113 prepolymer compounds provide superior resistance to ultra-high vacuum environments. (Table VII shows typical out-gassing data for cured Solithane resin compounds.

* McKesson Chemical Company-Division of G. Mann & Co.

PROCESSING

Processing Temperatures

Although Solithane® S113 prepolymer is pourable at 80°F (27°C), heating the prepolymer will make it easier to handle. (The effect of temperature on the viscosity of Solithane® S113 is shown in Figure II).

Solithane® C113-300 curing agent, a clear liquid polyol, will cure Solithane® S113 prepolymer at room temperature 80°F (27°C) without any noticeable exotherm. This system is most practical when potting temperature-sensitive parts. Curing agent TIPA, a low melting solid, will cure Solithane® S113 prepolymer either alone or in varying proportions with Solithane® C113-300 curing agent. Melting TIPA (m.p. 137°F [58°C]) prior to its addition to Solithane® S113 prepolymer alleviates "lumping" in the cure. When blends of TIPA and Solithane® C113-300 curing agent are heated together in the proportions recommended in Table IV, a very stable, clear homogeneous mixture is obtained. Separation of these mixtures will not occur, even when stored at low temperatures.

Solithane® S113 prepolymer can be cured at temperatures as high as 300°F (149°C), when rapid mold turnover is desired. (The effect of different cure temperatures on two formulations from Table IV is shown in Table I).

MIXING AND DEGASSING

Solithane® S113 prepolymer can be processed by the "hand batch" technique or with automatic mixing and metering machines. The prepolymer can be adequately mixed at 80°F (27°C) with Solithane® C113-300 curing agent and/or TIPA. As the amount of Solithane® C113-300 curing agent is increased, the initial mix viscosity is decreased (as shown in Figure III). Effective degassing of these compositions is dependent upon the percentage of Solithane® C113-300 curing agent used, the total amount of material being degassed, and the efficiency of the vacuum system.

When processing at higher temperatures, degassing of the mix is faster and easier, and can be further improved by taking the following steps:

1. Preheat Solithane® S113 prepolymer to processing temperature.
2. Degas the prepolymer at a vacuum less than 10mm Hg.
3. Return prepolymer to processing temperature.
4. Heat the curing agent and maintain in the molten state.
5. Combine prepolymer and curing agent, blend thoroughly.
6. Degas the blended material and release vacuum slowly when bubble formation is minimal.
7. Pour the blend into a properly released mold that has been preheated to curing temperature.
8. Cure the cast in a circulating hot air oven.

ADDITIVES

Plasticizers

The low temperature properties of Solithane® S113 prepolymer compounds are improved by the addition of plasticizers. A variety of plasticizers, (listed in Table II), can be used effectively up to 20 parts per 100 of prepolymer. Heat aging plasticized compounds 70 hours at 212°F (100°C) produces insignificant changes in physical properties.

Rohm & Haas TP-90B plasticizer effectively extends low temperature properties, and additionally incorporates fungus resistance into cured Solithane® S113 prepolymer compounds.

Accelerators

The effect of a typical organo-metallic compound on formulation No. 1 from Table IV is shown below:

Fomrez Sul-4*	Pot Life, 80°F (27°C)
None	180 minutes
0.120	90 – 120 minutes
0.135	50 minutes
0.500	15 minutes

* WITCO

Colorants

Solithane® S113 prepolymer compounds can be formulated with pigment dispersions designed for polyester resins. The translucence, opacity and intensity of color are based on the amount of color paste used. The effect of color paste concentration on the physical properties of formulation No. 1 from Table IV is shown in Table IX.

CURING

Cure Systems

As indicated in Table I, the physical properties of the cured compound depend upon the type and amount of curing agent used, either alone or in combination with other curatives. An increase in the amount of Solithane® C113-300 curing agent:

- Lowers initial mix viscosity of system
- Increases pot life
- Lowers durometer hardness
- Lowers stress-strain properties
- Increases low-temperature properties

An increase in the amount of TIPA:

- Decreases pot life, cure time
- Increases durometer hardness
- Increases stress-strain properties*

*When used in blends with Solithane® C113-300 curing agent.

Alternate cure systems by polyfunctional curing agents containing active hydrogens are also possible, (but not discussed in this bulletin). However, the use of the above cure system minimizes the number of curatives necessary to formulate different applications.

The rate of cure for three formulations from Table IV, expressed as the change in viscosity at 15 minute intervals at 140°F (80°C) is illustrated in Figure IV.

POST CURE

Optimum properties are generally reached after 7 days at 80°F (27°C) (R.T.). Solithane® S113 prepolymer compounds are relatively unaffected by additional heating at temperatures up to 250°F (121°C). However, signs of instability become evident in some formulations after three weeks exposure to 300°F (149°C). The effect on the physical properties of cured Solithane® S113 compounds exposed to various temperatures is shown in Table III.

BONDING

Solithane® S113 prepolymer compounds adhere to most substrates without the use of a primer. Some substrates can be simply treated with a solvent wipe or light abrading with sandpaper. However, bonding surfaces should be clean and free of oily films.

If a primer is used, the manufacturer's recommendations should be followed. Some bonding agents used effectively with Solithane® S113 prepolymer compounds are *Chemlok 218. **Thixon XAB-1153, and Conap's 1146C.

*Lord Chemical Company
**Rohm & Haas

RELEASING AGENTS

Mold used for casting Solithane® S113 prepolymer compounds should be clean and lubricated properly for easy removal of the finished product. A variety of release agents are commercially available and the manufacturer's recommendations should be followed. Some release agents used effectively with Solithane curing agents are Exxit II, Korach 1711 (both aerosols) from Dexter and DC-7 or DC-20 mold release (wipe-on or brush-off release agents from Dow Corning Corporation.

STORAGE AND HANDLING

Solithane® S113 prepolymer can be handled conveniently at 140°F (60°C). This temperature is sufficient to reduce viscosity for easy pouring without fear of thermal molecular degradation or undue chain extension of the prepolymers.

Solithane® S113 prepolymer is available in 1 gallon or 5 gallon containers. Generally, compounders will "break down" these quantities into smaller units to minimize undue exposure of the entire batch to heat or atmospheric humidity. Flushing the container with nitrogen, prior to resealing, will inhibit "skinning" of the prepolymer.

To eliminate unnecessary thickening of the resin at elevated temperatures, refer to Figure I.

SAFETY

Please consult the relevant material Safety Data Sheet before using any LANXESS product.

Additional Information

For more detailed information about safe handling and use of TDI and isocyanate containing materials, refer to the "Chemical Safety Data Sheet SD-73" from the Manufacturing Chemists Association, Inc.

TEST METHODS All test methods are ASTM methods, unless otherwise specified.	
Hardness, Shore A/D	D-2240-75
Stress-Strain	D-412-68
(Tensile testing of Vulcanized rubber) **Stress Strain** **Impact Resistance**	 D-636-72 MIL-C-16923G (Oct. 1972)
Volume & Surface Resistivity	D-257-75a
Dielectric Constant & Dissipation Factor	D-150-74
Dielectric Strength	D-149-75

TABLE I **TYPICAL ALTERNATE CURE CYCLES**		
Formulation	1	17
Solithane® S113 Prepolymer, pbw	100	100
Solithane® C113-300 Curing Agent	73	—
TIPA	—	15
Cured at 75°F (23°C)		
Set Time	min.	20 min.
Tack-Free Time	150 min.	40 min.
Cure Time	180 min.	15 hrs.
Shore Hardness	40A	60D

Cured at 200°F (93°C)		
Set Time	50 min.	12 min.
Tack-Free Time	min.	20 min.
Cure Time	120 min.	120 min.
Shore Hardness	40A	60D
Cured at 250°F (121°C)		
Set Time	12 min.	7 min.
Tack-Free Time	15 min.	10 min.
Cure Time	90 min.	60 min.
Shore Hardness	53A	66D

* 12 – 16 hours
(1) Time required to demold
(2) After Cure Time

TABLE II

Plasticizers for Solithane® S113 Prepolymers

Control Formula compound No. 1
(see Table I)

Original Physical Properties						
Plasticizer	**Parts**	**Tensile psi, (kg/cm²)**	**Elongation %**	**Shore A Hardness**	**Die C Tear Pli (kg/cm) °F °C**	**L.T. Torsional (G10,000) Modulus**
Control	none	400 (28)	100	60	15 (2.7)	+3 (-16)
TP-90B Plasticizer	5 10 20	330(23) 290 (20) 235 (17)	95 80 60	60 58 56	19 (3.4) 19 (3.4) 17 (3.0)	-6 (-21) -15 (-26) -33 (-36)
Di-Octyl Sebacate	5 10 20	450 (32) 325 (23) 225 (16)	130 95 60	58 56 54	25 (4.5) 22 (3.9) 16 (2.8)	0 (-18) -20 (-29) -30 (-34)
Tri-Octyl Phosphate	5 10 20	340 (24) 260 (13) 195 (14)	95 80 55	57 55 52	24 (4.3) 19 (3.4) 16 (2.8)	.2 (-19) -12 (-24) ——

TABLE III

Heat Resistance of Solithane® S113 Prepolymer Compounds

Physical Properties

(After 28 days at temperature indicated)

Original Physical Properties								
Temperature	**100% Modulus psi (kg/cm²)**		**Elongation, %**		**Shore Hardness**		**Tensile psi (kg/cm²)**	
Formulation No.	1	17	1	17	1	17	1	17
80°F (27°C)	—	—	80	5	66A	79D	375 (26)	3060 (215)
158°F (70°C)	430 (30)	—	105	5	68A	77D	470(33)	3450 (242)
212°F (100°C)	450 (31)	—	105	5	67A	75D	460 (32)	3760 (264)
250°F (121°C)	460 (32)	—	105	20	65A	72D	525 (37)	4010 (282)
300°F (149°C)	525 (37)	—	160	100	65A	25D	675 (47)	2165 (152)

TABLE IV (1-9)

Compounds of Solithane® S113 Prepolymer with Solithane® C113-300 Curing Agent & TIPA

Original Physical Properties									
Formulation, pbw	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Solithane® S113 Prepolymer	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Solithane® C113-300 Curing Agent	73.0	80.0	90.0	100.0	110.0	120.0	150.0	65.5	58.0
TIPA	—	—	—	—	—	—	—	—1.5	—3.0
Working Properties @ 80°F (27°C)									
Pot Life, Hours	3	6	6	6.5	6.5	6.5	8	3.5	3.6
Set Time, Hours	overnight	overnight	overnight	overnight	overnight	48	overnight	overnight	8
Tack Free Time, Days	4	3	3	4	4	4	4	4	3
Properties after 1 hour at 300°F (149°C) Shore Hardness After:									
1 Day @ 80°F (27°C)	55A	53A	52A	49A	44A	35A	16A	40A	55A
3 Days @ 80°F (27°C)	57A	54A	51A	48A	43A	35A	—	55A	58A
5 Days @ 80°F (27°C)	58A	—	—	—	43A	35A	—	55A	58A
7 Days @ 80°F (27°C)	60A	54A	51A	47A	43A	36A	15A	62A	64A

Properties after 1 hour at 300°F (149°C) and 7 days at 80°F (27°C) Stress Stain Properties:									
Tensile Strength, psi (kg/cm²)	400 (28)	340 (24)	280 (2)	245 (17)	140 (10)	160 (11)	70 (5)	460 (32)	(32)
Elongation	100	95	85	95	75	110	145	115	125
100% Modulus, psi (kg/cm²)	58A	—	—	—	43A	35A	—	55A	58A
7 days @ 80°F (27°C)	350 (25)	—	—	—	—	155 (11)	50 (4)	395 (28)	425 (32)

TABLE IV (1-9 cont'd)

Compounds of Solithane® S113 Prepolymer with Solithane® C113-300 Curing Agent & TIPA

Properties after 1 hour at 300°F (149°C) and 7 days at 80°F (27°C) Stress Stain Properties:									
Formulation, pbw	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Properties after 1 hour at 300°F (149°C) and 7 days at 80°F (27°C) Tear Properties:									
Tear Strength, Die C pli (kg/cm)	10 (1.8)	18 (32)	15 (2.7)	15 (2.7)	10 (1.8)	0	0	20 (3.6)	20
Bashore Resilience Rebound %	4	7	6	10	10	15	10	3	6
Taber Abrasion: Abrasion Index	70	65	45	45	40	70	150	85	105

TABLE IV (10-17)

Compounds of Solithane® S113 Prepolymer with Solithane® C113-300 Curing Agent & TIPA

Formulation, pbw	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Solithane® S113 Prepolymer	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Solithane® C113-300 Curing Agent	51.0	44.0	36.5	29.0	21.5	14.7	7.3	15.0
TIPA	4.5	6.0	7.5	9.0	10.5	11.8	13.2	15.0
Working Properties@ 80°F (27°C)								
Pot Life, Hours	1.8	1.7	1	0.5	0.5	0.4	0.5	0.3
Set Time, Hours	7	4.5	6	6.5	3.2	1	1.8	1
Tack Free Time, Days	2	3	3	3	2	2	overnight	overnight
Properties after 1 hour at 300°F (149°C)								
1 Day @ 80°F (27°C)	55A	68A	70A	72A	40D	49D	65D	75D
3 Days @ 80°F (27°C)	60A	68A	72A	78A	52D	41D	68D	75D
5 Days @ 80°F (27°C)	61A	70A	78A	85A	56D	47D	69D	80D
7 Days @ 80°F (27°C)	66A	70A	80A	87A	58D	60D	70D	80D
Properties after 1 hr at 300°F (149°C) and 7 days @ 80°F (27°C) Stress Strain Properties:								
Tensile, psi (kg/cm²)	770 (54)	1310 (92)	2100 (148)	2750 (193)	2890 (203)	3200 (225)	3480 (295)	2530 (178)
Elongation %	130	150	120	120	95	60	50	20
100% Modulus, psi (kg/cm²)	475(33)	670(147)	1140(80)	2335(164)	—	—	—	—

TABLE IV (10-17 cont'd)

Compounds of Solithane® S113 Prepolymer with Solithane® C113-300 Curing Agent & TIPA

Formulation, pbw	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Properties after 1 hr at 300°F (149°C) and 7 days @ 80°F (27°C)								
Tensile, psi (kg/cm²)	770 (54)	1310 (92)	2100 (148)	2750 (193)	2890 (203)	3200 (225)	3480 (295)	2530 (178)
Elongation %	130	150	120	120	95	60	50	20
100% Modulus, psi (kg/cm²)	475 (33)	670 (147)	1140 (80)	2335(164)	—	—	—	—
Tear Properties:								
Tear Strength, Die C (pli kg/cm)	45 (8.0)	65 (11.6)	110 (19.6)	175 (31.3)	310 (55.4)	450 (80.4)	445 (79.5)	425 (79.5)
Bashore Resilience Rebound %	25	20	25	35	40	40	40	30
Falling Ball impact: Impact Strength, ft-lbs. (kg/cm)	>107.4 >14.9	>107.4 >14.9	>107.4 >14.9	>107.4 >14.9	107.4 >14.9	107.4 >14.9	82.1 12.1	95 13.1
Taber Abrasion:								
Abrasion Index	120	130	120	175	165	165	195	150

TABLE V

Electrical Properties of Solithane® S113 Prepolymer Compounds
Samples cured 2 hrs. at 300°F (149°C) + 7 Days at 75°F (23°C)

Formulation No. (Refers to Table IV)	**1**	**6**	**12**	**15**
Hardness Shore A or D	60A	35A	80A	60D
Vol. Resistivity, ohm-cm				
80°F (27°C)	2.5×10^{14}	7.0×10^{12}	2.7×10^{14}	3.6×10^{14}
185°F (85°C)	7.2×10^{12}	5.0×10^{10}	2.7×10^{12}	2.4×10^{13}
Surface Resistivity ohm				
80°F (27°C)	1.5×10^{15}	1.5×10^{15}	1.5×10^{15}	1.5×10^{15}
185°F (85°C)	1.5×101^{5}	1.5×10^{15}	1.5×10^{15}	1.5×10^{15}
Dielectric Constant, 1kc				
80°F (27°C)	4.2	5.0	3.6	2.8
185°F (85°C)	4.8	4.8	5.1	4.5
Dissipation Factor, 1kc				
80°F (27°C)	0.162	0.091	0.056	0.014
185°F (85°C)	0.006	0.079	0.028	0.120
Dielectric Constant, @ 80°F (27°C)				
50kc	3.6	3.8	3.5	2.8
100kc	3.5	3.8	3.5	2.8
500kc	3.4	3.4	3.5	2.8
2mc	3.2	3.3	3.4	2.8
10mc	3.0	3.2	3.4	2.8
Dialectric Strength, Volts/mil, 80°F (27°C)				
75 Mill Sheet				
Short Time	378	512	440	340
Step/Step	324	473	347	334

TABLE V

Resistance of Solithane® S113 Prepolymer Compounds
To Common Chemicals and Solvents

FORMULATION NO.	**1**		**17**	
(Refer to Table I) Fluid Tested:	% Vol.	% Wt.	% Vol.	% Wt.
Acetone				
1 Day	Specimens Cracked			
30 Days				
Toluene				
1 Day	Specimens Cracked			
30 Days				
Ethyl Acetate				
1 Day	Specimens Cracked			
30 Days				
Ethyl Acetate				
1 Day	6.6	18.3	1.0	10.8
30 Days	6.3	16.0	6.7	18.2
Water				
1 Day	0	0.23	0	0.25
30 Days	0	0.18	-0.7	0.33
Sodium Hydroxide, 10%				
1 Day	0	0.24	0	0.30
30 Days	—	0.04	—	0.16
Hydrochloric Acid, 10%				
1 Day	0	0.30	-0.7	0.23
30 Days	30	0.16	0	0.27
Sulfuric Acid, 10%				
1 Day	0	0.31	0	0.31
30 Days	0	0.15	-0.7	0.28
SR-6 Ref. Fuel				
1 Day	23.6	66.9	9.3	26.0
30 Days	—	—	13.7	38.6
ASTM Fuel No. 1				
1 Day	5.6	11.0	0	0.50
30 Days	6.7	14.9	0	3.2

*At room temperature by immersion

TABLE VII

Effect of Boiling Water on Physical Properties
Of Solithane® S113 Prepolymer Compound

FORMULATION NO. (Refer to Table I)	**1**		**17**	
Conditions:	7 days/75°F (23°C) Control	7 days/H2O 212°F (100°C)	7 days/75°F (23°C) Control	7 days/ H2O @212°F (100°C)
Physical Properties				
Modulus, psi @100% (kg/cm2)	270 (19)	270 (19)	610 (45)	530 (37)
Tensile, psi (kg/cm2)	320 (22)	420 (30)	1840 (129)	1700 (120)
Elongation, %	120	130	170	175
Shore A	55	55	80	78

TABLE VIII

Typical Outgassing Data

FORMULATION NO. (Refer to Table I)	**pbw**
Solithane® S113 Prepolymer	100
Solithane® C113-300 Curing Agent	74
Temperature	Weight loss (at 10 x 177mmHg)
R.T.	(0.136%)
140°F (60°C)	(0.199%) Entirely Water
180°F (82°C)	(0.260%)
248°F (120°C)	(1.39%)

TABLE IX

FORMULATION:	
Solithane® S113 Prepolymer	100 pbw
Solithane® C113-300 Curing Agent	73.5
Claremont Leaf Green Paste #4060-Cro-1	(As indicated)

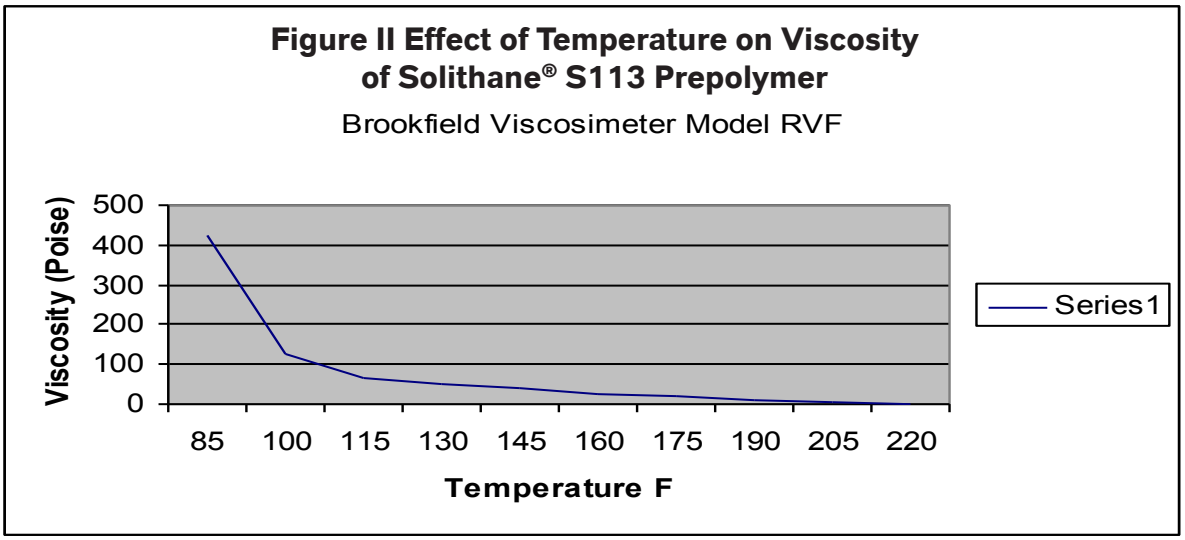
Paste Concentration, pbw	**Hardness, Shore A** psi (kg/cm^2) Samples cured 2 hrs at 300°F (149°C) + 7 days at 73°F (23°C)	**Tensile Strength**	**Elongation, %**
0.0	59	370 (26.0)	96
0.5	59	395 (27.8)	98
1.0	60	385 (27.1)	96
2.0	60	375 (26.4)	97
5.0	60	406 (28.5)	103
10.0	61	429 (30.2)	99
15.0	61	412 (29.0)	98

Brookfield Viscosimeter, Model
RVF Spindles No. 3

Solithane® S113 prepolymer may be stored under the usual warehouse conditions. Repeated freezing and thawing does not affect the performance of the polymer. No noticeable changes in its stability under ambient conditions have been experienced to date.

FIGURE II

Effect of Temperature on Viscosity of Solithane® S113 Prepolymer



Brookfield Viscosimeter
Model RVF

FIGURE III

Effects of Solithane® C113-300 Curing Agent on Viscosity of Solithane® S113 Prepolymer

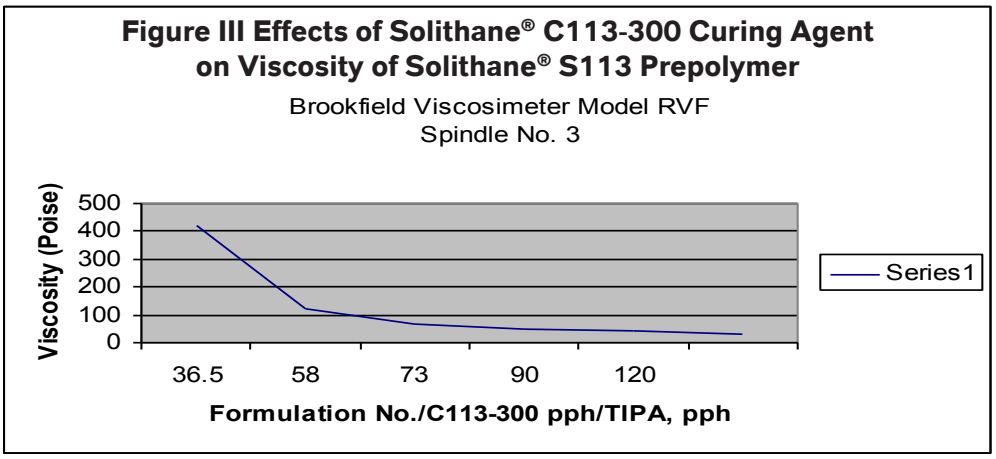
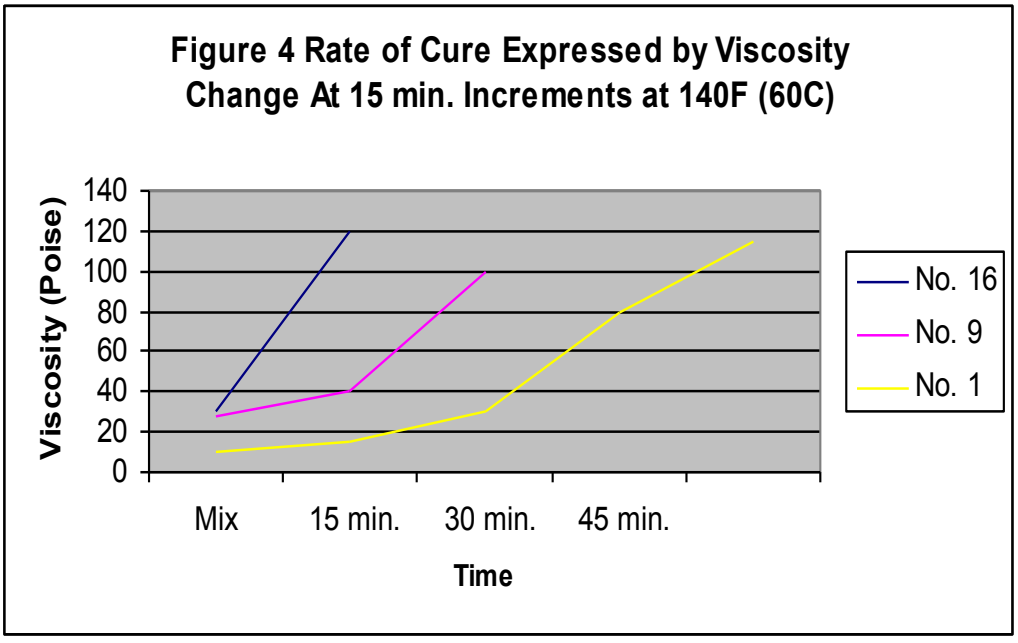


FIGURE IV

Rate of Cure Expressed by Viscosity Change
@15 minute Increments at 140°F (60°C)

Apparent Modulus of Rigidity of Solithane® S113 Prepolymer



Brookfield Viscosimeter
Model RVF
80°F (27°C)

Purpose

To determine G, the apparent modulus of rigidity of **Solithane® S113** prepolymer when formulated according to formula 1 in the Technical Bulletin.

Conclusion

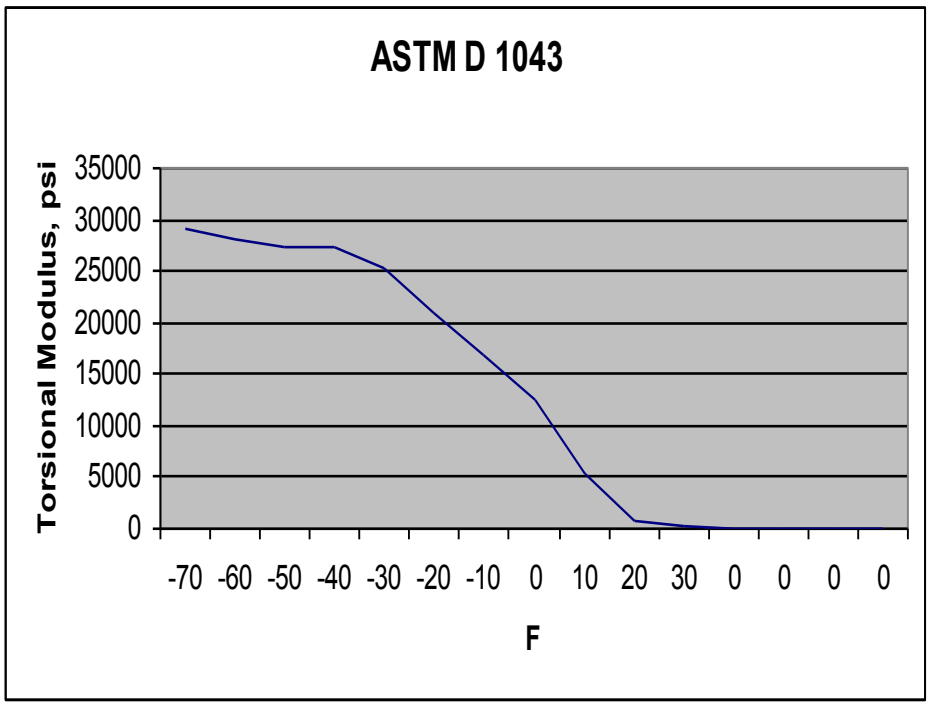
Solithane® S113 prepolymer exhibits a typical curve of rigidity vs. temperature when the values are plotted. The values show that the material is essentially rigid from -40°F (-40°C) down. The value, 10,000 psi, is reached at about +3°F (-16°C).

Procedure

The tests were run accordingly to ASTM D 1043 except as modified by the Morton Thiokol apparatus. Calculations are according to D 1043.

Typical G Values for Solithane® S113 Prepolymer - Formula 1
G= Apparent Modulus of Rigidity
Method: ASTM D 1043

°F	°C	G
+71	(+21.7)	78
+60	(+15.6)	74
+50	(+10)	81
+40	(+4.44)	86
+30	(-1.11)	220
+20	(-6.67)	778
+10	(-12.1)	5241
0	(-17.8)	12500
-5	(-20.5)	15556
-10	(-23.3)	16977
-20	(-28.9)	20857
-30	(-34.4)	25333
-40	(-40)	27222
-50	(-45.6)	27222
-60	(-51.1)	28000



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Listed below are data on Solithane® S113 prepolymer (100 parts) when cured with Solithane® C113-300 curing agent (73 parts). Such data may be helpful in aerospace applications.

1. Coefficient of Lineal Expansion
   7 x 10-5 inches/inch/degree F (from -65°F to +160°F)
2. Specific Heat
   0.44 calories/°C/gram
3. Thermal Conductivity
   5.0 x 10-4 calories/second/sq.cm/°C/cm
4. Ionising Radiation Resistance
   10 million RAD
5. Brittle Point
   +6.2°F (-14°C)

Solithane® S113 Prepolymer

Property	Specification Limits	Test Method
Isocyanate, % by wt.	10.4 to 10.8	ZS1078B
Viscosity @ 25°C, poises	200 – 300	ZM1109B
Specific Gravity, 25/25°C	1.065 to 1.085	ZM1041D

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Solithane® C113-300 Curing Agent

Property	Specification Limits	Test Method
Acid Number (mg KOH/g)	0.80 maximum	ZS1066A
Hydroxyl Number (mg KOH/g)	160 - 167	ZS1104
Moisture, % by wt.	0.02 maximum	ZS1007D
Specific Gravity @ 24°C	0.957 – 0.961	ZM1041D
Refractive Index, n D @ 25°C	1.4765 – 1.4780	ZS1101B

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Energizing Chemistry

Unless specified to the contrary, the values given have been established on standardized test specimens at room temperature. The figures should be regarded as guide values only and not as binding minimum values. Kindly note that the results refer exclusively to the specimens tested. Under certain conditions, the test results established can be affected to a considerable extent by the processing conditions and manufacturing process.

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