MECHANICAL PROPERTIES OF TATB/KEL-F 800
FORMULATION

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ABSTRACT

The effects of controlled crosshead velocity or strain-rate application on the compression and tensile test results for LLL B8 TATB PBX appeared to be statistically insignificant.

Bartherm treatment of billets resulted in a decrease in tensile strength. The thermal growth of the dimensional test specimen thermal cycled under a constant load of 1.72 MPa in L45 silicone oil was 50% less than the control specimen growth.

DISCUSSION

An 18.14 kg billet pressed from LLL B8 RX-03-BB yielded a finished density of 1.902 Mg/m³. Twelve tensiles and eight compression test specimens were fabricated from this billet. The individual test data utilizing constant crosshead velocity are given in Tables I and II. The strain rate control B8 tensile and compression test results are given in Tables III and IV. The application of the student "t" shows there is no significant difference at the 95% confidence level test between the two mean values of the constant crosshead velocity and the strain rate control tensile and compression tests (see Figs. 1 and 2).

Three billets were pressed from LLL B6 RX-03-BB in order to make three tensile, three compression and two dimensional stability test specimens. The three billets designated Parts A, B and C were pretreated as follows:

Part A	Bartherm-treated in tap water at constant pressure and temperature (1.72 MPa at 74 C) for 7 days
Part B	Epoxy coated and pretreated at the same conditions for Part A
Part C	Bartherm-treated in L45 silicone oil at a constant pressure of 1.72 MPa. This part was thermally cycled from -54 C to 74 C to -54 C per 24 hours for 20 days

At the end of the pretreatment the parts were inspected by the Gage Lab (dye check, density and dimensional measurements). Tensile, compression and growth specimens were then fabricated from these parts. The tensile and compression specimens were run at constant crosshead velocities of 0.002 mm/sec and 0.001 mm/sec, respectively, at 21 C. Groups A and C tensile and compression results (see Tables V through X) were significantly lower than those for Group B (Epoxy coated). The curve for Group A (see Fig. 3) represents only one test. The initial portion of test curve for one specimen was lost. The compression results (see Fig. 4) indicate that the epoxy coated bartherm treatment enhances the B6 compressive strength and strain.

DIMENSIONAL STABILITY

The dimensional stability test specimens fabricated from the three pre-treated parts (Parts A, B and C) previously mentioned were placed in an environmental chamber and thermally cycled from -54 C to 74 C to -54 C once every 24 hours for twenty cycles. The specimen dimensions were measured daily for the first five cycles. The remaining readings were taken at least twice weekly during the last fifteen cycles. The Group B (Epoxy coated) test specimen growth was almost as high as the control specimen growth. The Part C specimen produced the smallest dimensional change on thermal cycling (see Fig. 5).

Test specimens made from a B8 billet were heated at 113 C in tap water and held at 1.72 MPa for 7 days. A total density drop of 0.018 Mg/m³ and dimensional growth of approximately 4.8 mm/m occurred during the heat treatment. The same test specimens were thermally cycled unconfined for 20 additional cycles. The growth results are shown in Fig. 6.

CONCLUSIONS

A comparison of the compression and tensile results for LLL B8 conducted at constant crosshead velocities and constant strain rate application shows no significant difference in results.

The dimensional stability test results show that the total thermal growth of uncoated parts was decreased after bartherm treatment. Temperature cycling in silicone oil during bartherm treatment resulted in 50% less total growth than the control after bartherm.

The bartherm treatment of RX-03-BB does not significantly reduce thermal growth. In some cases, e.g. the 113 C treatment, the total growth during bartherm plus growth during unconfined thermal cycling is more than for the control specimens.

The tensile results of bartherm-treated RX-03-BB were lower than the control. The compression results of coated material after bartherm indicate an improvement in compressive properties.

Table I. Tensile Test at a Constant Crosshead Speed of 0.002 mm/sec at 21 C

(RX-03-BB, Final B8, Lot 5300-145-02, Pressing No.
83303Y4602, Density 1.9015 Mg/m³)

Piece No.	Rupture ^a Mode	Initial Modulus ^b (GPa)	Rupture		
			Time (sec)	Stress (MPa)	Strain (%)
11	6	7.5	306	8.39	0.26
12	4	5.0	262	7.30	0.21
14	4	7.2	292	8.32	0.31
20	5	6.4	372	8.74	0.31
Mean		6.5	308	8.19	0.28
Std. Dev.		1.1	47	0.62	0.05

^a 1 & 7 are in curved section, 2 & 6 are in the straight section outside the extensometers, 3 & 5 are at the knife edges and 4 is between the knife edges

^b Initial Modulus: (20% Rupture stress)/strain

Table II. Compression Test at a Constant Crosshead Speed of 0.001 mm/sec at 21 C

(RX-03-BB, Final B8, Lot 5300-145-02, Pressing No.
83303Y4602, Density 1.902 Mg/m³)

Piece No.	Initial Modulus ^a (GPa)	Failure			Rupture		Work to Rupture (MJ/m ³)
		Time (sec)	Stress (MPa)	Strain (%)	Time (sec)	Strain (%)	
1	4.41	2160	17.65	2.12	4440	5.64	0.871
3	4.00	2235	18.01	2.03	4485	7.10	1.086
5	3.16	2100	17.38	2.04	4485	7.50	1.092
8	10.1	2241	17.65	1.80	4260	6.14	0.895
Mean	5.42	2184	17.67	2.00	4418	6.60	0.986
Std. Dev.	3.16	67	0.26	0.14	107	0.86	0.194

^a Initial Modulus: (20% Failure stress)/strain

Table III. Tensile Test at 16.67 $\mu\text{E}/\text{sec}$ at 21 C
(RX-03-BB, Final B8, Lot 5300-145-02, Pressing No.
83303Y4602, Density 1.902 Mg/m^3)

Piece No.	Rupture ^a Mode	Initial Modulus ^b (GPa)	Rupture	
			Stress (MPa)	Strain (%)
18	4	8.4	6.74	0.13
19	2	5.5	7.70	0.24
21	2	8.6	6.90	0.19
22	3	41.2	8.25	0.22
Mean		16.0	7.40	0.20
Std. Dev.		16.9	0.71	0.05

^a1 & 7 are in curved section, 2 & 6 are in the straight section outside the extensometer, 3 & 5 are at the knife edges and 4 is between the knife edges

^bInitial Modulus: (20% Rupture stress)/strain

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Table IV. Compression Test at 16.67 $\mu\text{E}/\text{sec}$ at 21 C
(RX-03-BB, Final B8, Lot 5300-145-01, Pressing No.
83303Y4602, Density 1.903 Mg/m^3)

Piece No.	Initial Modulus ^a (GPa)	Failure		Rupture Strain (%)	Work to Rupture (MJ/m ³)
		Stress (MPa)	Strain (%)		
2	9.03	18.07	2.38	8.71	1.268
4	10.2	17.93	2.17	6.83	1.062
6	18.8	18.75	1.70	6.66	0.983
7	7.28	18.20	2.23	6.36	0.982
Mean	11.3	18.24	2.12	7.14	1.074
Std. Dev.	5.10	0.36	0.29	1.07	0.135

^aInitial Modulus: (40% Failure stress)/strain

A-6

Fig. 1. RX-03-BB Tensile Test at 21 C (LLL B3; Lot 5300-145-02)

Fig. 2. RX-03-BB Tensile Test at 21 C (LLL B8; Lot 5300-145-02)

Table V. Tensile Test at a Constant Crosshead Speed of 0.002 mm/sec at 21 C

(RX-03-BB, B6, Lot 5136-145-01, Pressing No.
83211Y3102, Density 1.902 Mg/m³)Group A

Piece No.	Rupture ^a Mode	Initial Modulus ^b (GPa)	Time (sec)	Rupture Stress (MPa)	Strain (%)
1	6	43.5	258	7.61	0.09
2	5		289	8.00	0.07
Mean		75.1	273	7.81	0.08
Std. Dev.		44.7	22	0.27	0.01

^a1 & 7 are in the curved section, 2 & 6 are in the straight section outside the extensometers, 3 & 5 are at the knife edges and 4 is between the knife edges^bInitial Modulus: (20% Rupture stress)/strain

Table VI. Compression Test at a Constant Crosshead Speed of 0.001 mm/sec at 21 C

(RX-03-BB, B6, Lot 5136-145-01, Pressing No.
83211Y3102, Density 1.903 Mg/m³)Group A

Piece No.	Initial Modulus ^a (GPa)	Time (sec)	Failure Stress (MPa)	Strain (%)	Time (sec)	Rupture Strain (%)	Work to Rupture (MJ/m ³)
4	6.52	1860	13.05	1.48	4002	5.55	0.858
5	5.45	1878	13.63	1.57	3768	3.97	0.732
7	4.73	1944	16.55	2.48	3840	8.50	1.135
Mean	5.57	1894	14.41	1.84	3870	6.01	0.908
Std. Dev.	0.90	44	1.88	0.55	120	2.30	0.206

^aInitial Modulus: (20% Failure stress)/strain

Table VII. Tensile Test at a Constant Crosshead Speed of 0.002 mm/sec at 21 C

(RX-03-BB, B6, Lot 5136-145-02, Pressing No.
83211Y3101, Density 1.902 Mg/m³)Group B

Piece No.	Rupture ^a Mode	Initial Modulus ^b (GPa)	Rupture		
			Time (sec)	Stress (MPa)	Strain (%)
1 ^c	3	12.0	708	9.93	0.17
2	5	11.1	325	10.6	0.18
3	6	16.6	275	9.97	0.12
Mean		13.3	436	10.2	0.16
Std. Dev.		3.0	237	0.36	0.03

^a1 & 7 are in the curved section, 2 & 6 are in the straight section outside the extensometers, 3 & 5 are at the knife edges and 4 is between the knife edges^bInitial Modulus: (20% Rupture stress)/strain^cTested at 0.001 mm/sec

Table VIII. Compression Test at a Constant Crosshead Speed of 0.001 mm/sec at 21 C

(RX-03-BB, B6, Lot 5136-145-01, Pressing No.
83211Y3101, Density 1.903 Mg/m³)Group B

Piece No.	Initial Modulus ^a (GPa)	Failure			Rupture		Work to Rupture (MJ/m ³)
		Time (sec)	Stress (MPa)	Strain (%)	Time (sec)	Strain (%)	
4	2.07	1920	16.55	2.72	4260	9.10	1.205
5	2.53	1980	16.47	2.60	3996	8.33	1.103
6	3.29	1878	16.44	2.39	3510	7.69	1.034
Mean	2.63	1926	16.48	2.57	3922	8.37	1.114
Std. Dev.	0.62	51	0.06	0.17	381	0.71	0.086

^aInitial Modulus: (20% Failure stress)/strain

Table IX. Tensile Test at a Constant Crosshead Speed of 0.002 mm/sec at 21 C

(RX-03-BB, B6, Lot 5136-145-01, Pressing No.
83211Y3103, Density 1,898 Mg/m³)

Piece No.	Rupture ^a Mode	Initial Modulus ^b (GPa)	Group C		
			Time (sec)	Rupture Stress (MPa)	Strain (%)
1	2	5.98	525.6	7.17	0.29
2	3	8.86	555.6	7.31	0.24
3	2	8.24	457.8	7.01	0.22
Mean		7.72	513.0	7.16	0.25
Std. Dev.		0.02	50.1	0.15	0.04

^a1 & 7 are in curved section, 2 & 6 are in the straight section outside the extensometer, 3 & 5 are at the knife edges and 4 is between the knife edges

^bInitial Modulus: (20% Rupture stress)/strain

Table X. Compression Test at a Constant Crosshead Speed of 0.001 mm/sec at 21 C

(RX-03-BB, B6, Lot 5136-145-01, Pressing No.
83211Y3103, Density 1.898 Mg/m³)

Piece No.	Initial Modulus ^a (GPa)	Group C			Rupture		Work to Rupture (MJ/m ³)
		Time (sec)	Failure Stress (MPa)	Strain (%)	Time (sec)	Strain (%)	
1	9.55	2400	14.33	1.92	4764	5.31	0.6233
2	4.81	2394	14.42	1.70	4506	5.58	0.6172
3	9.59	2208	14.38	1.49	4134	4.02	0.4881
4	3.60	2328	14.41	1.80	4338	4.22	0.5069
Mean	6.89	2332	14.39	1.73	4435	4.78	0.5589
Std. Dev.	0.31	89	0.04	0.18	267	0.78	0.0713

^aInitial Modulus: (20% Failure stress)/strain

Fig. 3. RX-03-BB; B6 Tensile Tests at a Constant Crosshead Velocity of 0.002 mm/sec at 21 °C

Fig. 4. Compression Tests at a Constant Crosshead Velocity of 0.001 mm/sec at 21 C (R-03-BB; B6)

Fig. 5. Dimensional Stability Tests for RX-03-BB Blend 6 (Lot 5136-145-01)

Fig. 6. Dimensional Stability Test for RX-03-BB LLL B8 (Lot 5300-145-02)