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PS/92/61

REPORT OF PLASTIC MATERIAL EVALUATIONS FOR USE IN PRESSURE SWITCH BASES

March 30, 1992

TEXAS INSTRUMENTS INCORPORATED
CONTROL PRODUCTS DIVISION
PRECISION CONTROLS DEPARTMENT
34 FOREST STREET
ATTLEBORO, MA 02703

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY S. [signature]	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP, ATTLEBORO, MA 02703	DOC.
DATE 3/30/92		PAGE 1

FORM 8286

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1.0 OVERVIEW

The testing summarized in this report was conducted in order to find the optimal material for use in the injection molded plastic bases of pressure switches. The report will be divided into two sections: 1) primary testing to select which material to use and 2) secondary testing of the chosen material to confirm its performance. All test bases were designed after the Ford F3LB HPCO A/C pressure switch.

The testing clearly indicates that the **Ultem** material meets the performance requirements of an A/C application most fully. However, the cost of Ultem is much greater than that of the other materials tested and as a result **Noryl GTX 830** was selected as the optimal material given both performance and cost considerations.

PRIMARY TEST MATERIALS

NAME	MATERIAL TYPE	COMPANY
NORYL	MOD. PPO	G.E. PLASTICS
STANYL	NYLON 4/6	DSM ENGINEERING PLASTICS
MINDEL	PSU ALLOY	AMOCO PERFORMANCE PRODUCTS
AMODEL	PPA	AMOCO PERFORMANCE PRODUCTS
AMODEL(a)	PPA	AMOCO PERFORMANCE PRODUCTS
CELANEX	PBT	HOSCHT CELANESE PLASTICS
CELANEX(a)	PBT	HOSCHT CELANESE PLASTICS
ULTEM	PEI	G.E. PLASTICS
ZYTEL	NYLON 6/6	DuPONT POLYMER PRODUCTS

2.0 PRIMARY TEST PROCEDURES

2.1 FLUID COMPATIBILITY

2.1.1 Equipment:
Humidity chamber RK model 5S; various test fluids.

2.1.2 Procedures:
Switches were tested per Section 3.16 of the ES.

2.1.3 Criteria:
After testing, the switch must meet the requirements of Sections 3.1 through 3.7 of the ES.

2.2 DSC / TGA / TMA

2.2.1 Equipment:
Testing performed at Technical Services Lab

2.3 INSERTION FORCE

2.3.1 Equipment:
Chatillon Digital Force Gauge DFG-100

2.3.2 Procedure:
Force was applied to terminal end of pins until they were pushed fully into base.

2.3.3 Criteria:
Minimize required force.

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2.4 **PUSH OUT FORCE**

2.4.1 Equipment:
Chatillon Digital Force Gauge DFG-100

2.4.2 Procedure:
Force was applied to shank end of pins until they were pushed fully out of bases.

2.4.3 Criteria:
Maximize required force.

2.5 **AIR LEAK**

2.5.1 Equipment:
Custom TI designed and built test station using an Aalborg Flowmeter.

2.5.2 Procedure:
Pressurize switch to 8 psi and check for leakage.

2.5.3 Criteria:
Switch must be able to maintain system pressure of 8 psi.

2.6 **REFRIGERANT LEAKAGE**

2.6.1 Equipment:
Custom TI designed and built test station, including a Heise pressure gauge model 69016, Inficon Halogen Leak Detector and HLD-2 GE Halogen Leak Standard Type L5-20.

2.6.2 Procedure:
Switches were tested per Section 3.6 of the ES.

2.6.3 Criteria:
R-134a Refrigerant leakage at 300 psig is not to exceed an equivalent leak rate of 5 grams/year.

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2.7 **BASE ROTATION**

2.7.1 Equipment:
Base fixture and torque wrench

2.7.2 Procedure:
While holding base with fixture, use torque wrench to find maximum torque before base begins to turn in crimp.

2.7.3 Criteria:
Maximize torque (desire > 15 in-lb).

2.8 **HYDROSTATIC BURST**

2.8.1 Equipment:
Custom TI designed and built test station using an Enerpac P-392 hand operated hydraulic pump with Enerpak hydraulic oil as the pressure medium. US gauge #33714, and safety enclosure.

2.8.2 Procedure:
Switches were tested per Section 3.7 of the ES.

2.8.3 Criteria:
Switches must withstand 1250 psig internal pressure for 30 seconds without any signs of leakage.

2.9 **HOUSING STRENGTH**

2.9.1 Equipment:
Custom TI designed and built pendulum test station

2.9.2 Procedure:
Apply a 52 pound side load at a rate of 20 inches per minute at the locking tab.

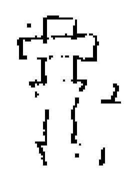
2.9.3 Criteria:
Switch housing must not break or crack.

	TEST	NORYL MOD. PPO	STANYL NYLON 4/6	MINDEL PSU ALLOY	AMODEL PPA	CELANEX PBT	AMODEL(a) PPA	CELANEX(a) PBT	ULTEM PEI	ZYTEL NYLON 6/6	
1	FLUID COMPATIBILITY	FAIL (BATT ACID)	FAIL (BATT ACID)	PASS	PASS	PASS	PASS	PASS			
2	DSC/TGA/ OTHER MAT'L ANAL.			DEGRADED DRYING?	MOLD TEMP TOO LOW?						
3	INSERTION FORCE (LB)	41 30	47 39	43 34	46 38	44 31	50 43	44 32			LG. BARB * SM. BARB **
4	PUSH OUT FORCE (LB)	30 25	36 31	22 23	34 31	29 23	29 32	30 23			LG. BARB SM BARB
5	INSERT. FORCE/ PUSH OUT RATIO	1.4 1.2	1.3 0.9	2.0 1.5	1.7 1.3	1.5 1.3	1.7 1.3	1.5 1.4			LG. BARB SM BARB
6	AIR LEAK	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	
7	REFRIG. LEAK	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	
8	BASE ROTATION TORQUE, IN-LB	30+	30+	30+	30+	30+	30+	30+	30+	30+	
9	AIR LEAK AFTER HI TEMP EXP.	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	PASS	FAIL	
10	REFRIG. LEAK AFTER HI TEMP EXP.	PASS	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	
11	BASE ROTATION TORQUE, IN-LB AFTER HI TEMP EXP.	11	10	3	8	5	6	6	>30	7	DESIRE >15 IN LB
12	BURST (PSIG)	2200 2200	2200 2200	1950 1950	2200 2200	1600 1725	2200 2200	1650 1675	2200 2200	2200 2175	NO HI TEMP EXP POST HI TEMP EXP.
13	HOUSING STRENGTH	PASS	PASS	FAIL CRACK AT LOCK TAB	PASS	PASS	PASS	PASS	PASS	PASS	
	COST ($/LB)	1.95	3.25-3.75	2.65-3.35	3.00	1.65	3.00	1.65	5.80	2.60	
		NORYL	STANYL	MINDEL	AMODEL	CELANEX	AMODEL(a)	CELANEX(a)	ULTEM	ZYTEL	

AJM,050,101,9/5/91

* ϕ.070-.073/ϕ.078-.077 (B.-b 1/B.-b 2)

** ϕ.068-.069/ϕ.074-.075



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4.0 PRIMARY CONCLUSIONS

The Primary Test Results indicate that the material properties of the various plastics are quite similar for most of the tests. The High Temperature Base Rotation test provided some differentiation among the plastics. Ultem, Noryl and Stanyl gave the most acceptable base rotation results. Of these three, Ultem clearly delivers the best performance but does so at 3 times the cost of Noryl and 1.5 times the cost of Stanyl. The final decision on material selection must be based on the cost vs. performance criteria for a given application. It would appear that in most situations Noryl would be the optimal choice.

PERFORMANCE RANK	MATERIAL	COST ($/LB)
1	Ultem	5.60
2	Noryl	1.85
3	Stanyl	3.25-3.75
4	Zytel	2.60
5	Amodel	3.00
6	Celanex	1.86
7	Mindel	2.65-3.35

TEST LOT NO.	TEST	DEVICE
TESTED BY		
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5.0 **SECONDARY T.ST PROCEDURES**

Further te: .ing was performed on the Noryl bases to confirm t at their performance capabilities were acceptable

5.1 **FLUID COMPA:IBILITY** (TEST NO. 62-15-06)

5.1.1 Equipment:
Same setup as in Primary test with the exception of battery acid. The battery acid had caused degradation of the Noryl in the Primary test and was subsequently deemed an unecessary part of the specification.

5.1.2 Procedure:
Same as Pr'mary Test.

5.1.3 Criteria:
Same as Pri y Test

5.1.4 Results:
The Noryl p ad the modified fluid compatibility test.

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5.2 **TEMPERATURE/PRESSURE/AGE** (TEST NO. 54-15-6)

5.2.1 Equipment:
Thermotron Model S8 programmable temperature chamber

5.2.2 Procedure:
Obtain vessel volume. Charge vessel with R-134a. Charge vessel with oil. Weigh vessel. Run 126 thermal cycles on vessel as follows:

(3) hours min. @ -29 C
(1) hour min. ramp up to 125 C
(3) hours min. @ 125 C
(1) hour min. ramp down to -29 C

Weigh vessels every 21 cycles.

5.2.3 Criteria:
Decrease in weight of vessel should not exceed 0.05% of initial weight.

5.2.4 Results:
Three samples using the Noryl material were run against three samples using the PBT material used in previous devices. The Noryl bases showed a significant improvement in leak resistance over the PBT bases.

TEST LOT NO.	TEST	DEVICE
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E SWITCH DATA Form 21603 TEST NO [illegible]

	DATE REQUESTED	REQUESTED BY	
[illegible]	[illegible]	[illegible]	
BY: [illegible]	DATE STARTED: [illegible] 92	DATE COMPLETED: [illegible] 92	APPROVED: [illegible]

TITLE: [illegible] TEST

INTERNAL

PURPOSE OF TEST: TO EVALUATE [illegible]

[illegible]

[illegible] 9059 [illegible] AA

	PRE-TEST								POST-TEST							
	ACT	REL	T.T ACT	T.T REL	MID	FREQ		ACT	REL	T.T ACT	T.T REL	MID	FREQ	[illegible] LEAKAGE	BURST
-01	410	234	1.5	1.2	2	✓		409	237	1.5	2.2	[illegible]	✓	✓	✓
-02	421	244	1.6	2.3	2	✓		423	245	1.5	2.3	2	✓	✓	✓
-03	410	243	1.6	1.3	2	✓		414	243	1.6	2.3	2	✓	✓	✓
-04	421	252	1.6	2.3	2	✓		422	25[illegible]	1.6	2.4	2	✓	✓	✓
-05	422	240	1.6	1.7	2	✓		426	238	1.6	2.4	[illegible]	✓	✓	✓
-06	423	244	1.6	1.4	2	✓		428	242	1.5	2.4	2	✓	✓	✓

COMMENTS: ALL UNITS PASSED POST-TEST REQUIREMENTS

CUT-IN/CUT-OUT SET POINT CHANGE AT 1%

TI-NHTSA 004729

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 5-15-6

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL DATE
EX3445-16, 20	11/01/91	D CZARN	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
R RUGGIER / R TURNER	11/05/91		

PROJECT TITLE: TEMP - PRESSURE AGE CYCLING

CUSTOMER:

PURPOSE OF TEST:

PROCEDURE:
1. OBTAIN VESSEL VOLUME = 1223.0 CM3
2. R134a CHARGE = 75.0 gm
3. OIL = 4.35 gm
4. WEIGH VESSEL
5. ADD OIL
6. ADD R134a

42 CYCLES OF:
(3) HOURS (MIN) @ -29°C
(1) HOUR (MIN) RAMP UP TO 125°C
(3) HOURS MIN @ 125°C
(1) HOUR (MIN) RAMP DOWN TO -29°C

ID #	VESSEL #	(A) INIT WT	(B) WT + OIL	(C) WT OIL+CHG	(D) WT @21CYC	% (D) CHANGE C-D/C	(E) WT @42CYC	% (G) CHANGE C-E/C	(H) WT @63CYC	% (I) CHANGE C-H/C
PET-209	R1	426.810	431.160	505.084	504.526	0.110	503.888	0.237	502.553	0.501
PBT 219	R3	428.984	433.354	508.347	507.860	0.096	507.257	0.214	505.899	0.482
PBT-246	R6	428.242	432.682	507.709	441.585	13.024	REMOVED FROM TEST			—
N-1	9	400.927	405.282	480.320	480.300	0.001	480.250	0.015	480.240	0.017
N-2	15	404.305	408.645	483.550	483.531	0.004	483.489	0.013	483.466	0.017
N-3	16	401.260	405.604	480.477	480.449	0.006	480.194	0.059	479.534	0.196

WEIGHT A: VESSEL, SW HOUSING, DEFLATOR, ADAPTER (FOR PBT ONLY)
WEIGHT B: WEIGHT A PLUS ~4.350 OIL
WEIGHT C: WEIGHT B PLUS R134a CHARGE

NOTE: VESSEL #R6 HAD TO BE RECHARGED BEFORE TEST DUE TO POSSIBLE LEAK BETWEEN ADAPTER AND VESSEL THREADS ENGAGEMENT.

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ID #	VESSEL #	(J) WT @ BASIC	(K) % CHANGE C-J/C	(L) WT @ 45 CYC	(M) % CHANGE C-L/C	(N) WT @ 126 CYC	(O) % CHANGE C-N/C
PST 209	R1	501.960	0.615	501.064	0.796	498.524	1.299
PST 219	R3	505.320	0.595	504.399	0.777	501.812	1.286
PST 246	R4	—	—	—	—	—	—
N-1	9	480.181	0.029	480.112	0.043	480.100	0.046
N-2	15	483.409	0.029	483.332	0.045	483.306	0.050
N-3	16	479.191	0.268	478.738	0.362	477.948	0.526

C. Summary of ES Tests and Acceptance Parameters (Cont.)

Nr.	Charac-teristics	PV or IP	Lower Toler-ance	Target	Upper Toler-ance	Minimum Conform-ance To Tolerance
3.10	Vibration Durability	PV	36 hours, 20 Hz-2000 Hz	Maximize	---	
3.11	Connector Housing/ Terminal Strength	PV	52 lb hsg load; 12/2.25 lb term. load	Maximize		
3.12	Drop Test	PV	1.5 meters	Maximize		
3.13	Impact Test	PV	200 gram weight dropped 0.5 meters	Maximize		
3.14	Humidity Test	PV	120 hours	Maximize		
3.15	Salt Spray	PV	240 hours	Maximize		
3.16	Fluid Com-patibility	PV	Immersions plus humidity exposure	Maximize		
3.17	Dust Exposure	PV	24 hours	Maximize		

III. TEST PROCEDURES AND REQUIREMENTS

3.1 Calibration

1. Switch settings are to be checked at 16° to 35°C using ambient dry air.

2. Calibration shall be as specified on the part drawing, with the setting checked after 2 or more cycles. A relay load (-14A640-) or PEO approved equivalent must be used. Calibration is to be checked while conducting 0.1-0.3 amperes when 10.0-14.0 volts D.C. is applied and the CCD-PEO approved load is employed.

3. The cut-out set point is to be checked with increasing pressure, and the cut-in set point is to be checked with decreasing pressure. The differential set point is to be calculated using the cut-in pressure minus the cut-out pressure.

4. Calibration criteria after Test Sections 3.9, 3.10, 3.11, 3.13, 3.14, 3.15, 3.16 and 3.17 is:

   a. Cut-out set point pressure cannot change more than ± 5% from the cut-out pressure initially measured in Section 3.1, paragraph 2.

   b. Cut-in set point pressure cannot change more than ± 5% from the cut-in pressure initially measured in Section 3.1, paragraph 2.

3.2 Continuity

1. Check is to be made at 16° to 35°C using ambient dry air, on the first switch cycle.

2. Test with an electrical load of 0.1-0.3 amperes at 10-14 volts D.C. using the approved (-14A640-) relay (PV), or with the production pressure/creep/continuity tester load of approximately 10-40 milliamps at 20-28 volts D.C. or equivalent (IP). Continuity must be monitored during the entire test. Pressurize the switch to 500 psig at a rate of 50 psi/second max. Continuity must change to an open circuit when the cut-out pressure is reached, and remain open at pressures above the cut-out pressure.

3. Reduce the pressure at a rate of 50 psi/second max until 0 psig is reached. Continuity must change to a closed circuit when the compresso cut-in pressure is reached, and remain closed at pressures less than the cut-in pressure.

3.3 Creep Check

1. Switch is to be creep checked at 16 to 35°C using ambient dry air.

2. The creep check is to be made after the switch has been cycled one or more times while employing relay (-14A640- or equiv.) load (PV) or production pressure/creep/continuity tester load or equivalent (IP). The current is to be 0.1-0.3 amperes at 10-14 volts D.C (PV) or approximately 10-40 milliamps at 20-28 volts D.C. (IP).

3. As the switch pressure is increased, the positive disc snap must occur within 5 milliseconds of electrical discontinuity at the cut-out point. The rate of pressure rise is to be no greater than 10 psi/secor at the creep check point.

4. As the switch pressure is decreased, the positive disc snap must occur within 5 milliseconds of electrical continuity at the cut-in point. The rate of pressure decay is to be no greater than 10 psi/second at the creep check point.

3.4 Voltage Drop

1. Voltage drop is to be measured after 2 or more cycles employing relay load (-14A640-) or equivalent with 0.1 to 0.3 amperes, 10-14 volt D.C. through the switch. Under these conditions at room ambient with switch closed the voltage drop across the switch is to be measured. Millivolt connection interface at terminals to be less that 10mVolts.

2. Voltage drop not to exceed 200 mvolts at 0.1-0.3 amperes, 10-14 volt D.C.

3.5 Current Leakage

1. Current leakage is to be checked with 500 volts, 60 Hz. A.C.

2. Current leakage is to be checked:

   a. Between the switch leads with contacts open.
   b. Between each lead and the switch housing with contacts open.
   c. Between either switch lead and the switch housing with the switch closed.

3. Current leakage not to exceed one milliampere.

3.6 Refrigerant Leakage

1. Refrigerant Leakage to be checked at room ambient, 24 ± 6°C using refrigerant or an acceptable tracer gas. Increase the pressure to 300 ± 10 psig using dry nitrogen or air.

2. Total equivalent leak rate of the switch, as an assembly not to exceed 5 gr/yr.

3.7 Hydrostatic Burst

1. Hydrostatically pressurize the switch with hydraulic fluid until 1250 psig pressure is reached.

2. Switch must not show evidence of leakage while being held at this pressure for 30 seconds.

3.8 High Pressure Durability

1. Subject the switch to 200,000 cycles of 0 psig to 500 ± 10 psig pressure, at a cycling rate of 25 ± 10 cycles per minute, while maintaining the switch in an ambient temperature of 125 ± 3°C. The pressure must be increased and decreased at an even rate to eliminate transient pressure spikes. Refrigerant oil or ATF may be used as the pressure medium.

2. At the completion of the cycling test, subject the switch to 30 cycles of 0 to 711 ± 25 mm (28 ± 1 inch) of mercury vacuum, maintaining the vacuum for a minimum of 5 minutes at room ambient.

3. After pressure cycling and vacuum cycling, switch must conform to Section 3.6.

3. Repeat steps "1" and "2" above, positioning the sensor such that the point of impact occurs 0.2 inches from end of surface connector housing, perpendicular to the housing.

4. After impact test, the switch must conform to Sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7 and 3.8. Additionally, the switch electrical connector housing must not break or crack.

3.14 Humidity

1. Mount the switch by its normal mounting means (valve stem and O-ring seal) in the vertical position in the humidity chamber, the switch pressure port pointing down (terminals up). The valve stem may be plugged to prevent moisture from entering the switch directly. Mating electrical connector (CCD-PEO to supply) and wiring drip loop must be installed before start of test.

2. Subject the switch to 10 humidity cycles as follows:

   a. 8 hours at 38°C (minimum) at 90 to 100% relative humidity.
   b. Lower temperature to 24°C (maximum) over a two hour period.
   c. Raise temperature to 38°C (minimum) and humidity to 90 to 100% over a two hour period.

3. After completion of the last humidity cycle, the switch must conform to Sections 3.1, 3.2, 3.3, 3.4, 3.5 and 3.6.

3.15 Salt Spray

1. Mount the switch by its normal mounting means (valve stem and O-ring seal) in the vertical position in the salt spray chamber, the switch pressure port pointing down (terminals up).

2. Switch is to be tested with the Ford released electrical connector installed (CCD-PEO to supply) with electrical continuity of the CCD-PEO approved relay load (-14A640-).

3. The switch is to be pressurized at 300 ± 10 psig for the duration of the test.

4. Expose the assembly to salt spray for 240 hours per ASTM B117.

5. After exposure, the switch must conform to Sections 3.1, 3.2, 3.3, 3.4, 3.5 and 3.6.

3.16 Fluid Compatibility

1. With the switch pressure port plugged, and the mating electrical connector/wiring installed, submerge switch for five seconds in each of the following fluids: engine oil, gasoline, diesel fuel, engine coolant (Ethylene Glycol), automatic transmission fluid, brake fluid, windshield wiper solvent, and saturated salt water solution.

2. Allow switch/connector assembly to drip dry for five minutes at room temperature.

3. Repeat steps "1" and "2" above five times. At the completion of the 5th cycle, subject switch/connector assembly to 100°C and 85% relative humidity for eight hours.

4. After fluid exposure test, the switch must conform to Sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 and 3.7.

3.17 Dust Exposure

1. With the switch pressure port plugged, and the mating electrical connector/wiring installed, place the switch in the dust chamber in the vertical position (switch terminals up).

2. Expose the switch for 24 hours to Portland cement dust that is agitated for two seconds every 15 minutes.

3. After dust exposure test, check the switch must conform to Sections 3.1, 3.2, 3.3, 3.4 and 3.5.

IV. RE-VALIDATION REQUIREMENTS

In addition to the requirements of Section II., re-validation shall be required whenever requested by the Product Engineering Office (PEO) and prior to each model year production. Yearly re-validation shall consist of Test 3.9 (Pressure/Thermal Cycling).

The supplier and the design-responsible Product Engineering Office will jointly determine which potential changes to the process, materials or material sources would have significant impact on the product's function, performance, durability or appearance. The supplier will describe these conditions in the Control Plan, along with either (1) the revalidation plan that would be followed in each case, or (2) a provision to submit an amended Control Plan for approval if any of those process changes are planned.

V. INSTRUCTIONS AND NOTES

Control Plans address all significant design and process characteristics, which include all ES tests and Control Item characteristics. They describe the process potential studies that will be performed for product validation (including PV tests) and the ongoing product and process evaluation for continuing improvement (including IP tests). They include acceptance criteria, sample sizes, frequencies, data analysis methods and reaction plans.

The Control Plan is developed, and updated as necessary, by the supplier in conjunction with the design responsible Product Engineering Office and other appropriate functions such as SQA. The Control Plan defines the management of the upstream production process and part variables (significant process characteristics) that affect the outcome of the ES tests or other significant

SEPTEMBER 17, 1991

TO: ANDY MCKENNA
RON RUGGIERI

CC: HANK GRIFFIN

FROM: KAREN ROSS

RE: DSC,TGA TESTING TSL # 109886

WE RECEIVED 5 SAMPLES OF DIFFERENT RESINS IN BOTH THE MOLDED AND PRE-MOLDED FORMS, ALONG WITH 2 SAMPLES OF BASES WHICH WERE ANNEALED. DSC, TGA, AND TMA TESTS WERE PERFORMED ON THEM (ATTACHED). FURTHER DISCUSSION WILL BE NECESSARY IN ORDER TO FULLY UNDERSTAND THE RESULTS.

REGARDS,

KAREN ROSS

TSL # [illegible]

SAMPLES:	SPEC LIMITS

NORYL [illegible] POLYPHENYLENE [illegible] (PPO) G.E. PLASTICS [illegible]	Tm 530-575^F [illegible] 30% GLASS FILL
STANYL 4/6 NYLON DSM ENGINEERING PLASTICS 215-320-6992	Tm 55[illegible] (2[illegible] HDT 320^F [illegible]
MINDEL S322 POLYSULFONES, MODIFIED AMOCO PERFORMANCE PRODUCTS 800-621-4557	Tm [illegible] HDT 320^F (160 [illegible] 2[illegible]% GLASS FILL
AMODEL [illegible] POLYPHTHALAMIDE (PPA) AMOCO PERFORMANCE PRODUCTS	Tm [illegible] 33 [illegible] GLASS FILL
CELANEX 4300 POLYBUTYLENE TERETHYLATE (PBT) CELANESE 908-231-2062	Tm 450-500^F ([illegible]C) HDT 433^F (22[illegible] 30% GLASS FILL

TEST RESULTS

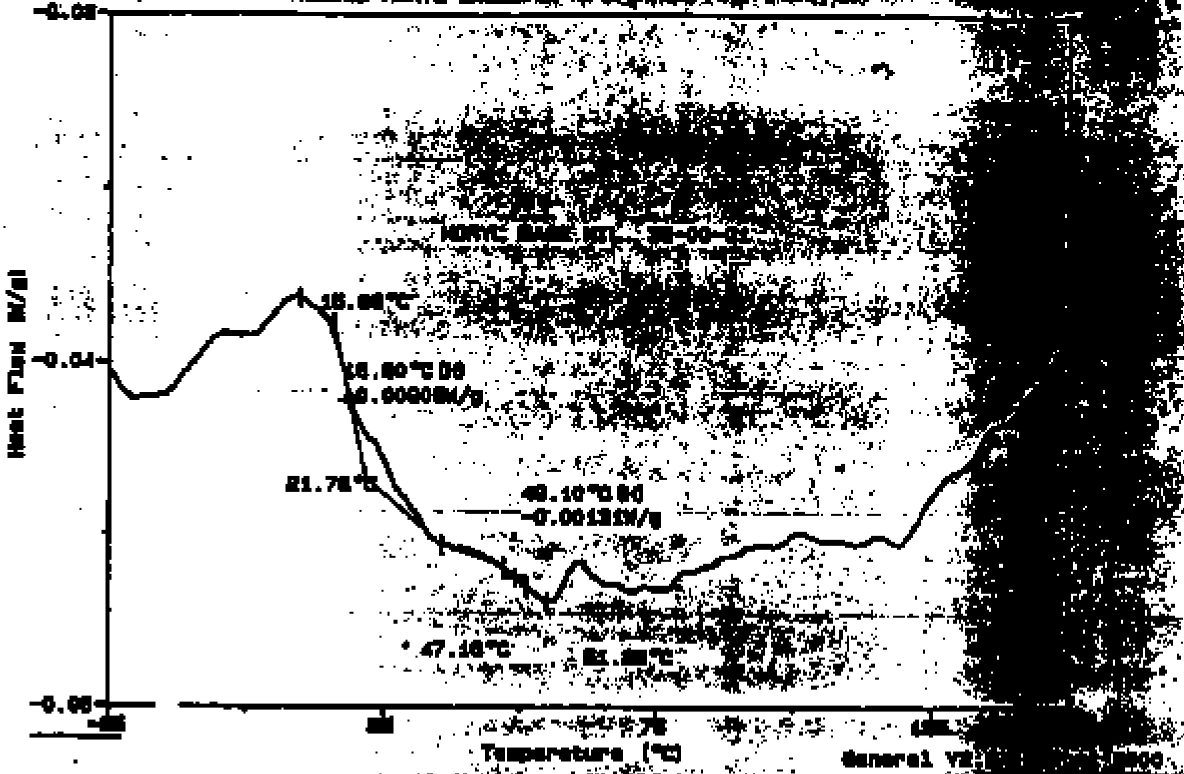
CELANEX BASE	Tg 49.48 76.92 49.27 79.32 Tm 227^c HDT 219^C 30.17 % GLASS
CELANEX PRE-MOLD	Tg 50.4 69.01 Tm 227^C
CELANEX BASE	Tg 51^C Tm 226^C HDT 218 29.77 % GLASS

TEST RESULTS

NORYL BASE	Tg [illegible].60 C 49.10 Tm 262^C [illegible] % GLASS HDT [illegible]
NORYL PRE-MOLD	Tg [illegible] C Tm 263^C HDT 285^C
STANYL BASE	Tg 16.56 25.78 Tm 292^C 31.46 % GLASS
STANYL PRE-MOLD	Tg [illegible] C 32.90^C Tm 292^C 27.64 % GLASS
MINDEL BASE	EXOTHERM 9.37 66.65 117.9[illegible] Tm 253^C HDT [illegible]33.13
MINDEL PRE-MOLD	Tg 16.11 80.82 EXO 124.35 Tm 252^C
AMODEL BASE	Tg 15.45 50.97 80.93 EXO 116.65 150.13 Tm 310^C HDT 298^C 35.16 % GLASS
AMODEL BASE ANNEALED	Tg 9.43 66.28 exo 117.57 150.36 Tm 319.14
AMODEL PREMOLD	Tg -18.37 12.77 75.43 -18.43 16.02 75.45 exo 120.72 Tm 252^C

Sample: NORYL ID 38-00-01
Size: 10.1800 mg
Method: 88N/10/350
Comment: TEL100888 MOLDED NORYL BASE

DSC



Sample: NORYL ID 38-00-01
Size: 10.1800 mg
Method: 88N/10/350
Comment: TEL100888 MOLDED NORYL BASE

DSC

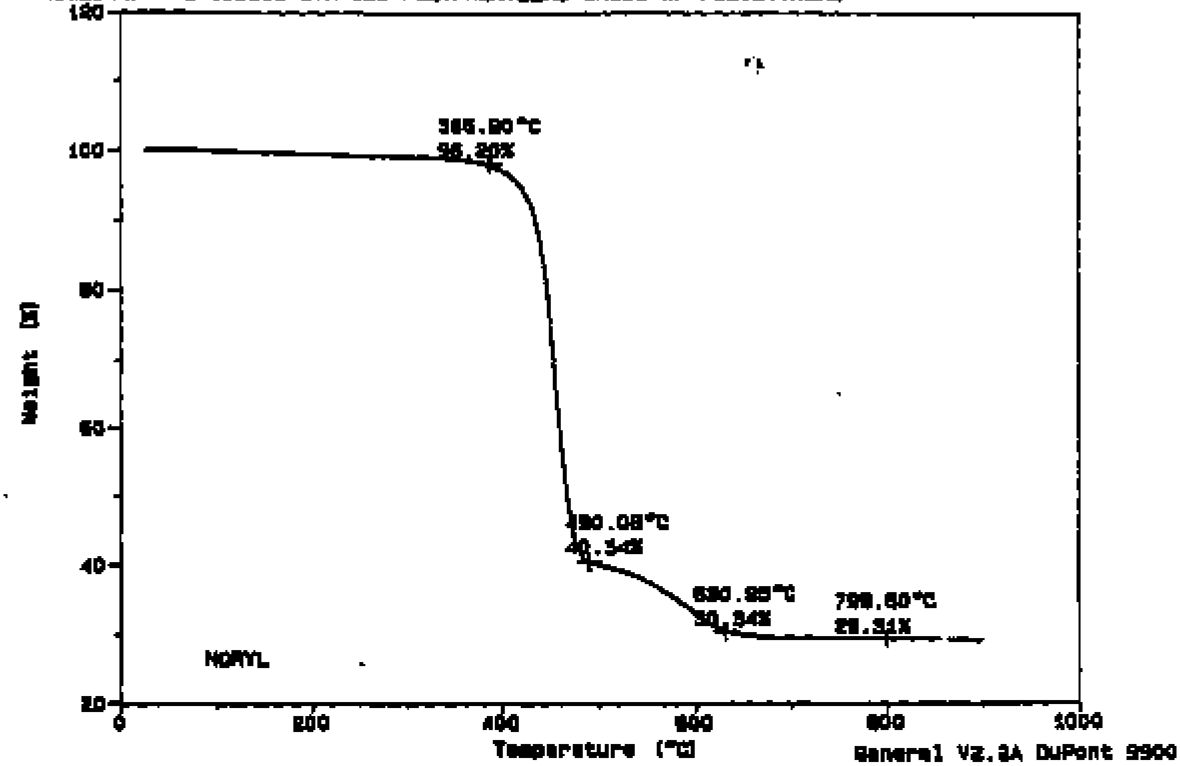
File: ORDNR.74
Run Date: 07/01/

TI-NHTSA 004741

Sample: NORYL ID 38-00-01
Size: 27.7600 mg
Method: 10/900/I50
Comment: TSL 109886 GTX-830 POLYPHENYLENE OXIDE W/ POLYSTYRENE

TGA

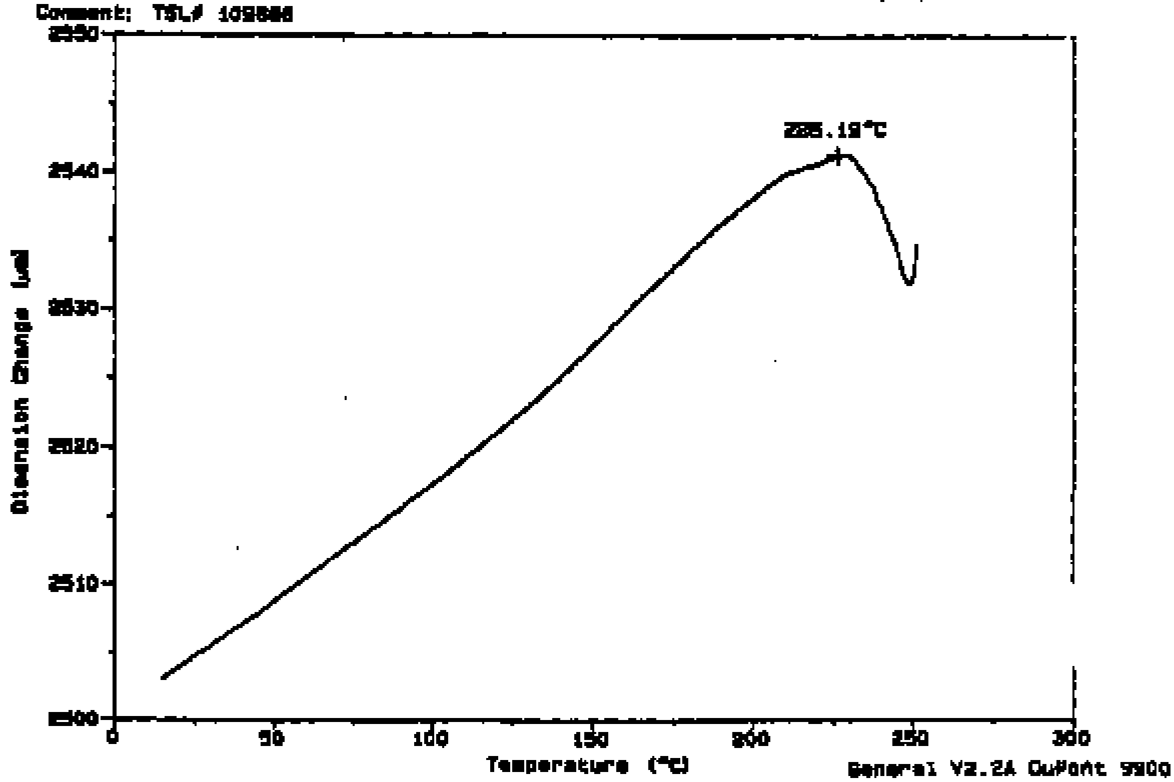
File: TRONA.05
Operator: KROSS
Run Date: 07/09/91 11:20



Sample: NORYL
Size: 318.0000 mm
Method: 10/320
Comment: TSL# 109886

TMA

File: TRONA.72
Operator: K ROSS
Run Date: 09/05/91 14:25

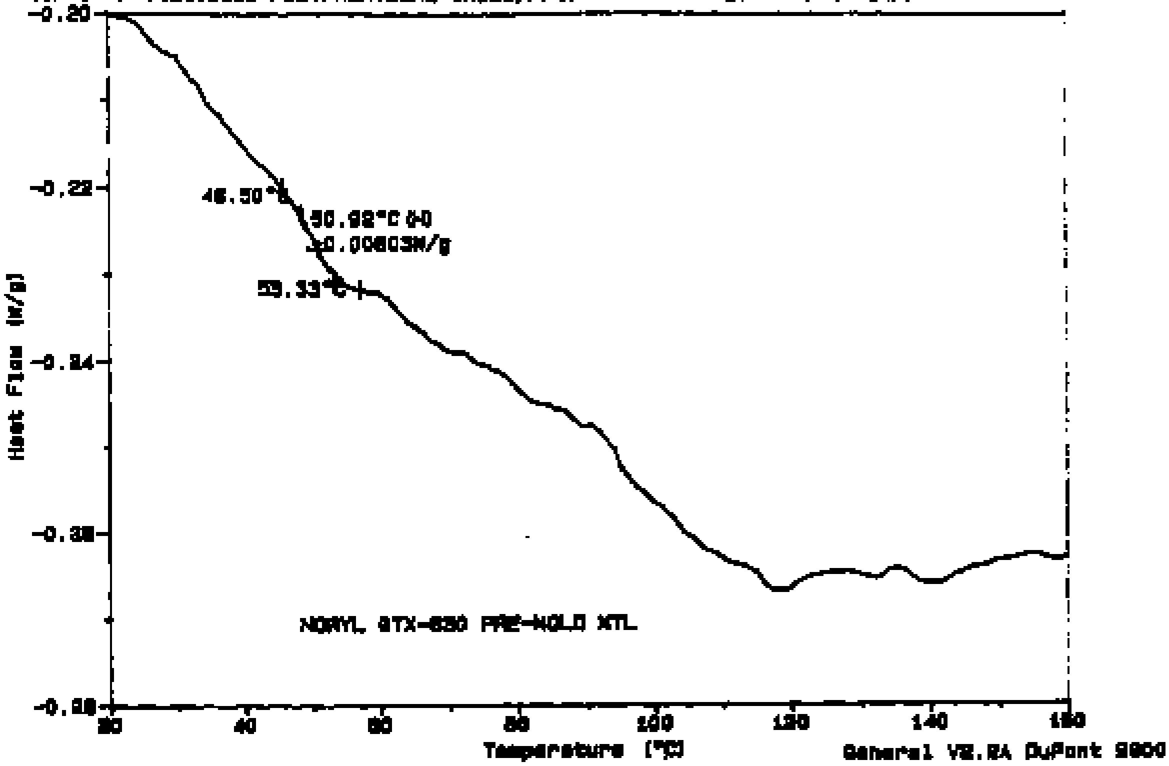


TI-NHTSA 004742

Sample: NORYL GTX-630 PRE-MOLD
Size: 9.7000 mg
Method: GEN/10/350
Comment: TSL105888 POLYPHENYLENE OXIDE, PPO, MODIFIED POLYSTYRENE BLEND

DSC

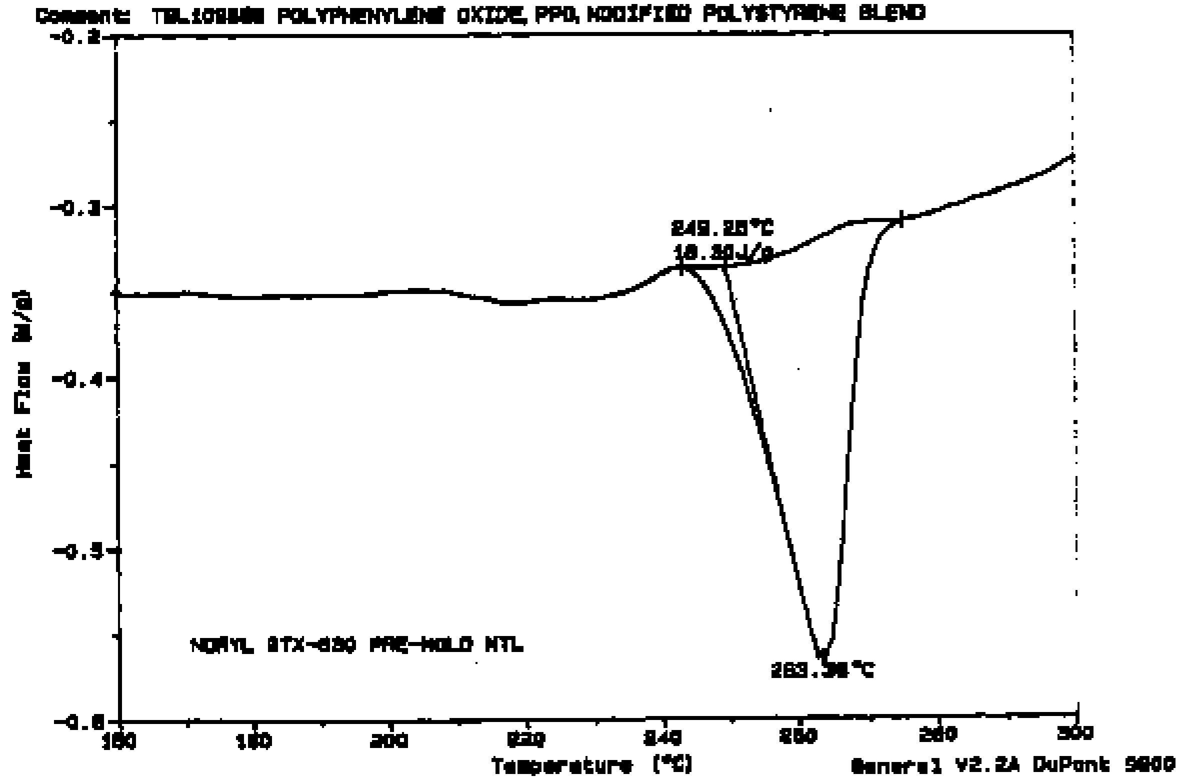
File: DRDNR.78
Operator: KROSS
Run Date: 07/01/91 14:10



Sample: NORYL GTX-630 PRE-MOLD
Size: 11.9000 mg
Method: GEN/10/350
Comment: TSL105888 POLYPHENYLENE OXIDE, PPO, MODIFIED POLYSTYRENE BLEND

DSC

File: DRDNR.78
Operator: KROSS
Run Date: 07/01/91 14:10

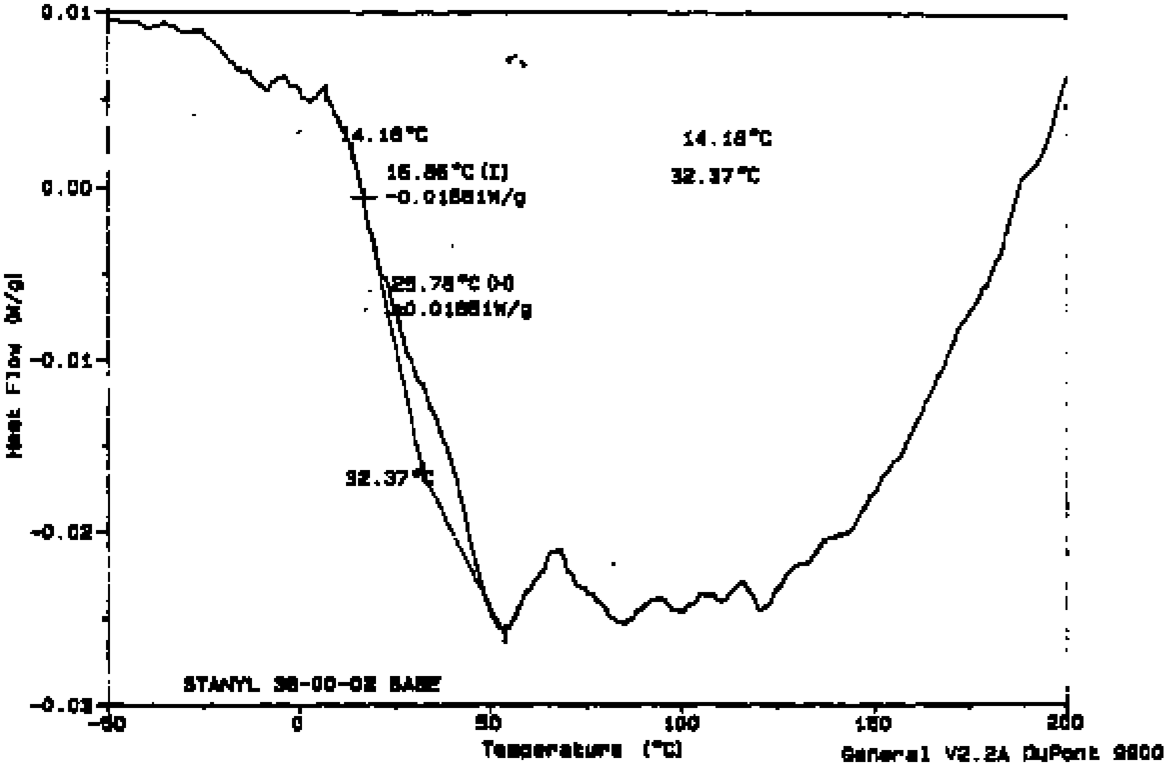


TI-NHTSA 004743

Sample: STANYL ID 38-00-02 BASE
Size: 11.4000 mg
Method: GEN/10/350
Comment: TSL109888 4/6 NYLON

DSC

File: DRONA.80
Operator: KROSS
Run Date: 07/02/91 08:38

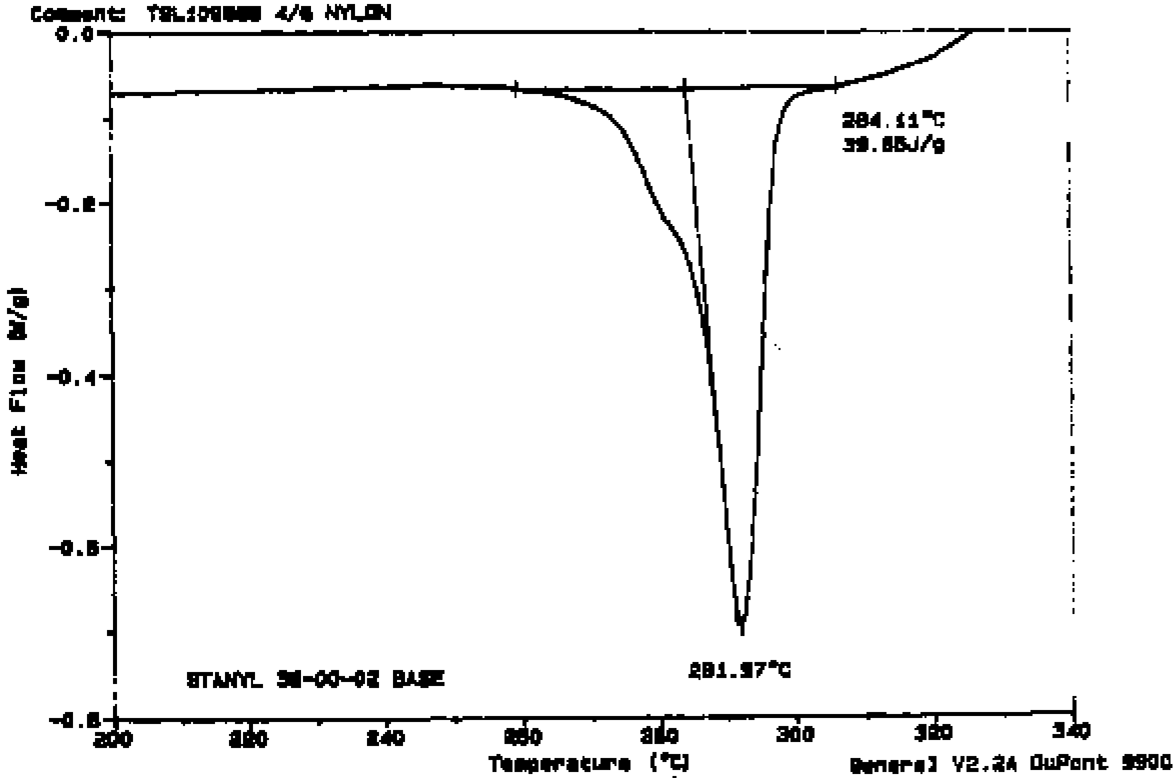


General V2.2A DuPont 9900

Sample: STANYL ID 38-00-02 BASE
Size: 6.6000 mg
Method: GEN/10/350
Comment: TSL109888 4/6 NYLON

DSC

File: DRONA.81
Operator: KROSS
Run Date: 07/08/91 08:36



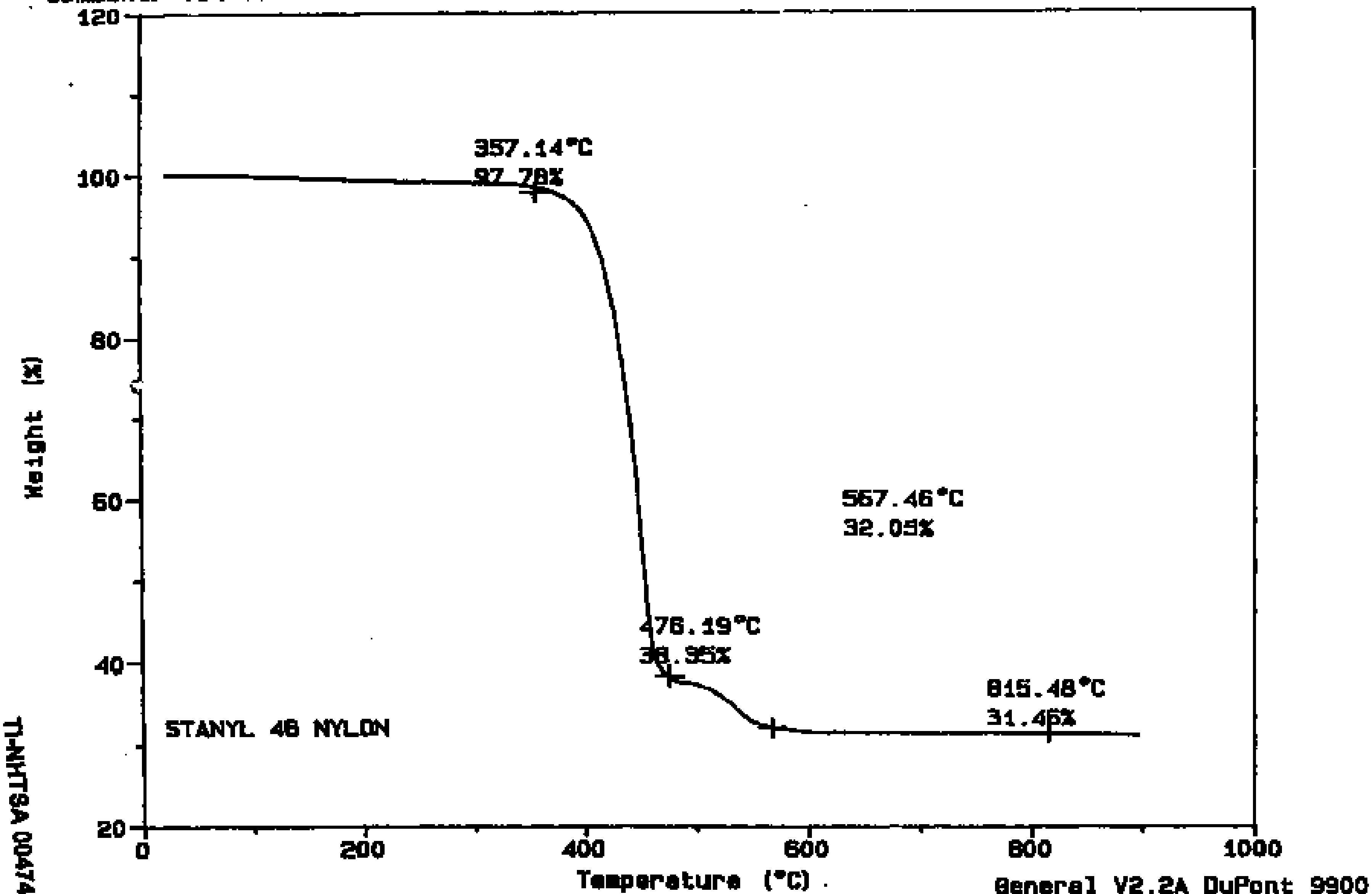
General V2.2A DuPont 9900

TI-NHTSA 004744

Sample: STANYL 46 NYLON ID 38-00-02
Size: 30.1680 mg
Method: 10/900/ISO
Comment: TSL 109886

TGA

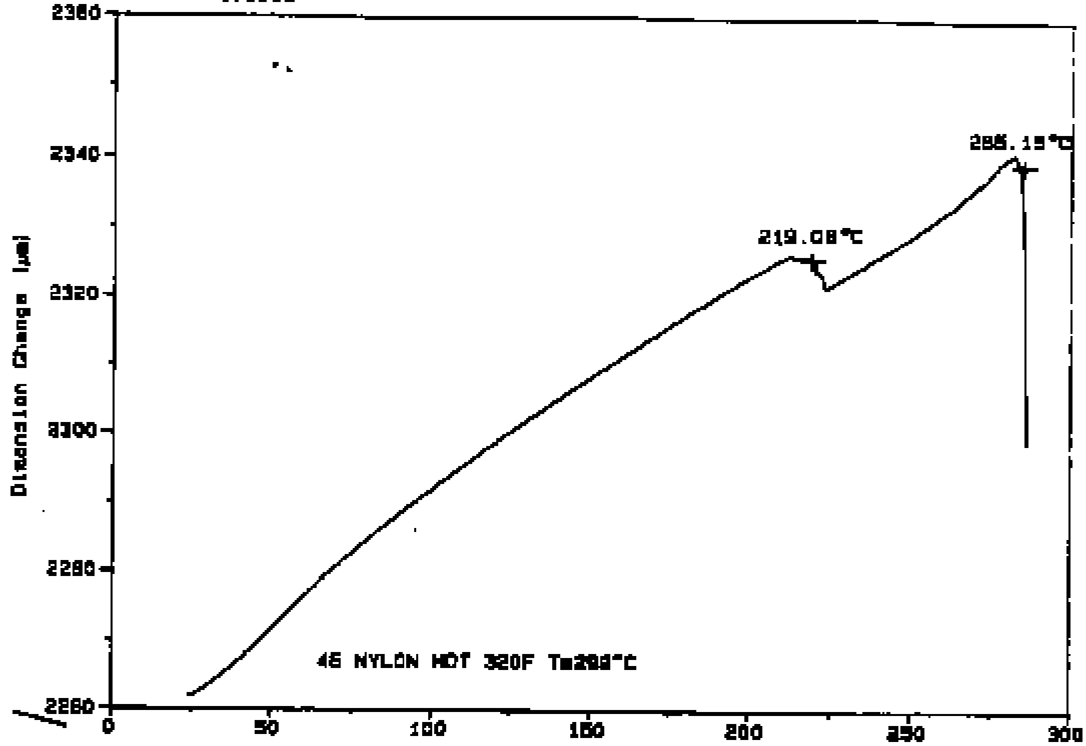
File: TRONA.07
Operator: KROSS
Run Date: 07/10/91 09:56



Sample: STANYL GTX 630
Size: 302.0000 um
Method: 10/320
Comment: TSL# 109686

TMA

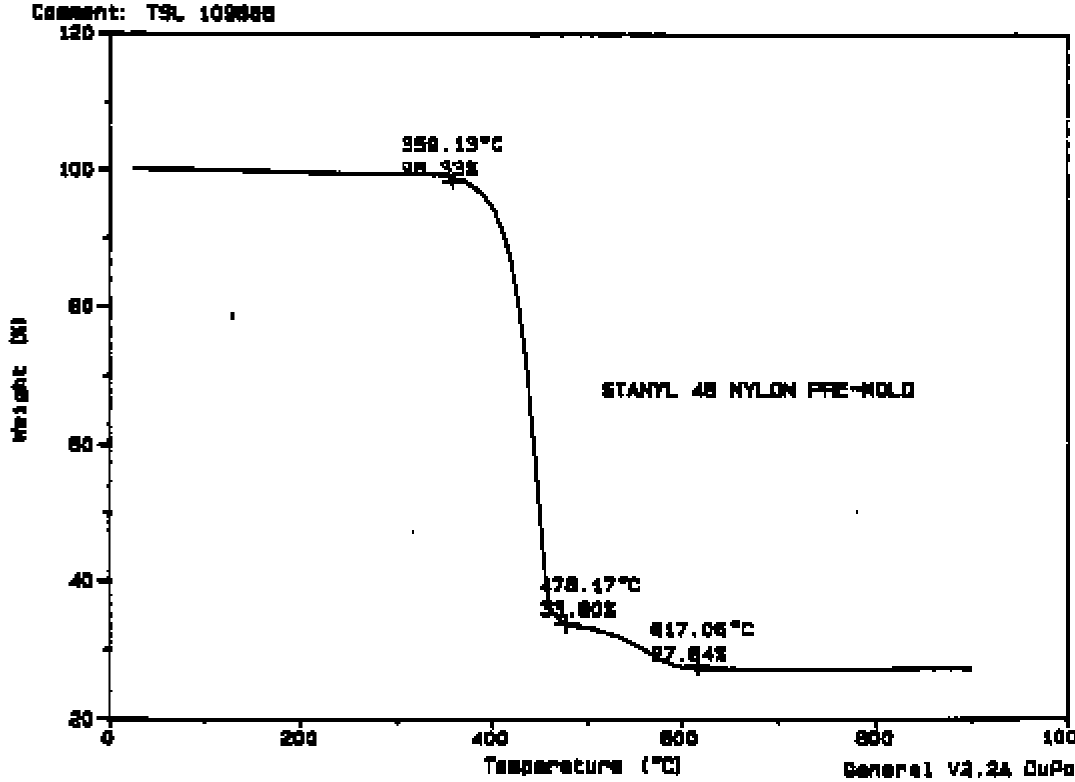
File: TRONA.74
Operator: K ROSS
Run Date: 09/06/91 08:56



Sample: STANYL 46 PRE-MOLD MATERIAL
Size: 45.0720 mg
Method: 10/900/ISO
Comment: TSL 109686

TGA

File: TRONA.06
Operator: KROSS
Run Date: 07/11/91 08:07



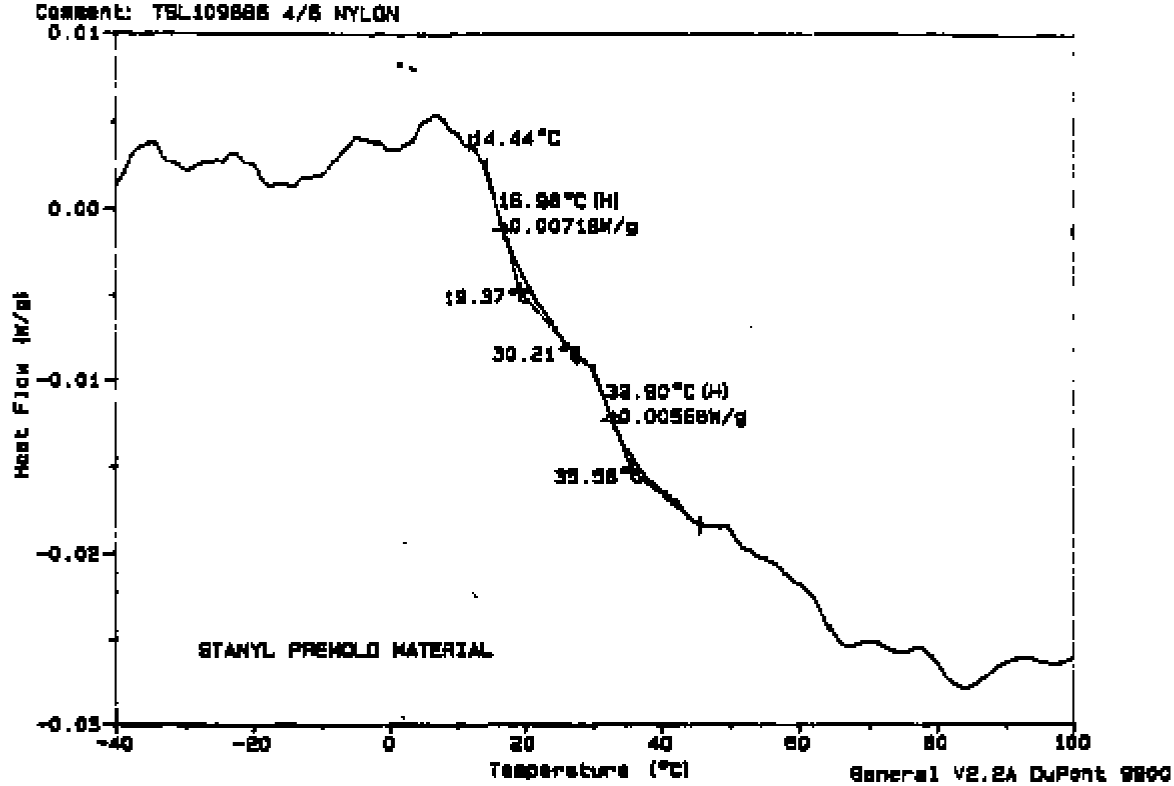
General V2.2A DuPont 9900

TI-NHTSA 004746

Sample: STANYL 4/6 PRE-MOLD MTL
Size: 10.2540 mg
Method: GEN/10/350
Comment: TSL109686 4/6 NYLON

DSC

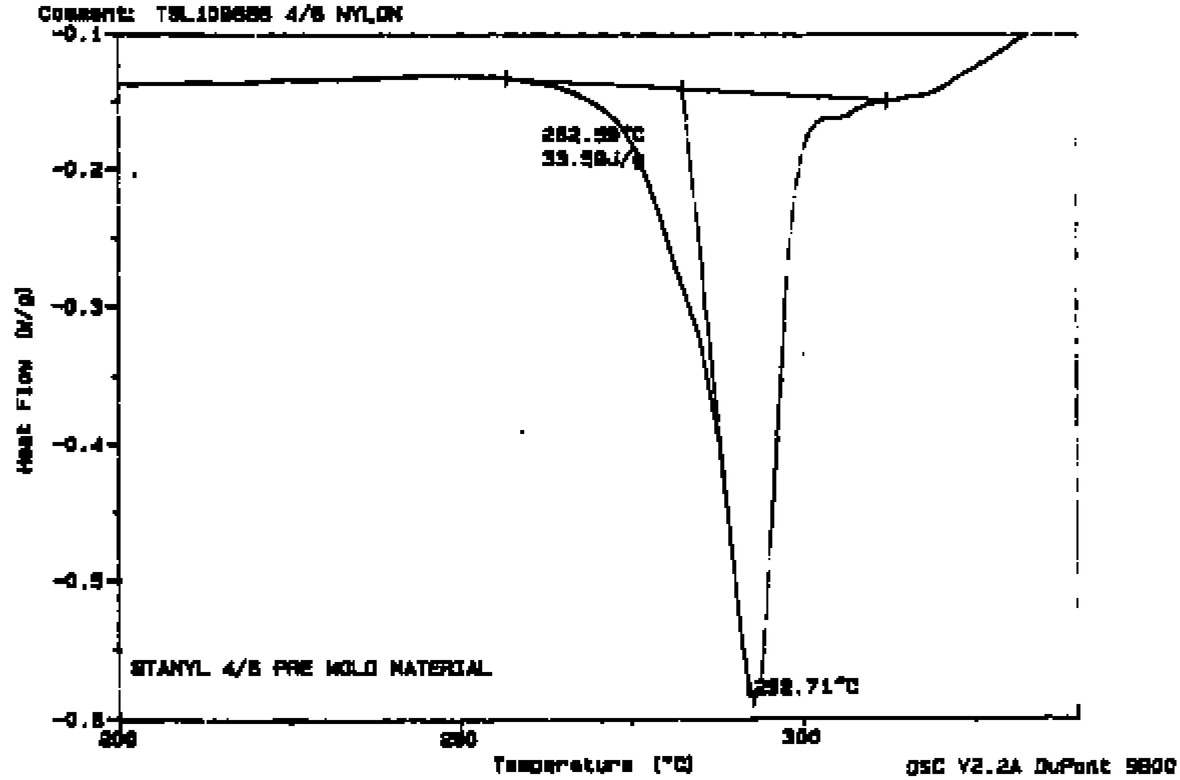
File: DRONR.62
Operator: KROSS
Run Date: 07/02/91 10:32



Sample: STANYL 4/6 PRE-MOLD MTL
Size: 14.1000 mg
Method: GEN/10/350
Comment: TSL109686 4/6 NYLON

DSC

File: DRONR.63
Operator: KROSS
Run Date: 07/02/91 10:32

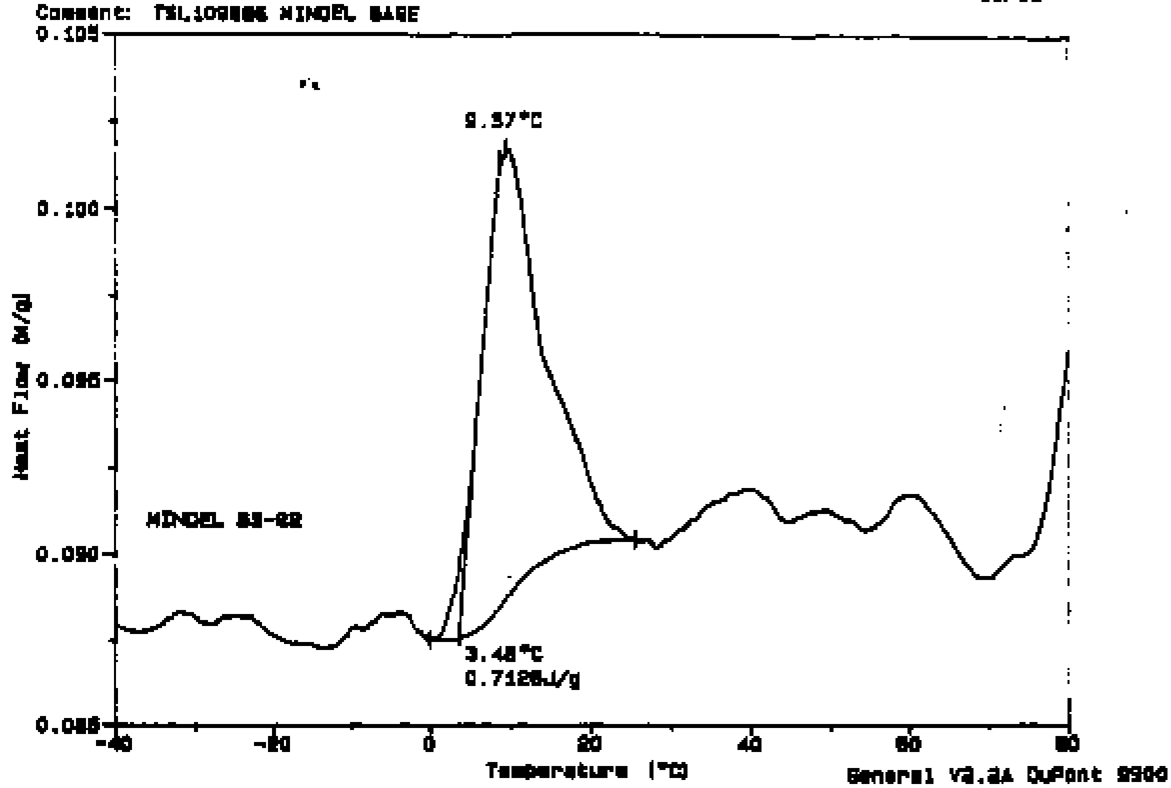


TI-NHTSA 004747

Sample: MINDEL ID 30-00-03 BASE
Size: 10.5500 mg
Method: SEN/10/350
Comment: TSL109886 MINDEL BASE

DSC

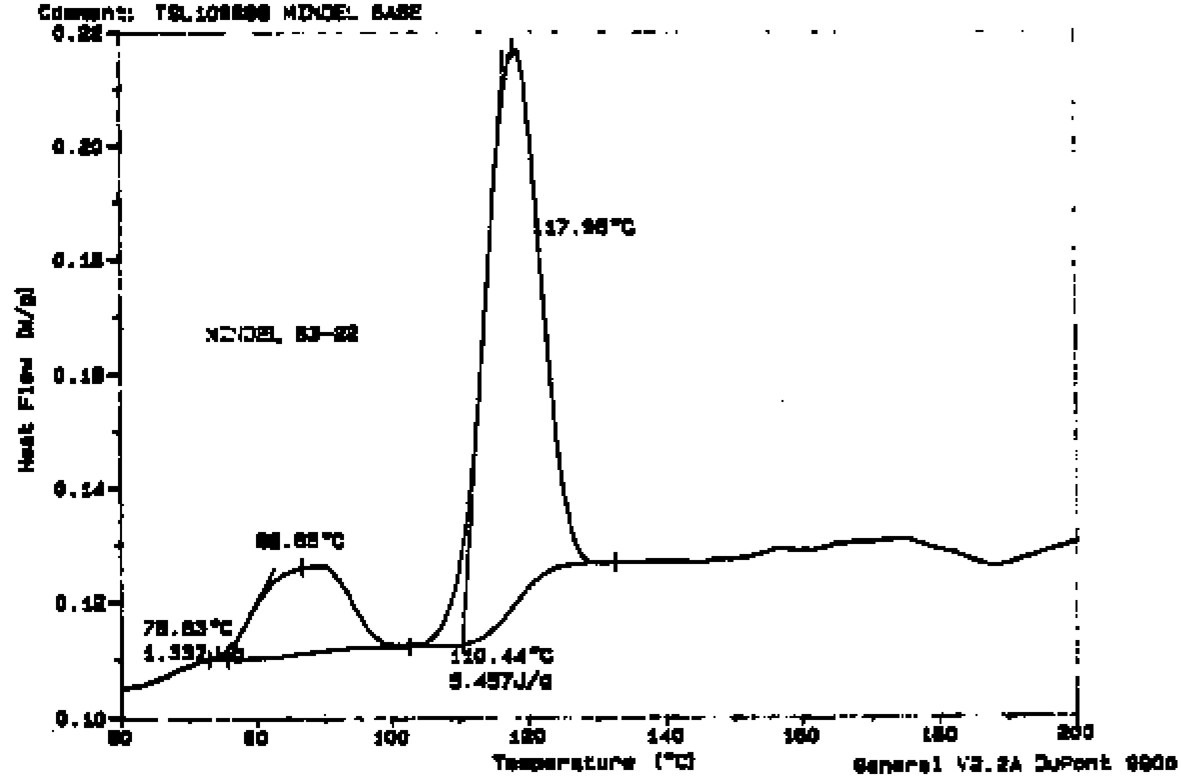
File: DRONA.86
Operator: KROSS
Run Date: 07/03/91 08:59



Sample: MINDEL ID 88-00-03 BASE
Size: 6.0500 mg
Method: SEN/10/350
Comment: TSL109886 MINDEL BASE

DSC

File: DRONA.87
Operator: KROSS
Run Date: 07/03/91 08:59

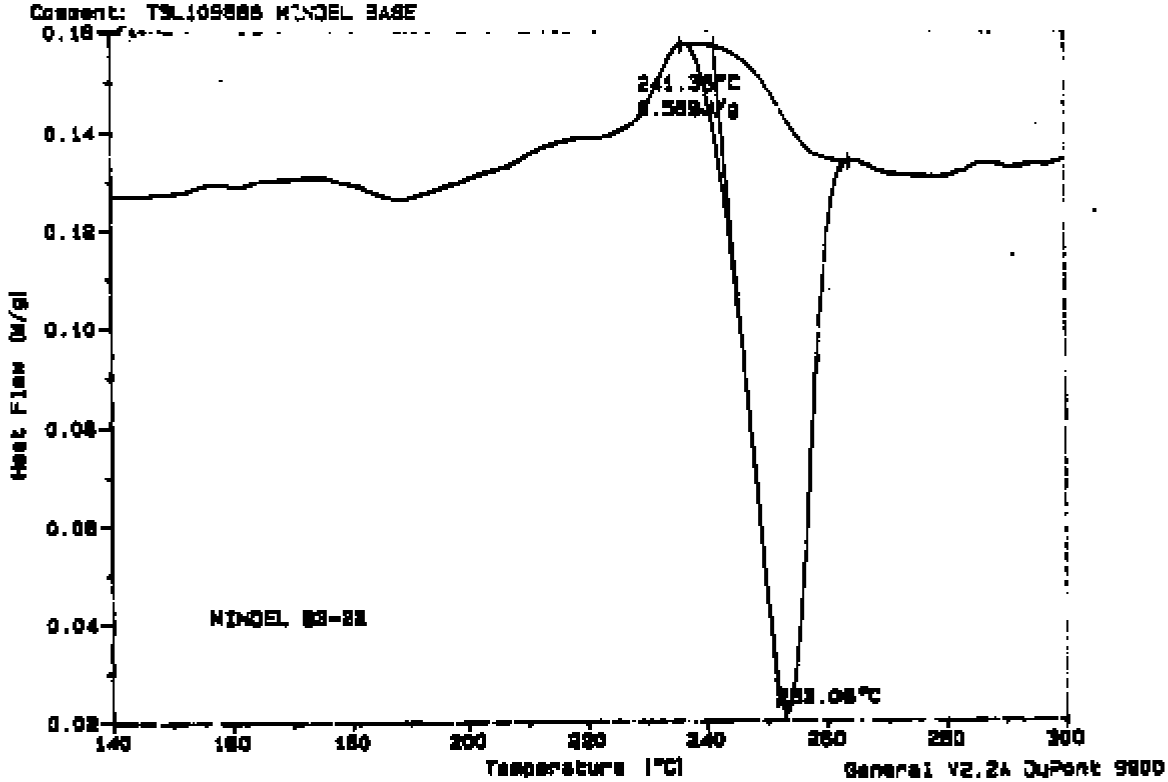


TI-NHTSA 004748

Sample: MINDEL ID 38-00-03 BASE
Size: 6.0800 mg
Method: GEN 10/350
Comment: TSL109888 MINDEL BASE

DSC

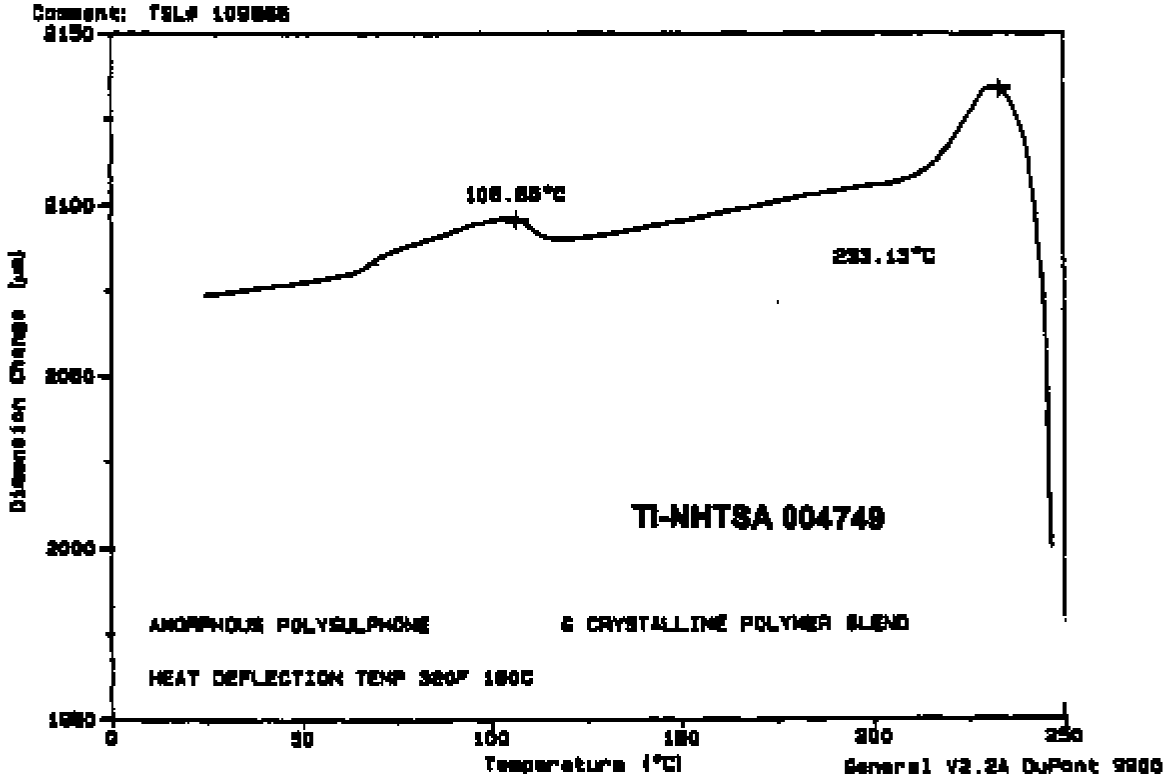
File: DRGNR.07
Operator: KROSS
Run Date: 07/03/91 08:59



Sample: MINDEL BASE
Size: 206.0000 mm
Method: 10/280
Comment: TSL# 109888

TMA

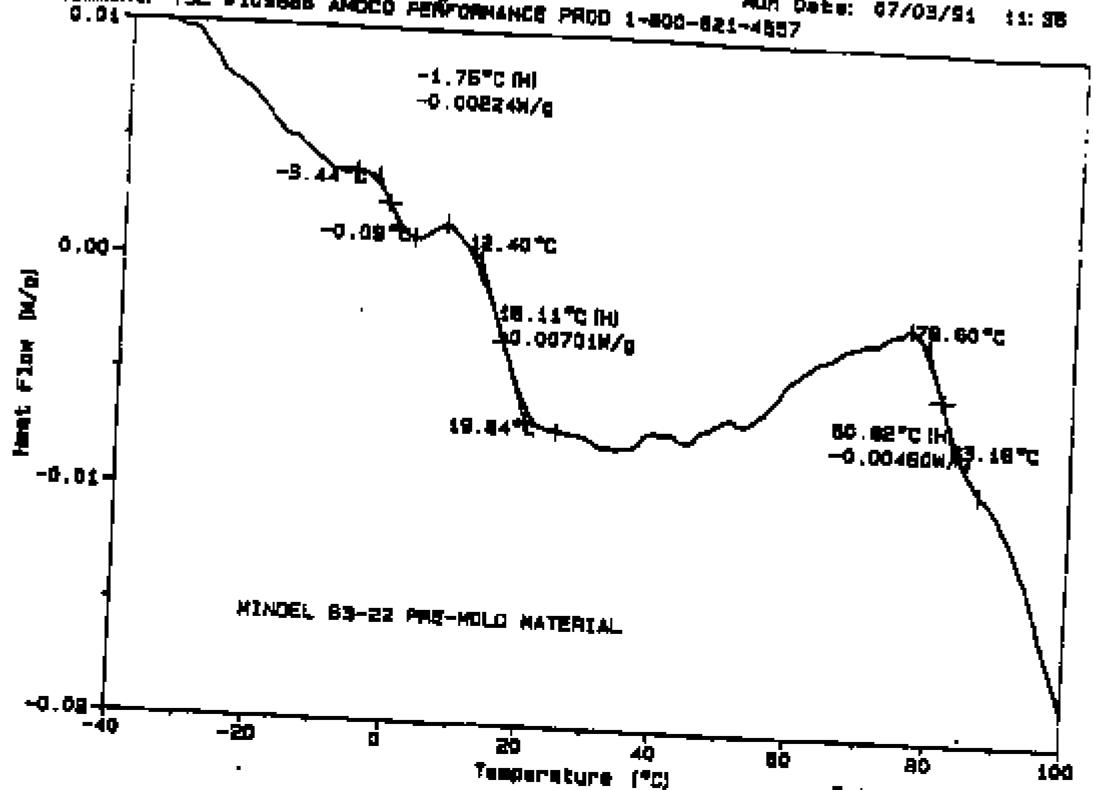
File: TRDNR.68
Operator: K ROSS
Run Date: 08/06/91 08:53



Sample: MINDEL B3-22 PRE-MOLD
Size: 10.6000 mg
Method: GEN/10/400
Comment: TSL #109886 AMOCO PERFORMANCE PROD 1-800-621-4557

DSC

File: ORONA.91
Operator: KROSS
Run Date: 07/03/91 11:38

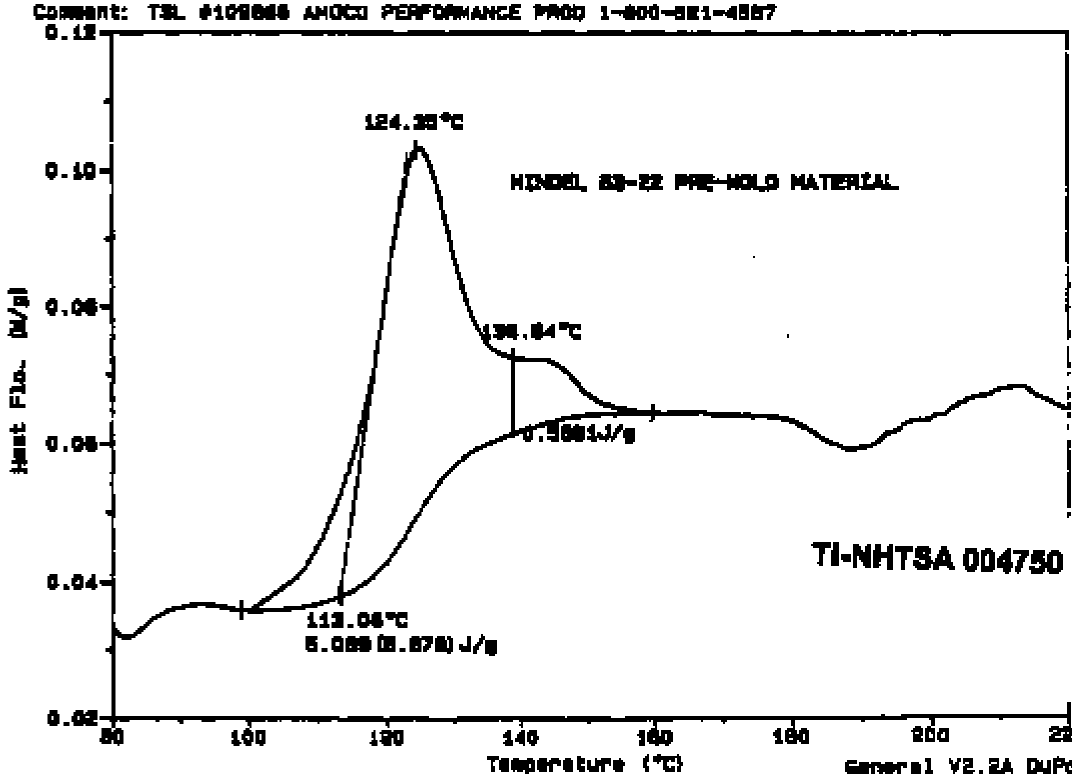


General V2.2A DuPont 9900

Sample: MINDEL B3-22 PRE-MOLD
Size: 14.0000 mg
Method: GEN/10/400
Comment: TSL #109886 AMOCO PERFORMANCE PROD 1-800-621-4557

DSC

File: ORONA.90
Operator: KROSS
Run Date: 07/03/91 11:38

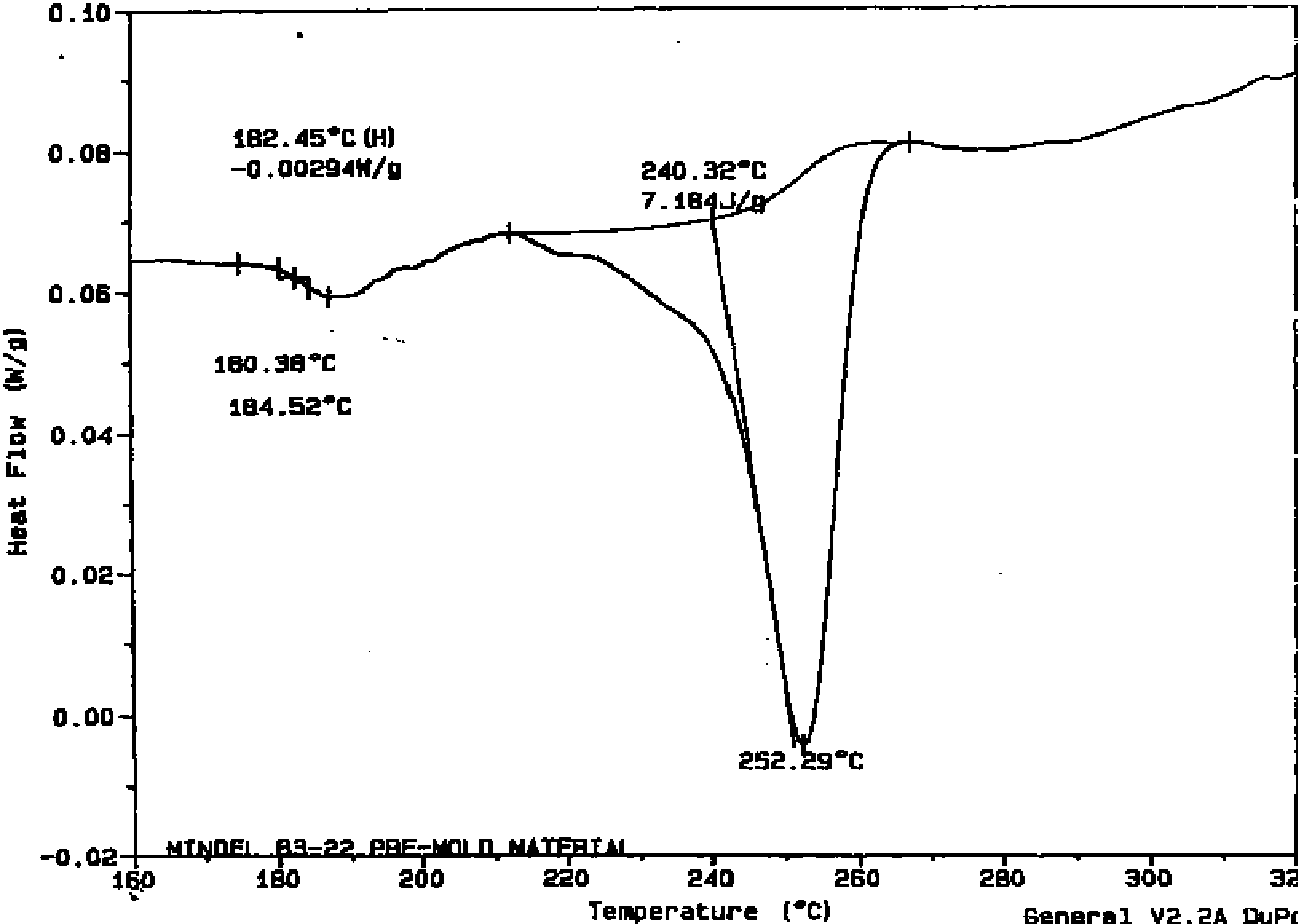


General V2.2A DuPont 9900

Sample: MINDEL 83-22 PRE-MOLD
Size: 14.0000 mg
Method: GEN/10/400
Comment: TSL #109886 AMOCO PERFORMANCE PROD 1-800-621-4557

DSC

File: DRONR.90
Operator: KROSS
Run Date: 07/03/91 11:36



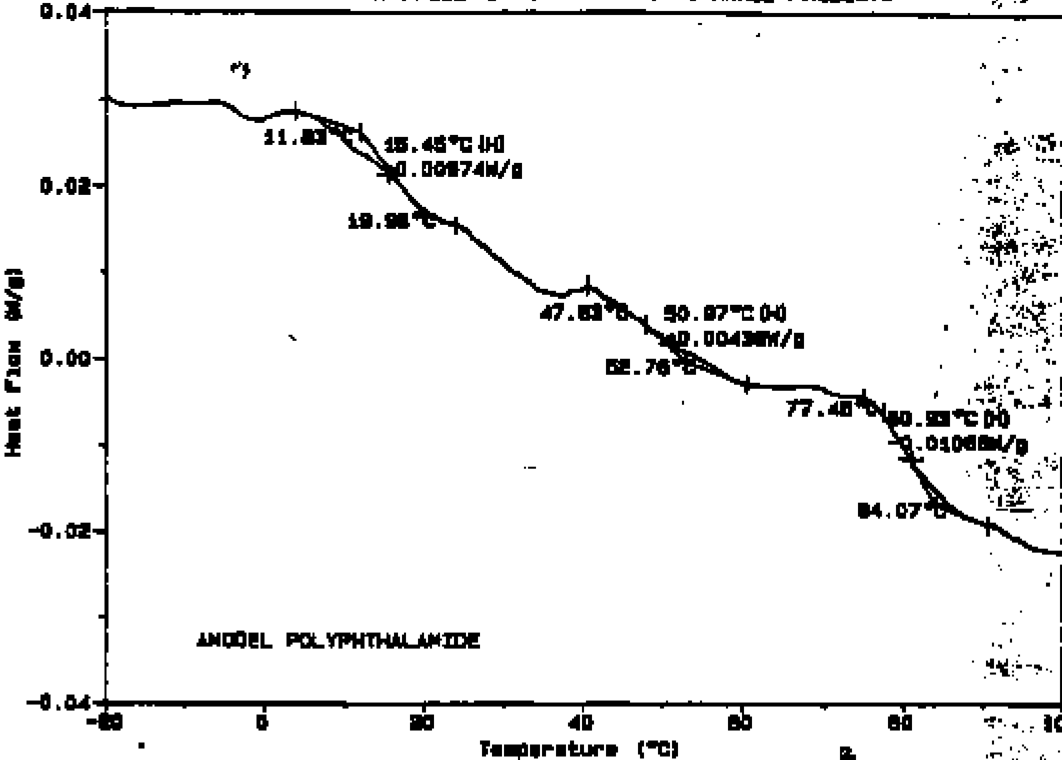
General V2.2A DuPont 9900

TI-NHTSA 004751

Sample: AMODEL ID 36-00-04 BASE
Size: 10.3700 mg
Method: GEN/10/400
Comment: TSL #109868 POLYPHTHAMIDE (PPA) AMOCO PERFORMANCE PRODUCTS

DSC

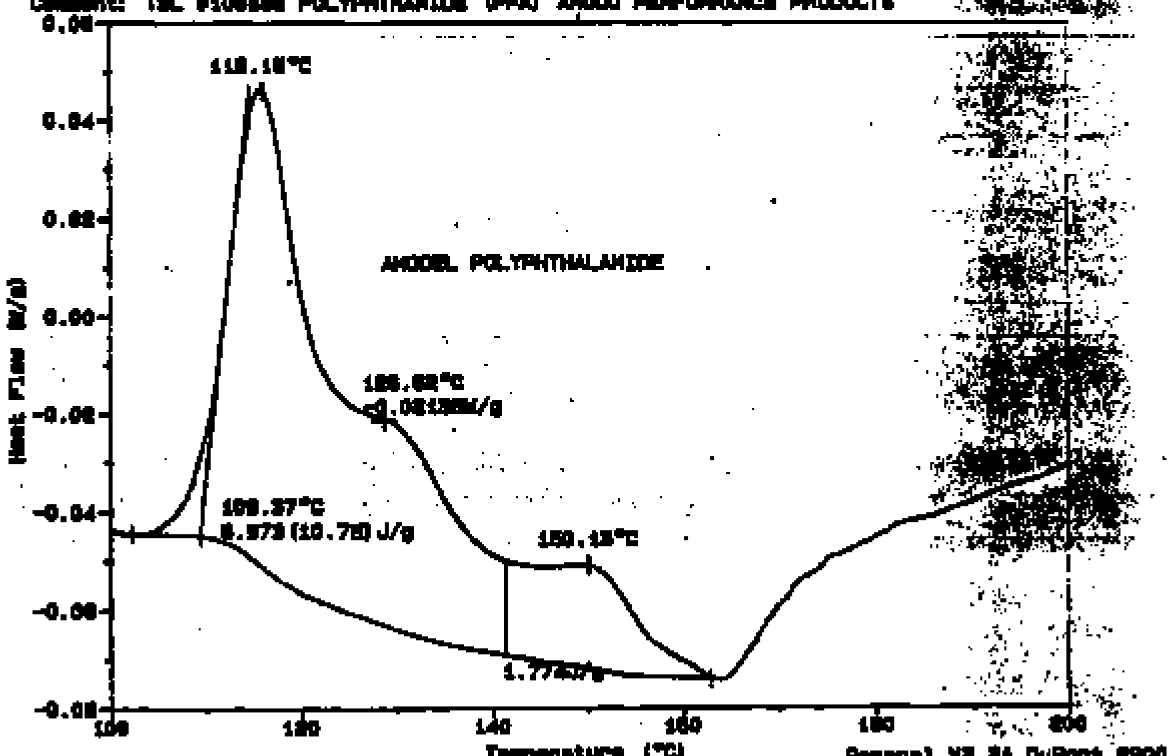
File: DRGNR.92
Operator: KROSS
Run Date: 07/03/91 15:52



Sample: AMODEL ID 36-00-04 BASE
Size: 7.1000 mg
Method: GEN/10/400
Comment: TSL #109868 POLYPHTHAMIDE (PPA) AMOCO PERFORMANCE PRODUCTS

DSC

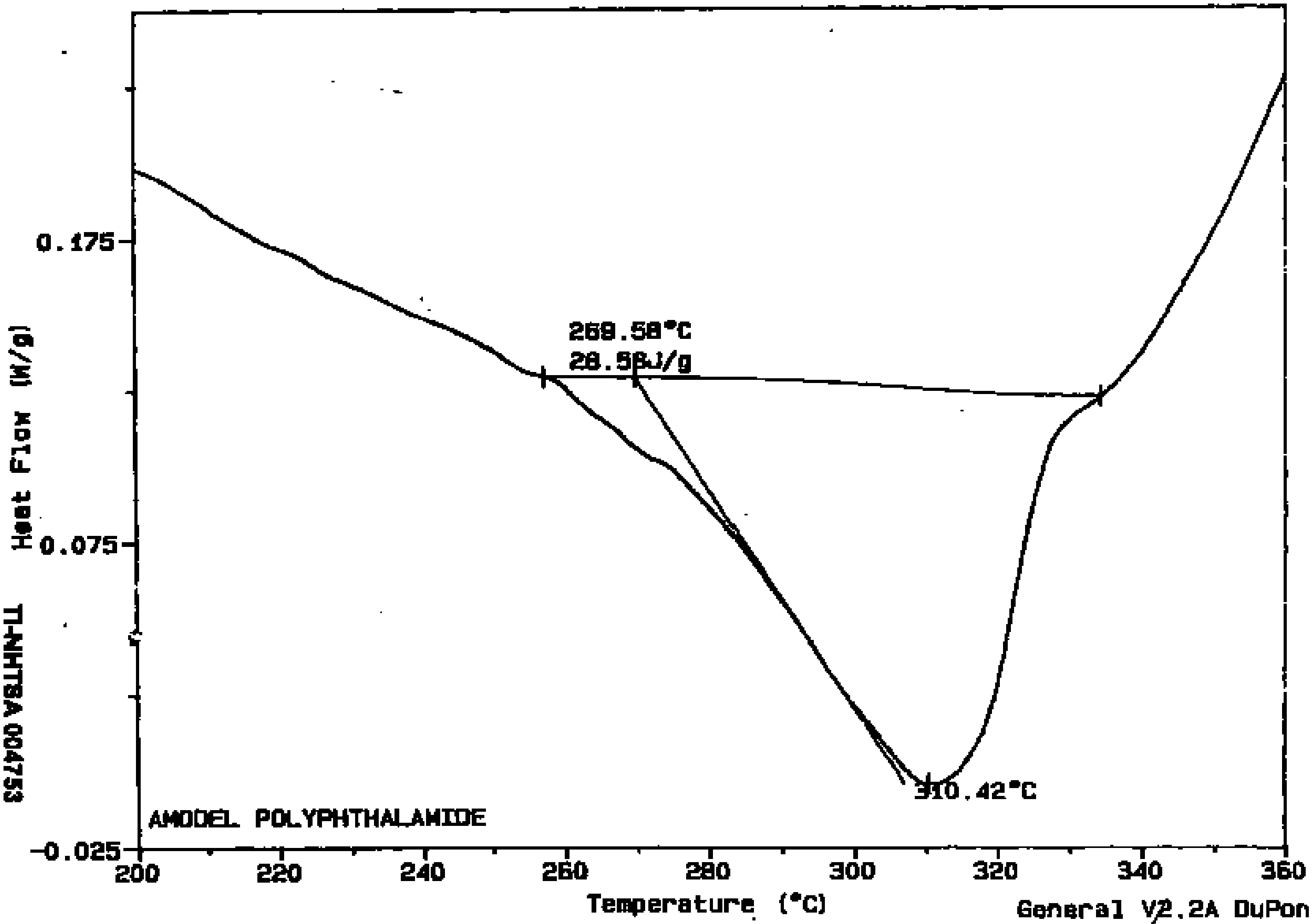
File: DRGNR.93
Operator: KROSS
Run Date: 07/03/91 15:53



Sample: AMODEL ID 38-00-04 BASE
Size: 10.3700 mg
Method: GEN/10/400
Comment: TSL #109886 POLYPHTHAMIDE (PPA) AMOCO PERFORMANCE PRODUCTS

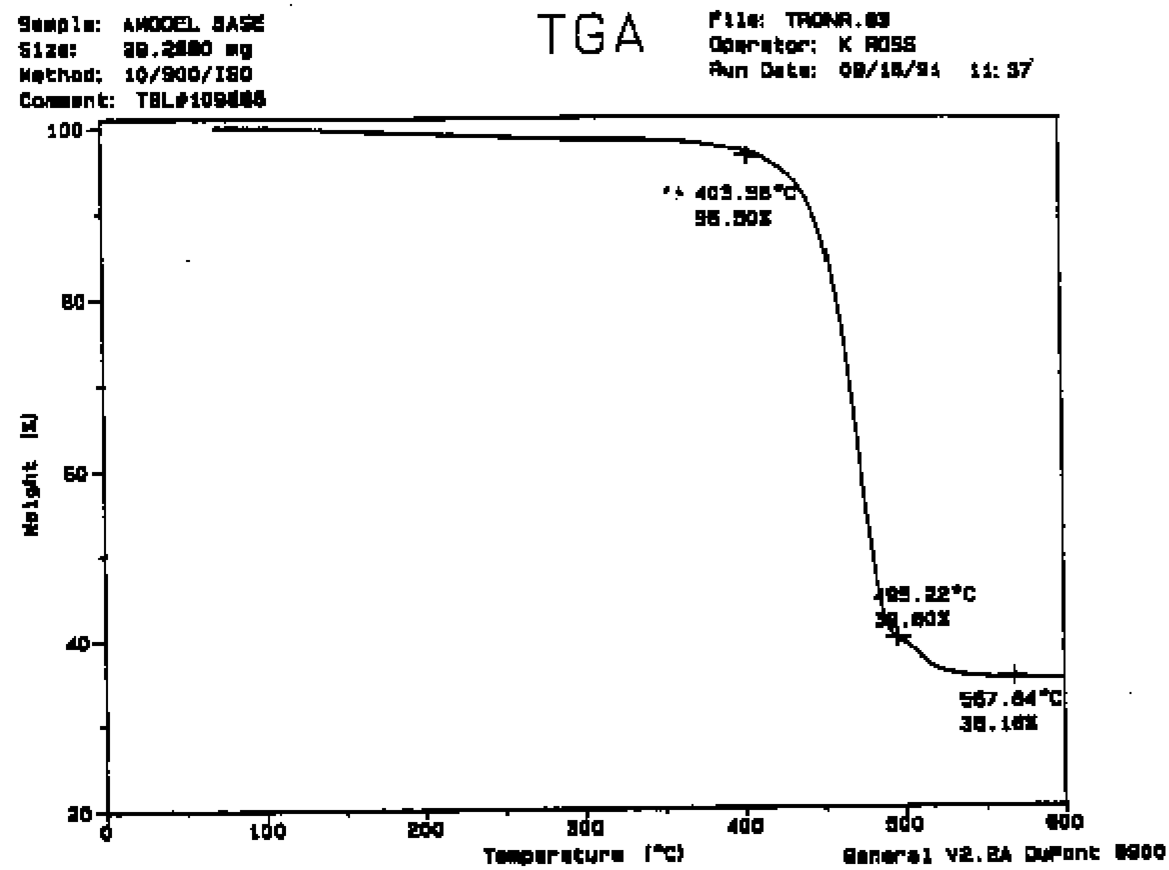
DSC

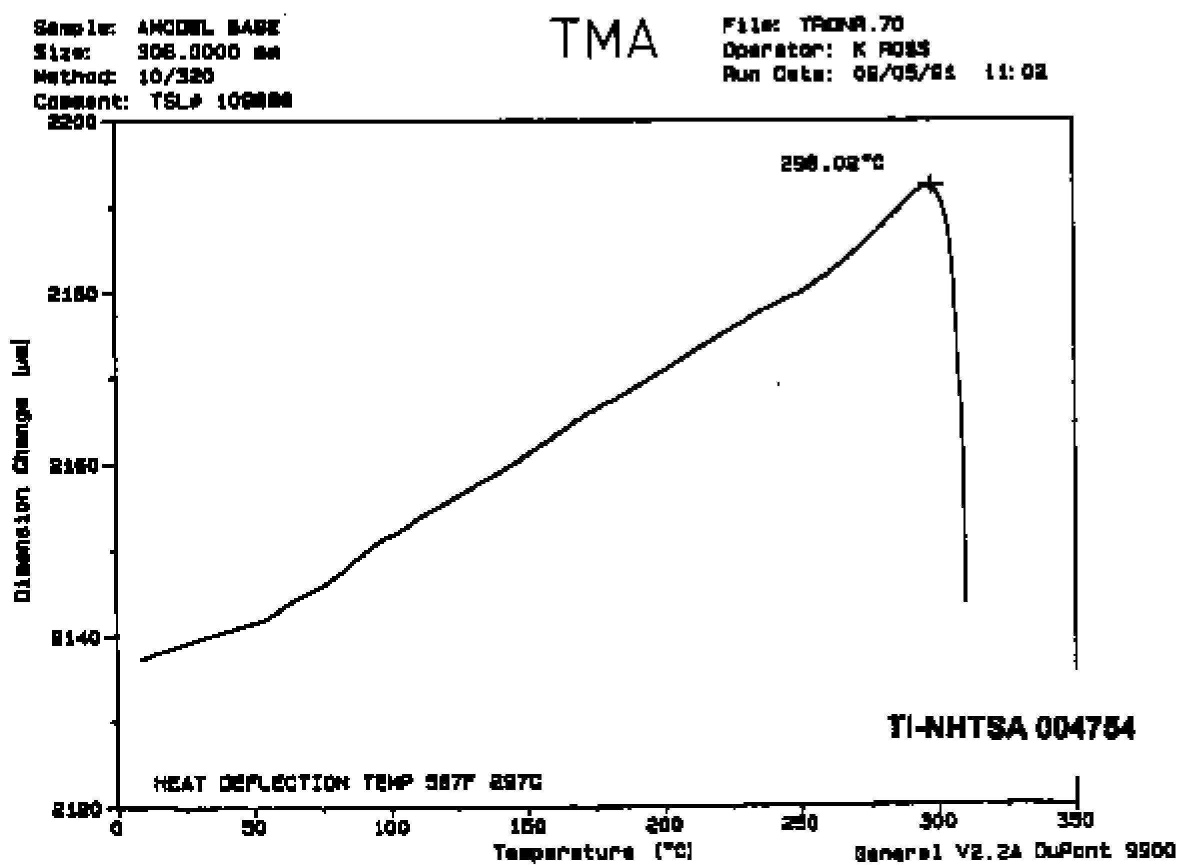
File: DAONA.92
Operator: KROSS
Run Date: 07/03/91 13:53



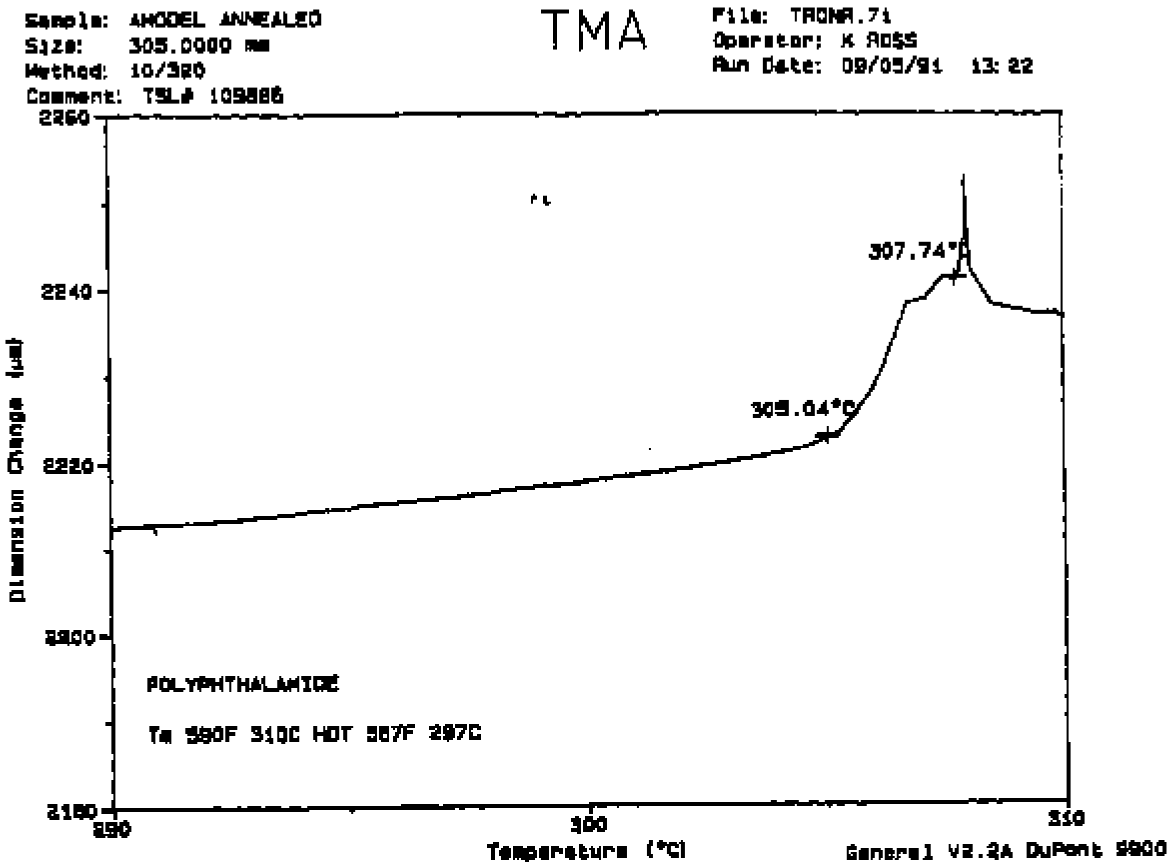
General V2.2A DuPont 9900

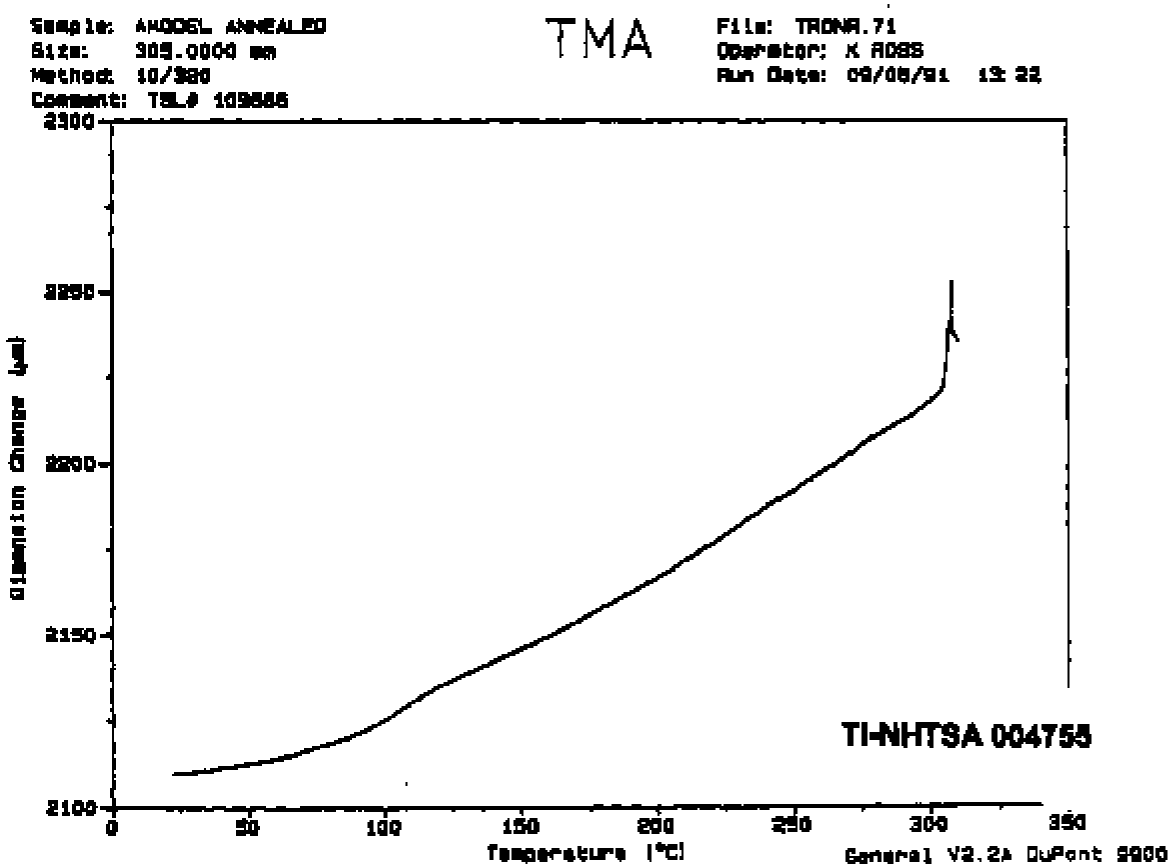
TI-NHTSA 004753





TI-NHTSA 004754



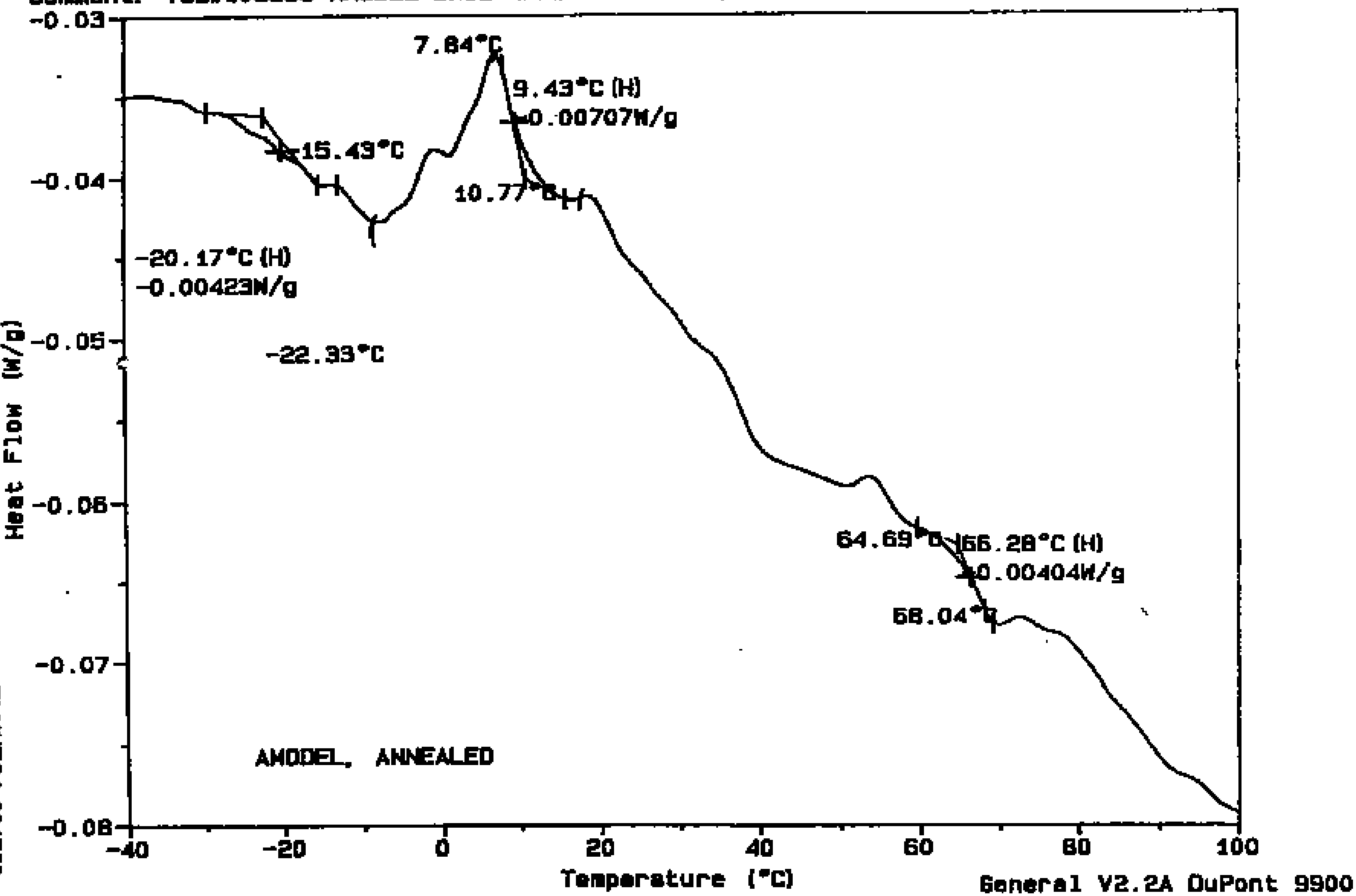


TI-NHTSA 004755

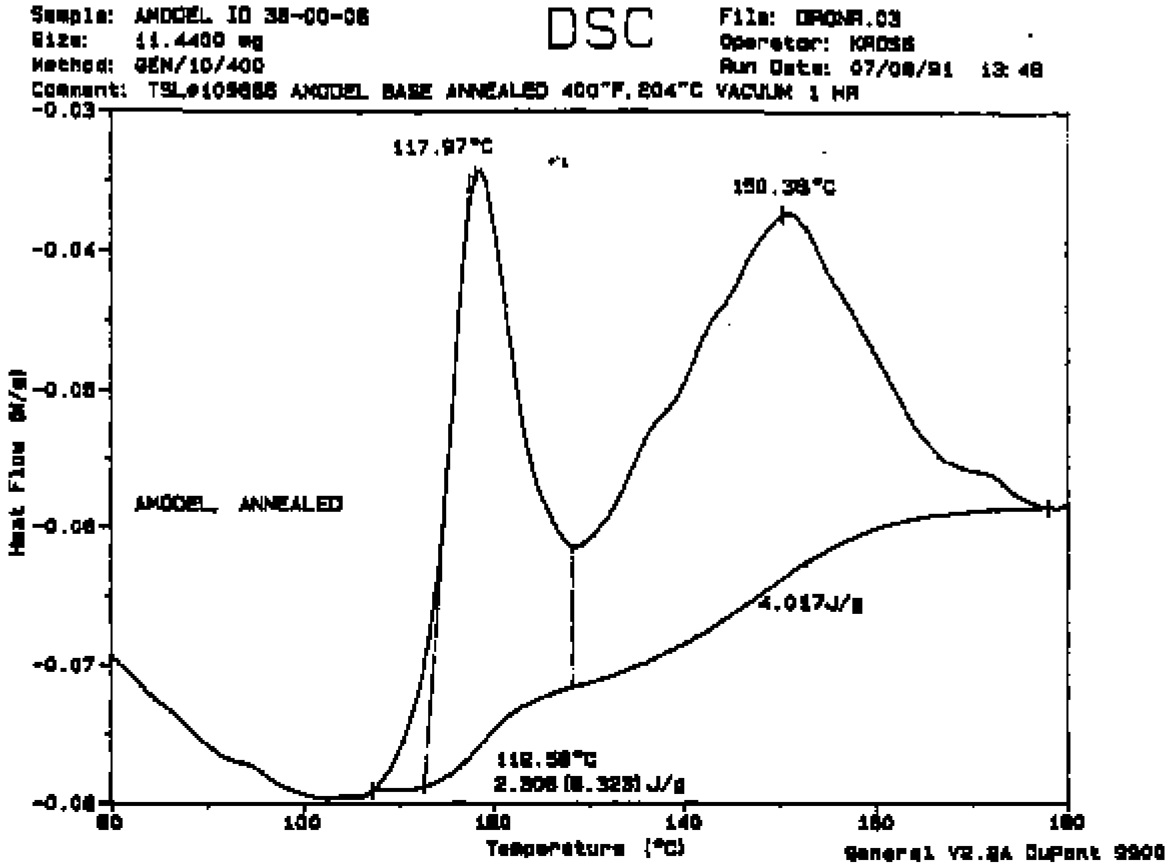
Sample: AMODEL ID 38-00-06
Size: 11.4400 mg
Method: GEN/10/400
Comment: TSL#109886 AMODEL BASE ANNEALED 400°F, 204°C VACUUM 1 HR

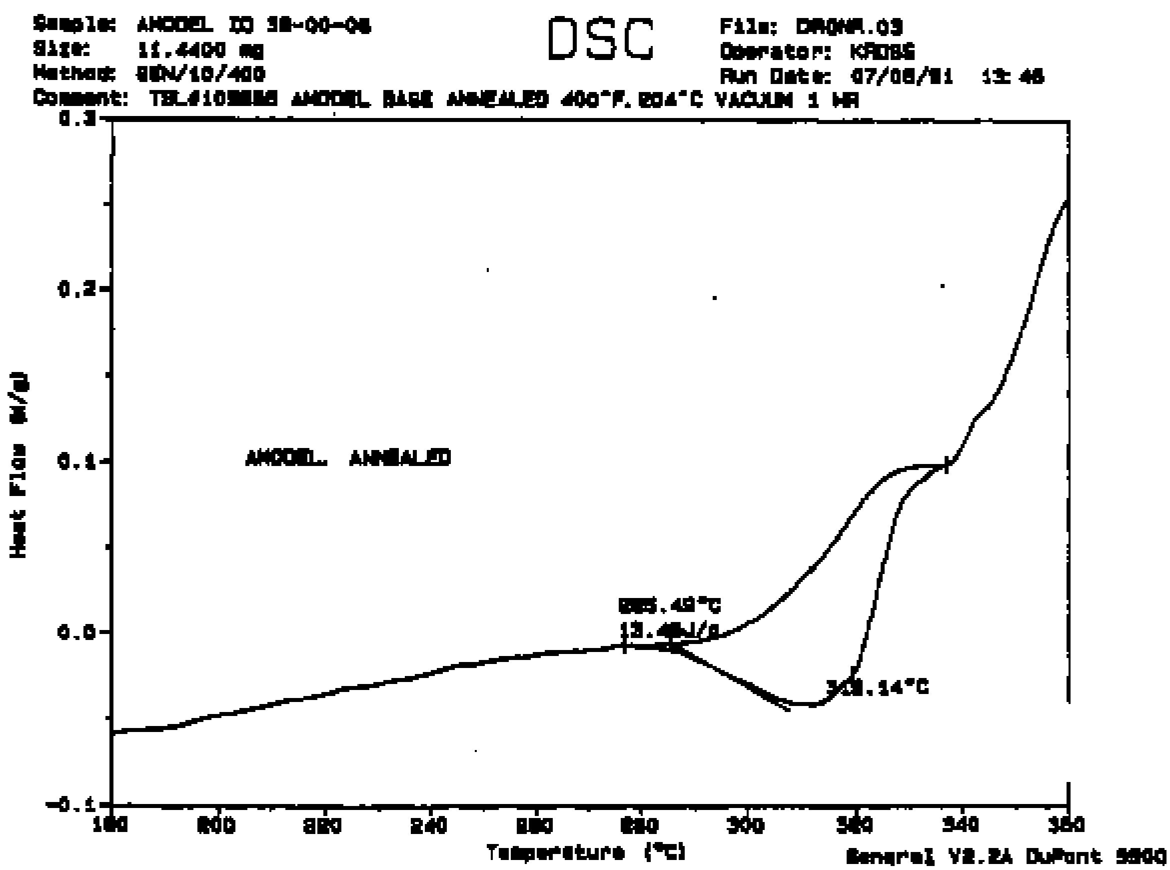
DSC

File: DRGNA.03
Operator: KROSS
Run Date: 07/08/91 13:46



TI-NHTSA 004758



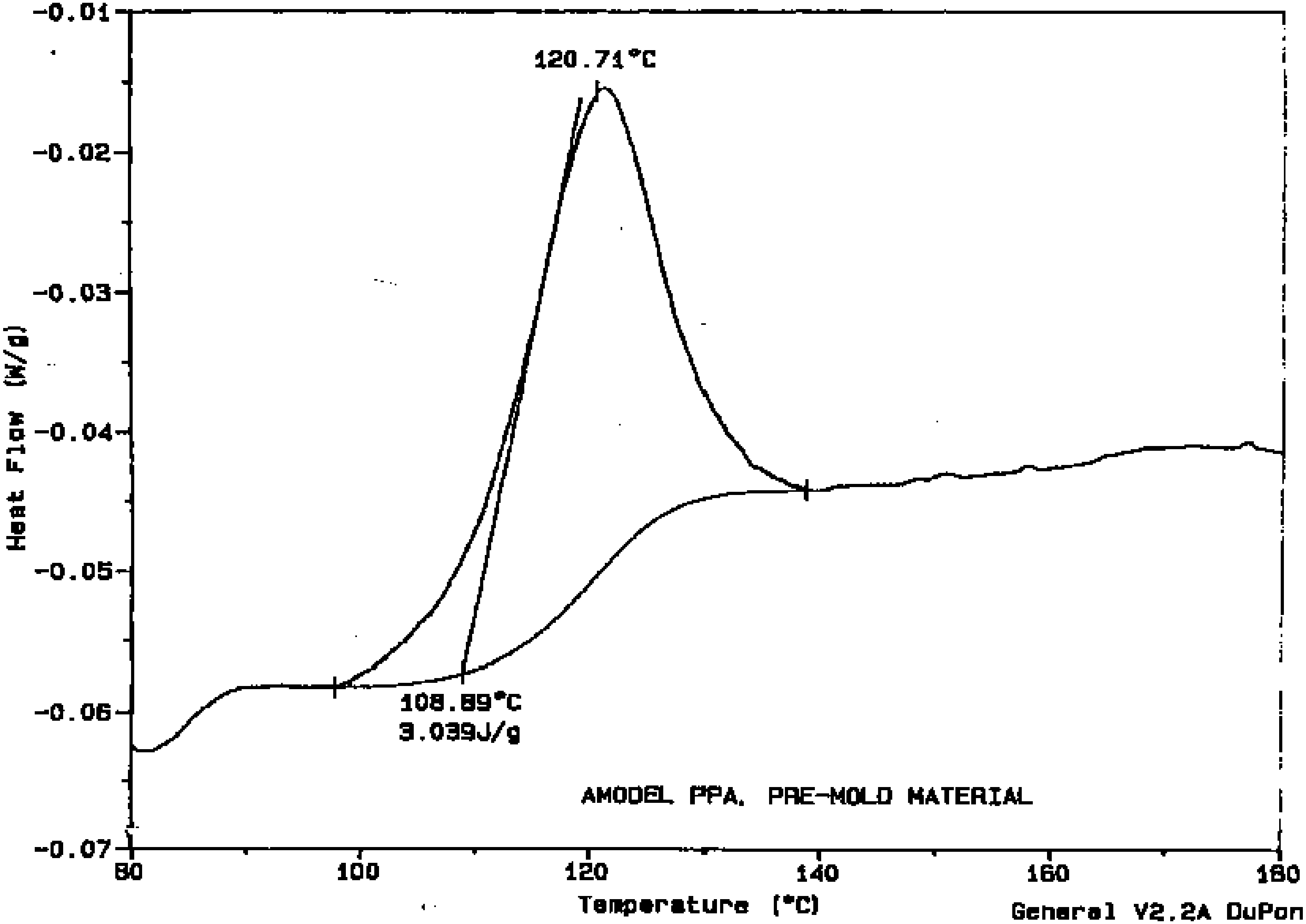


TI-NHTSA 004757

Sample: AMODEL PRE-MOLD
Size: 12.3500 mg
Method: GEN/10/400
Comment: TSL #109886 POLYPHTHAMIDE (PPA) AMOCO PERFORMANCE PRODUCTS

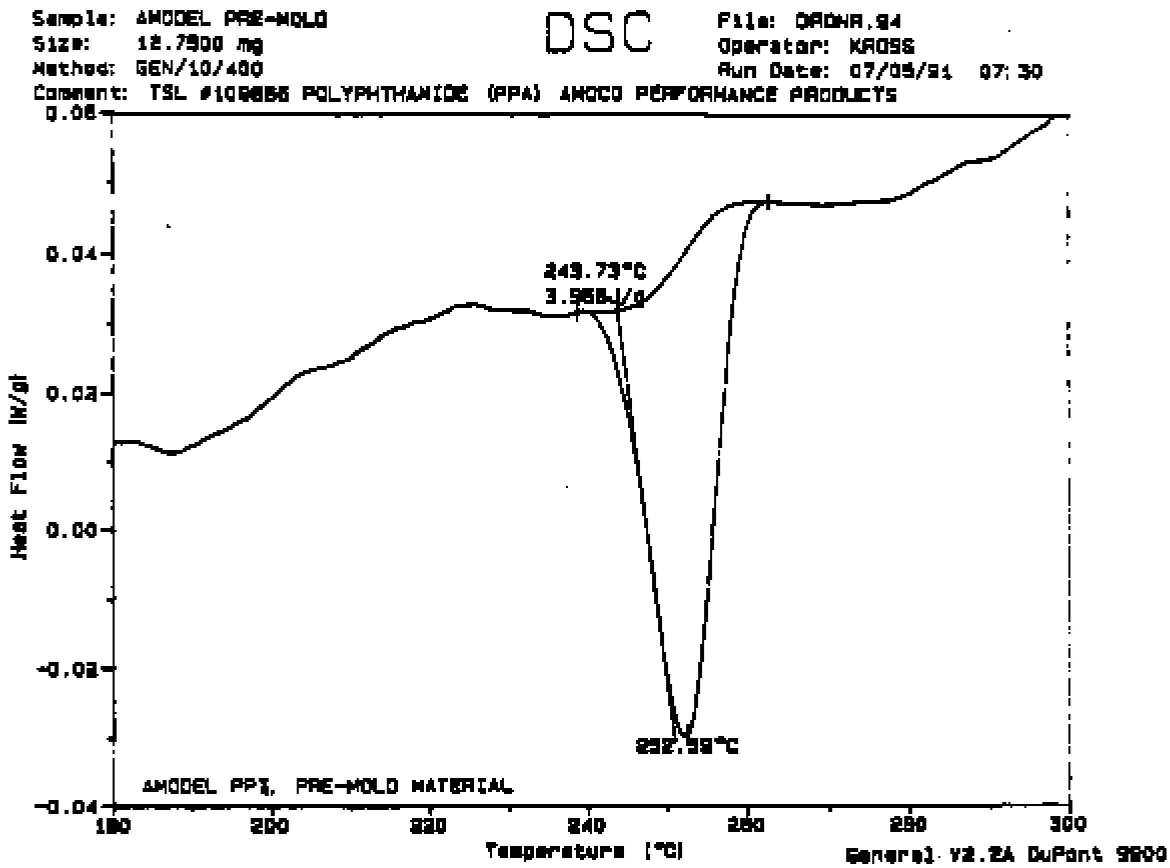
DSC

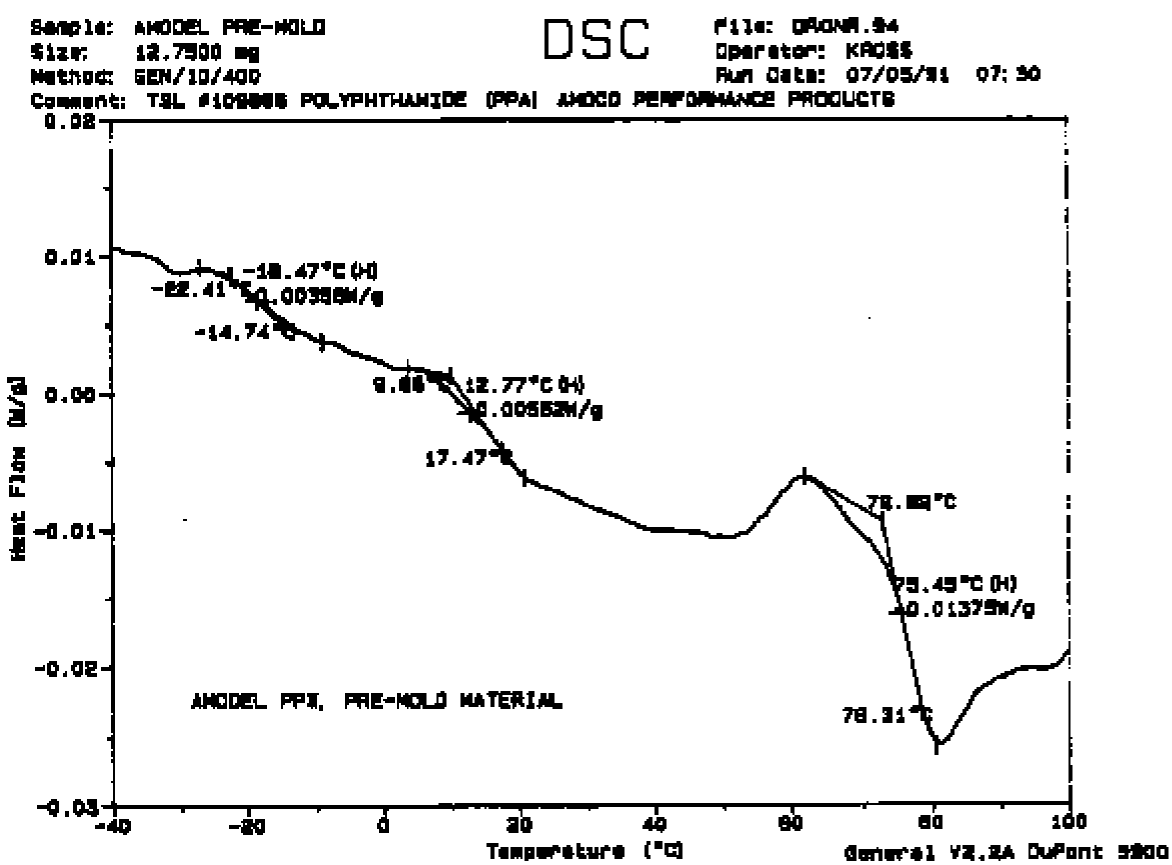
File: DRONA.95
Operator: KROSS
Run Date: 07/05/91 07:30



General V2.2A DuPont 9900

TI-NHTSA 004768



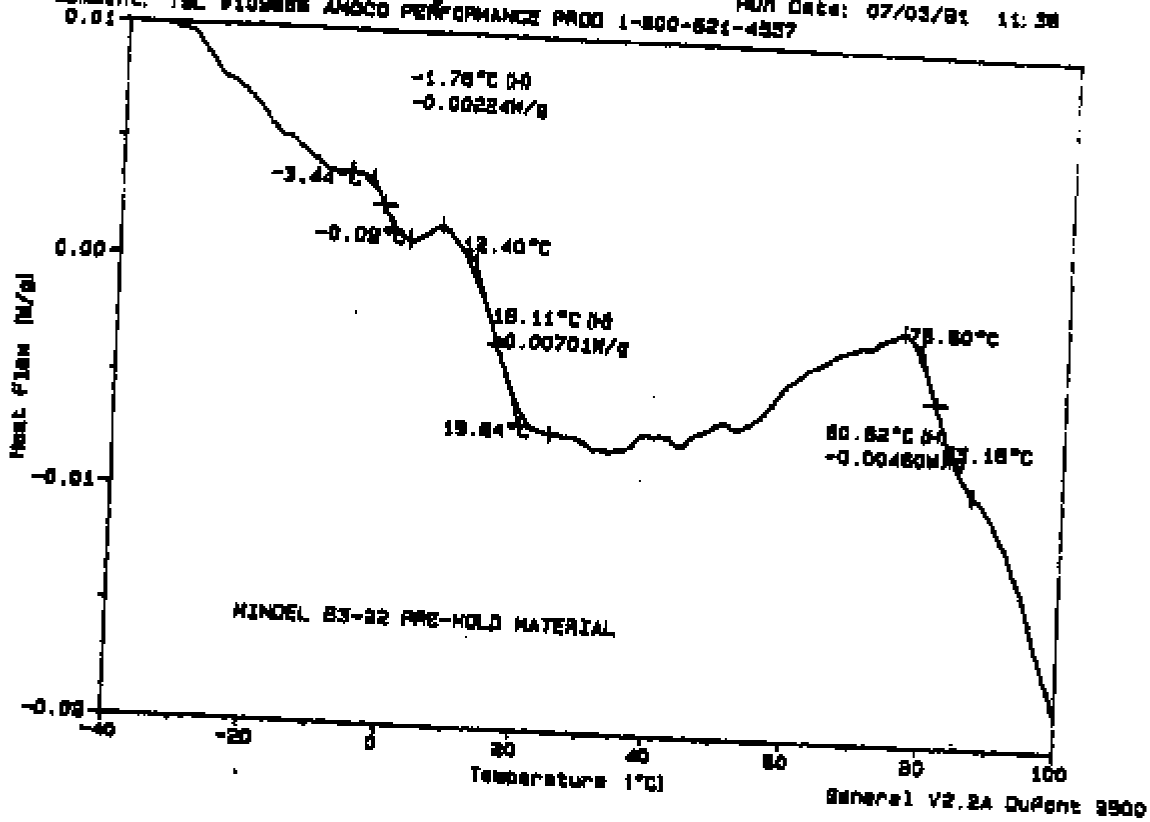


TI-NHTSA 004759

Sample: MINDEL B3-82 PRE-MOLD
Size: 10.8000 mg
Method: GEN/10/400
Comment: TSL #109886 AMOCO PERFORMANCE PROD 1-800-621-4557

DSC

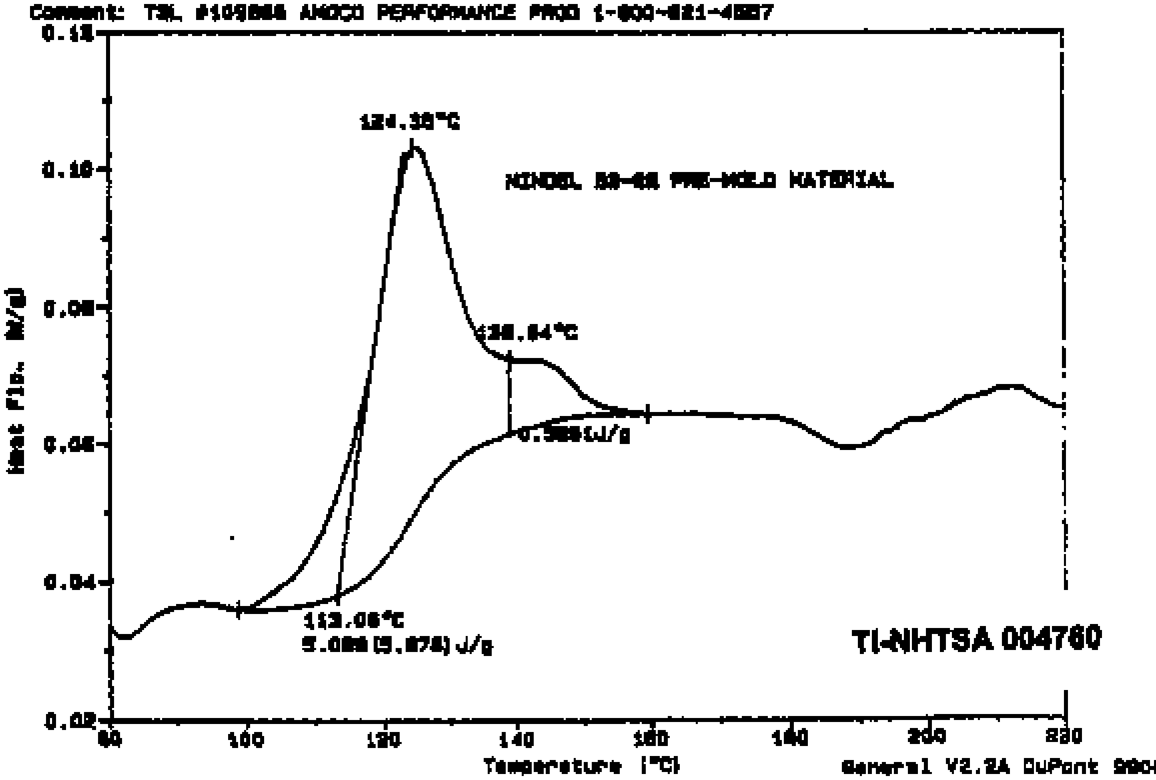
File: DRONA.81
Operator: KROSS
Run Date: 07/03/91 11:38



Sample: MINDEL B3-82 PRE-MOLD
Size: 14.0000 mg
Method: GEN/10/400
Comment: TSL #109886 AMOCO PERFORMANCE PROD 1-800-621-4557

DSC

File: DRONA.90
Operator: KROSS
Run Date: 07/03/91 11:38

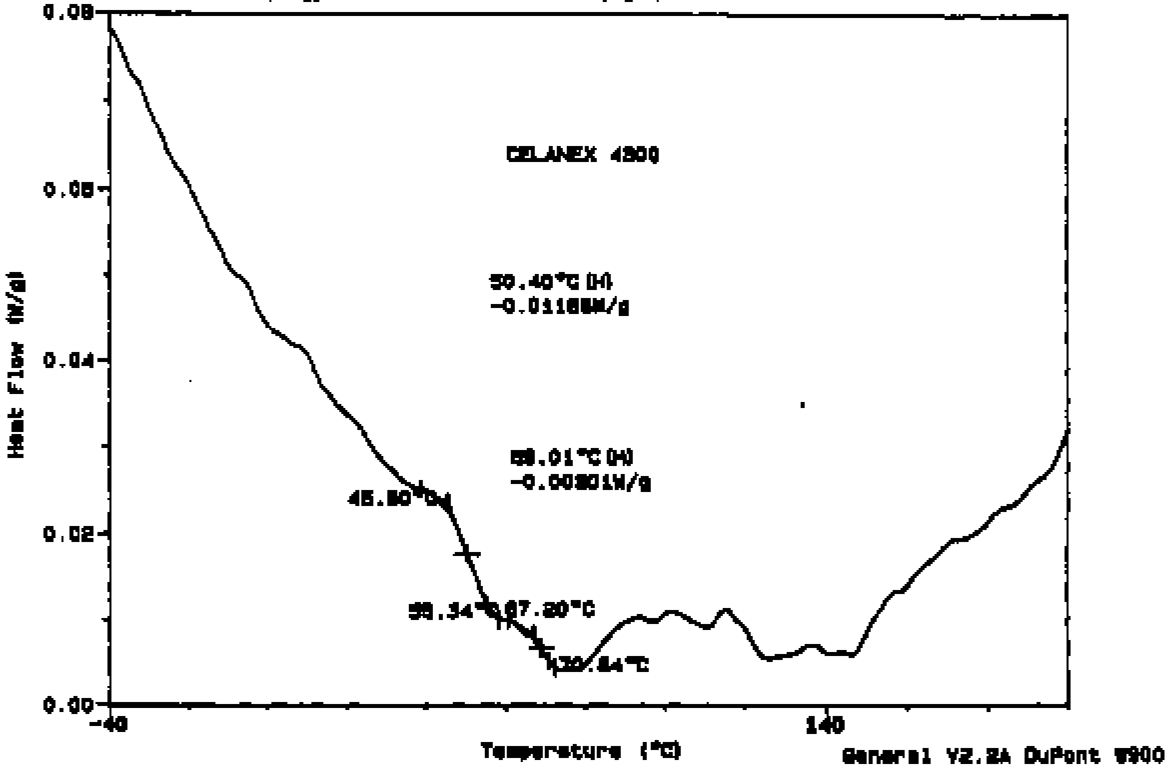


TI-NHTSA 004760

Sample: CELANEX 4300 PBT
Size: 10.7200 mg
Method: GEN/10/375
Comment: TSL#109888 CELANEX PBT PRE-MOLD MATERIAL

DSC

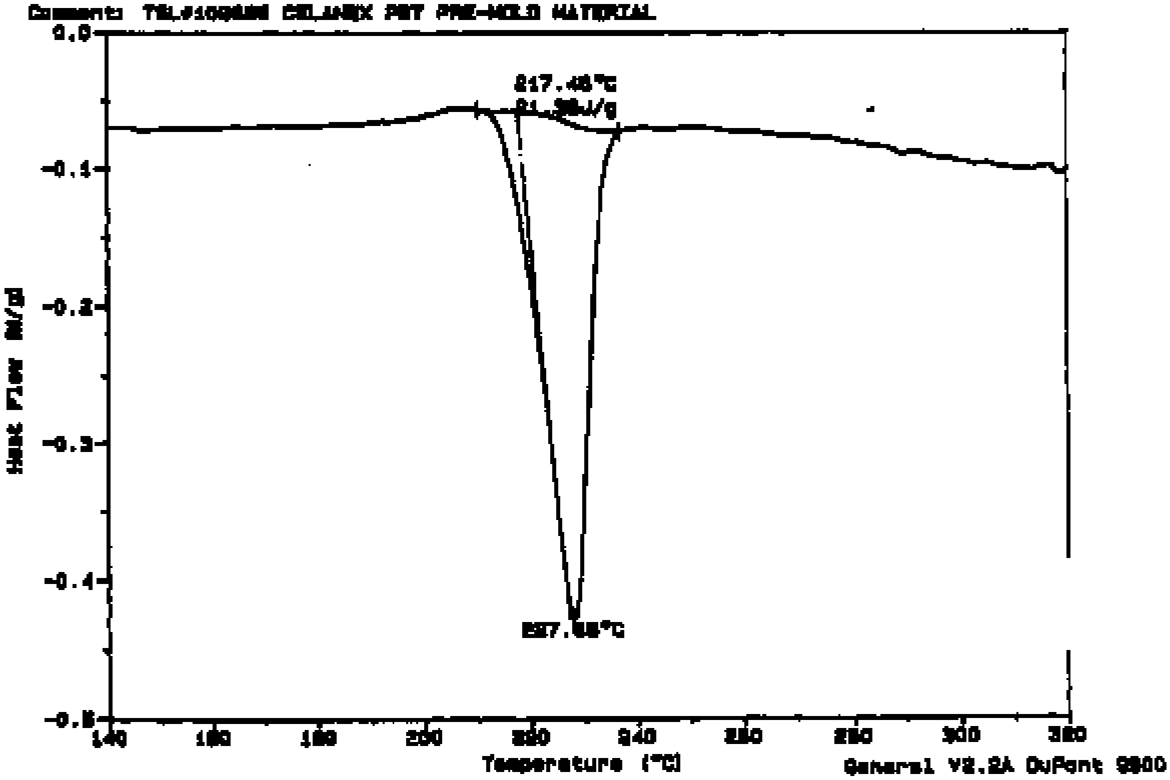
File: DRONR.11
Operator: KROSS
Run Date: 07/09/91 11:33



Sample: CELANEX 4300 PBT
Size: 13.1300 mg
Method: GEN/10/375
Comment: TSL#109888 CELANEX PBT PRE-MOLD MATERIAL

DSC

File: DRONR.12
Operator: KROSS
Run Date: 07/09/91 11:33

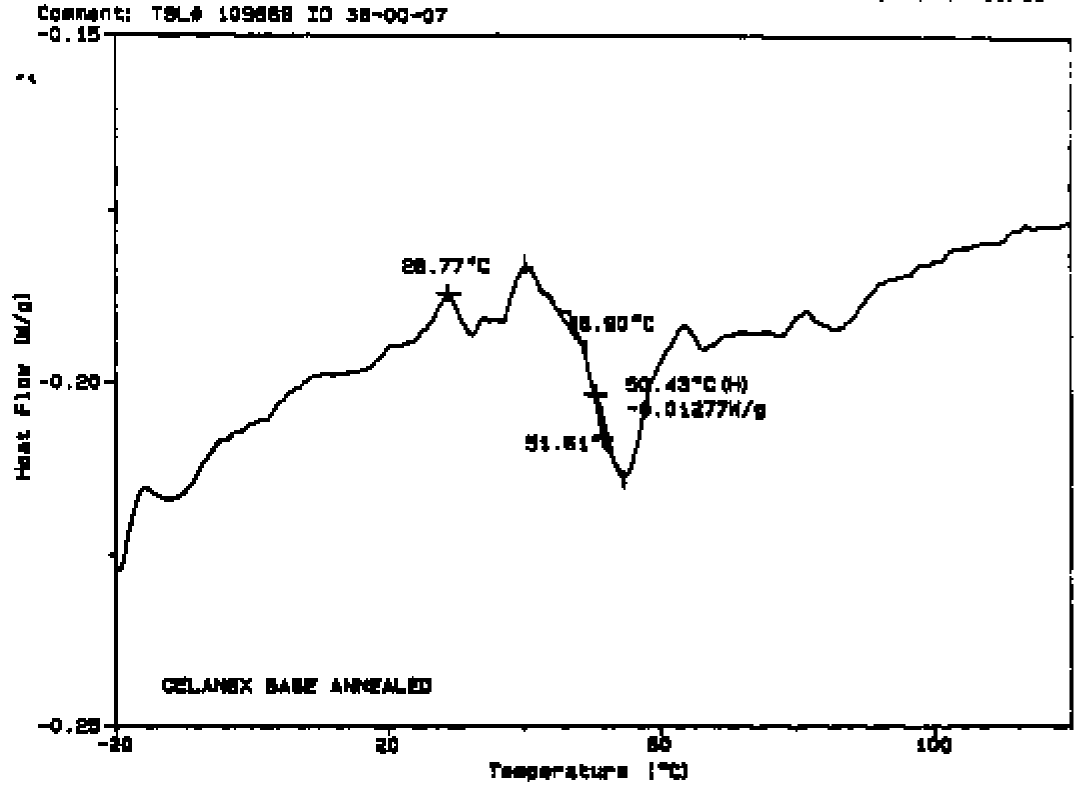


TI-NHTSA 004761

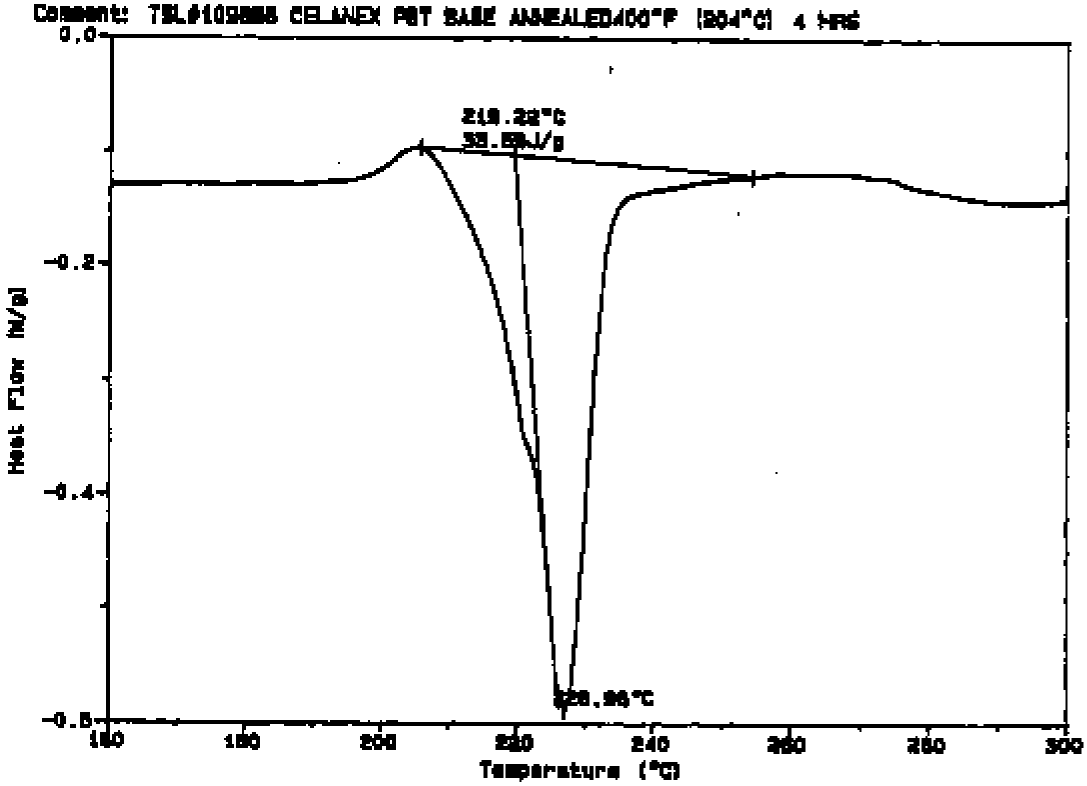
Sample: CELANEX BASE ANNEALED
Size: 10.7000 mg
Method: 10/350
Comment: TSL# 109868 ID 38-00-07

DSC

File: DRDNR.94
Operator: K ROSS
Run Date: 09/14/91 10:13



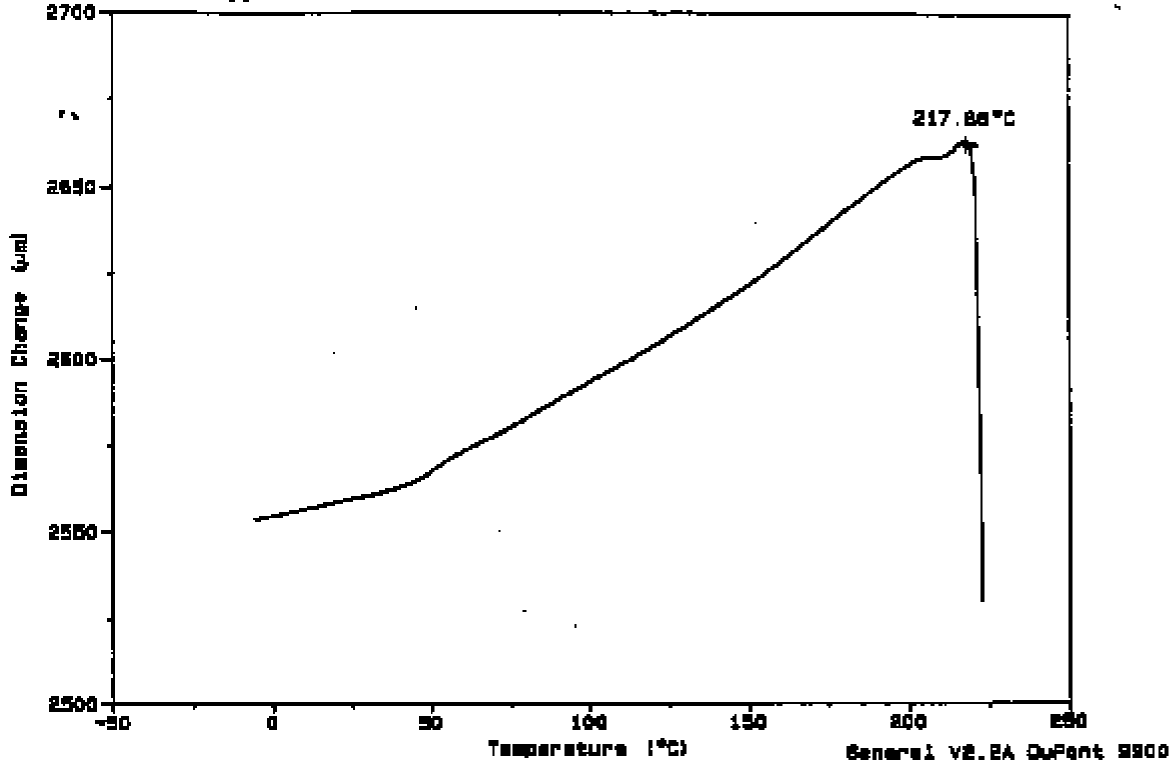
Method: GEN/10/375
Comment: TSL#109868 CELANEX PBT BASE ANNEALED400°F (204°C) 4 HRS



Size: 357.0000 mm
Method: 10/320
Comment: TSL# 109886

TMA

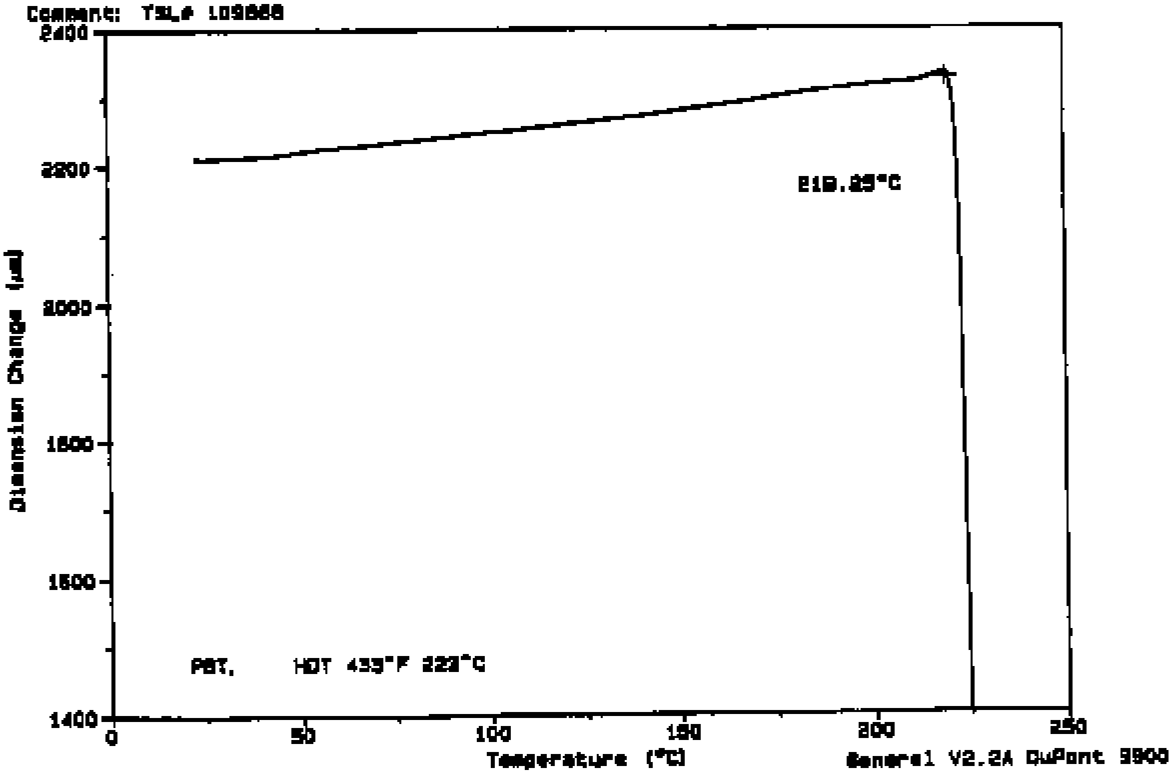
Operator: K ROSS
Run Date: 09/06/91 10:30



Sample: CELANEX 4300
Size: 298.0000 mm
Method: 10/320
Comment: TSL# 109888

TMA

File: TRONA.73
Operator: K ROSS
Run Date: 09/05/91 15:27

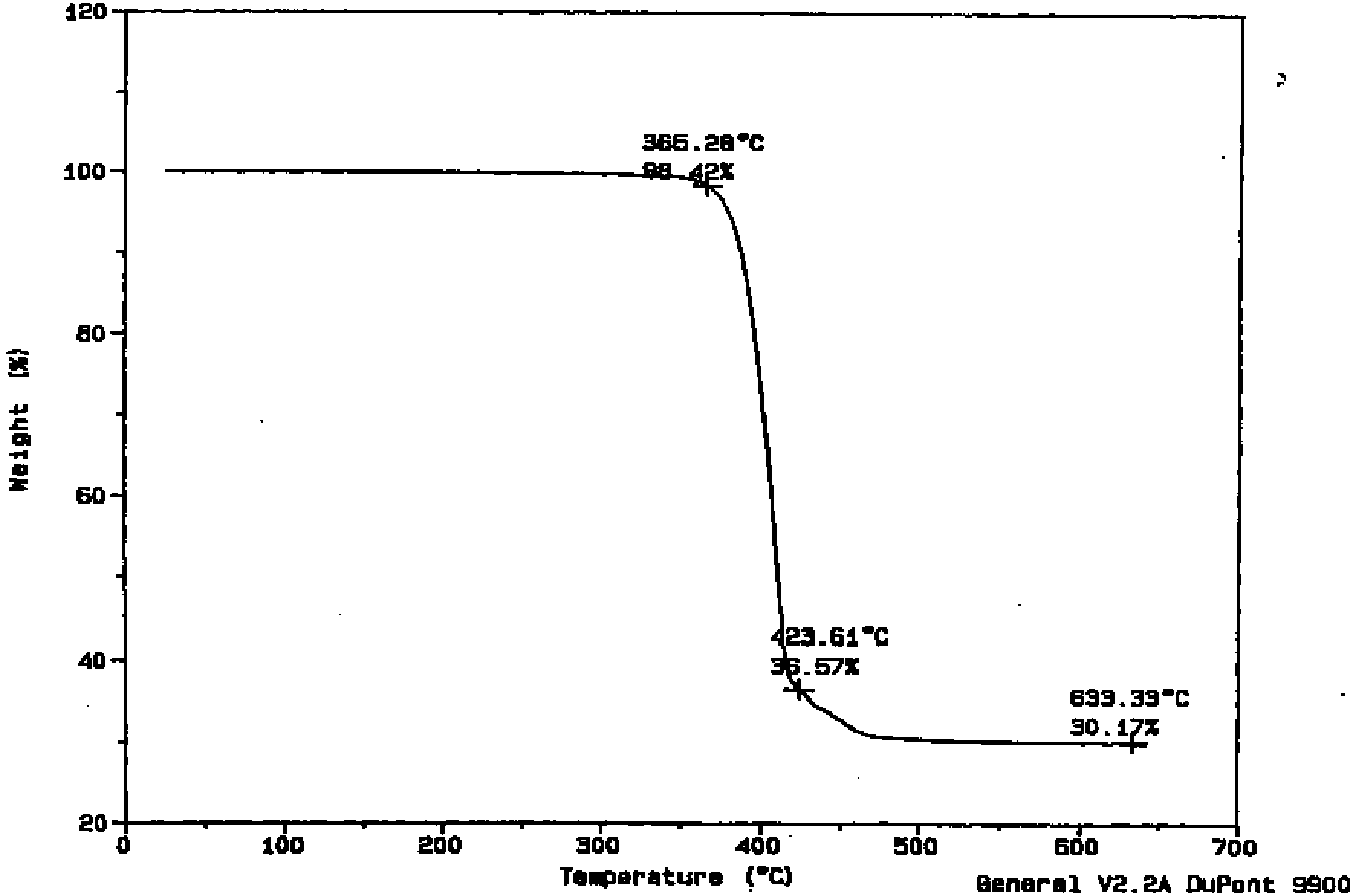


TI-NHTSA 004763

Sample: CELANEX BASE
Size: 24.7630 mg
Method: 10/900/ISO
Comment: TSL#109866

TGA

File: TAONA.84
Operator: K ROSS
Run Date: 09/16/91 14:36



7705 THERMAL SHIFT PHENOMENON

- DEVICES FOR EXPERIMENT TAKEN FROM A PRODUCTION-LINE PIN-WINDOW GROUP. THESE ARE BUILT W/ FIXED PIN LENGTH (± .0005) AND VARYING SWITCH CAL - .086" TO .093" (±.0005) IN INCREMENTS OF .001
- PRODUCTION PRESS TESTER SHOWED A WINDOW OF .086 - .094
- [illegible]'S CHAR (AT MUCH SLOWER RAMP RATE) SHOWED .087 - .092
- TWO DEVICES AT EACH INCREMENT PLACED IN CCPS CYCLER W/ MONITOR CKT (L.E.D.'s) CONNECTED. THE TEMPERATURE (AMB & FLUID) WAS RAISED TO +150°C (SPEC IS 121°C). THE TEMP AT WHICH EACH SWITCH BEGAN TO GO OPEN-CKT WAS RECORDED.
- THE "SHORT-PIN" (ACTUALLY HIGH CAL.) DEVICES @ .092-.093 WERE FIRST TO LOSE CONTINUITY, AROUND 120°C. BY 150°C, DEVICES TO .090" HAD LOST CONTINUITY. ALL OTHERS REMAINED SWITCHING NORMALLY. NOTE THAT .090" IS BASICALLY THE CENTER OF BOTH PIN WINDOWS, [illegible] + [illegible] TECHNIQUE. CONT. RETURNED ON TEMP↓ IN SAME ORDER LOST.
- DOWN TO -40°C, ALL SWITCHED NORMALLY.
- IT APPEARS THAT SHORT-TERM, DEVICES' PINNING TARGET SHOULD BE SET TO THE HIGH-SIDE, DOWN AS FAR AS THE ONSET OF CRUST-REL.
- WE ARE WORKING WITH THE .090's THAT WENT AWAY @ 150°C TO CHARACTERIZE THE ACTUAL ROOM-TEMP BASE CAL (TO .0001") AND A R.T. CHAR OF THE SENSOR HATCHET-CURVE. THIS WILL TELL US THE MAGNITUDE OF THE THERMAL SHIFT.
- NEXT, WE'LL EXPLORE POTENTIAL CONTRIBUTORS: BASE MAT'L EXPANSION, AL. CRIMP RING EXPANSION, SENSOR/SWITCH SEATING DIFFICULTIES, EXCESS ENV. SEAL COMPRESSION, HIGH-TEMP HATCHET CURVE ... LIGHT-TOWER [illegible] TBD

MEMORANDUM:

March 31, 1992
92-128

4 77PSL 3-1

TO:	ELAINE ROSE	GAHY
CC:	NEIL MACKINNON	MAPA
	JOE PAVAO	MAPA
FR:	AL HOPKINS	AHOP
SUBJECT:	DISCOLORATION ON CONTACT - TSL # 110790	

CONCLUSIONS:

The discoloration is caused by a thin layer of silver sulfide (tarnish).

RESULTS AND DISCUSSION:

SEM-EDAX (Scanning Electron Microscope with Energy Dispersive Analysis of X-Rays) analysis was performed originally. It showed a large amount of carbon, sodium and chlorine contamination. The pattern of this contamination didn't match that of the visual stain. I suspect that this contamination was the result of handling at one time or another.

The Auger analysis showed that the stained areas had excessive amounts of sulfur. We have often seen this color stain be caused by high levels of silver sulfide formed by atmospheric attack on silver plated surfaces (such as leadframes). I suspect, but am not sure, that it has something to do with the higher surface activity of a plated surface.

The data will be sent by Grace Dias (X3044) through the internal mail.

AL HOPKINS MSG: AHOP MS: 10-16 X3040

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 235-01-04

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77PS	3/31/92	Charlie Douglas	yesterday
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
Jeffrey D. Beranice	4/1/92		

PROJECT TITLE: Ford MY '92 etc...

CUSTOMER:

PURPOSE OF TEST: Silent samples

PROCEDURE: latest ultra-low diff disc
black acryl base w/ offset key
pinned Base + .056
Code F2UC 9F924 AAD 2092

Device #	Act / Rel	Δ
235-01-01	133 / 116	17
-02	154 / 140	14
-03	158 / 135	23
-04	139 / 123	16

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[redacted]

High Temp Shift Issue

3/31/92

Problem:

High temperature expansion of the 77PS molded base. This leads to effective reduction of the useable pinning window, and resultant yield loss at B.A.M. and F.T.M.

Solutions Being Evaluated:

Short term solutions to the heavy yield loss include relief on the release creep specification, tightening of the B.A.M. Calibration window, and introduction of alternate molding materials with better CTE performance.

This Experiment:

Build a matrix of 77PSL2-1 devices varying the base material and also the pinning offset.

Test Lot #	Material	Offset Range	# @ each offset
1	Current 46515-2 4300 PBT	45 to 65	3
2	Fortron (Post Bake)	45 to 65	3
3	Noryl GTX 820	45 to 65	3
4	Ultem 2300	45 to 65	3
5	Fortron (Prototype)	49 to 53 & 59 to 63	2 2

[redacted]

OFFSET CALCULATIONS

Pin length −	Base Calibration	= Calibration OFFSET
.149	.104	45
.149	.103	46
.149	.102	47
.149	.101	48
.149	.100	49
.149	.099	50
.149	.098	51
.149	.097	52
.149	.096	53
.149	.095	54
.149	.094	55
.149	.093	56
.149	.092	57
.149	.091	58
.149	.090	59
.149	.089	60
.149	.088	61
.149	.087	62
.149	.086	63
.149	.085	64
.149	.084	65

Calibration Procedure For test material:

Test lots 1-4

(1) Build 200 base assemblies <u>without</u> calibrating. Place calibrator in measure only mode and print Cal-Detail during builds.

(2) Separate <u>63</u> good assemblies from (1) and calibrate 3 each at .001" increments from <u>.084</u> to <u>.104</u> as measured on the check station. You may have to watch the Check Station data on the fly to tell you where to target the calibrator.

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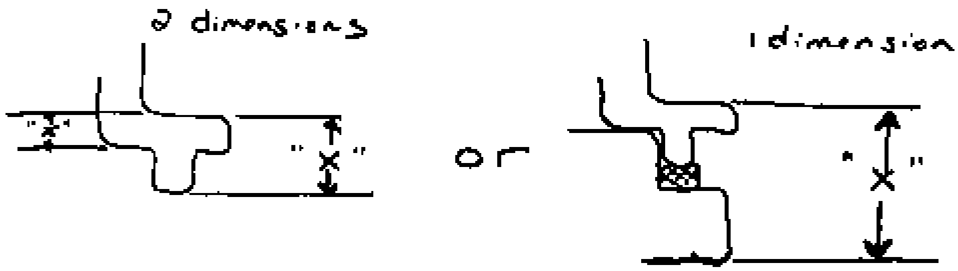
(3) When All 63 Are Completed - use the SPC gage to sort into .001" +/- .0005 categories. Review results with Matt Sellers.

(4) We will then need to build up Finished devices ensuring that 3 devices Are represented At each offset level.

(5) Before final crimping the following dimension needs to be measured on 5 devices from each material.



*Adjustments to the final crimp dimension may be required for each of the material lots.

(6) Crimp each lot of material paying particular Attention to base stress or cracking.

Test Lot #5

1) Follow same procedure As test lot 1-4, but due to limited number of raw bases the calibration target range has been limited.

* Vary Calibrator in .001" increments From .086 to .09[illegible] And then .096 to .100.

* Perform sorting and crimping same as Lots 1-4.