

# Antero 840CN03



## FDM Thermoplastic Filament

The information presented are typical values intended for reference and comparison purposes only. They should not be used for design specifications or quality control purposes.



## Overview

Antero™ 840CN03 is a PEKK-based FDM thermoplastic combining the excellent physical and mechanical qualities of PEKK with electrostatic dissipative (ESD) properties. The material is filled 3% by weight with carbon nanotubes.

As a high-performance polymer, Antero 840CN03 exhibits exceptional chemical and wear resistance, ultra-low outgassing properties and consistent ESD performance. ESD values range from  $10^4$  –  $10^9$  ohms per square inch. This makes the material particularly suitable for space and industrial applications where these qualities are critical.

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## Ordering Information

**Table 1. Printer and Support Material Compatibility**

Printer	Model Tip (Slice)	Support Material	Support Tip
Fortus 450mc™	T20F (10 slice)	SUP8000B™ (breakaway)	T16
F900™	T20F (10 slice)	SUP8000B (breakaway)	T16

### Build Sheets

High temperature

- 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)
- 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)

### Hardware

Hardened Upgrade

**Table 2. Antero 840CN03 Ordering Information**

Part Number	Description
<b>Filament Canisters</b>	
355-02510	Antero 840CN03, 92.3 cu in. – Plus
355-03260	SUP8000B, 92.3 cu in. – Plus
<b>Printer Consumables</b>	
511-10730-S	T20D tip
511-10740-S	T20F tip
511-10401	T16 tip
325-00275-S	High Temperature build sheet, 0.02 x 16 x 18.5 in. (0.51 x 406 x 470 mm)
325-00475-S	High Temperature build sheet, 0.02 x 26 x 38 in. (0.51 x 660 x 965 mm)

## Physical Properties

Values are measured as printed. XY, XZ, and ZX orientations were tested.

For full details refer to the [Stratasys Materials Test Procedure on www.stratasys.com](http://www.stratasys.com).

DSC and TMA curves can be found in the Appendix.

**Table 3. Antero 840CN03 Physical Properties**

Property	Test Method	XY	XZ/ZX
HDT @ 66 psi <sup>(1)</sup>	ASTM D648 Method B	149.5 C 301.1 F	
HDT @ 264 psi <sup>(1)</sup>	ASTM D648 Method B	150.8 C 303.4 F	
Tg	ASTM D7426 Inflection Point	157.6 C 315.7 F	
Melt Point	ASTM D7426 Peak Heat	300.3 C 572.5 F	
Mean CTE	ASTM E831 (40C to 140C)	47.4 $\mu\text{m}/[\text{m}^{\circ}\text{C}]$	51.24 $\mu\text{m}/[\text{m}^{\circ}\text{C}]$ 28.47 $\mu\text{m}/[\text{m}^{\circ}\text{F}]$
Volume Resistivity <sup>(2)</sup>	ASTM D257	10 <sup>4</sup> -10 <sup>9</sup> * $\Omega\cdot\text{cm}$	
Thermal Conductivity	ASTM E1952 @0C	0.2369 W/m <sup>2</sup> K 0.1369 BTU/(hr <sup>2</sup> ft <sup>2</sup> F)	
Thermal Conductivity	ASTM E1952 @30C	0.2447 W/m <sup>2</sup> K 0.1414 BTU/(hr <sup>2</sup> ft <sup>2</sup> F)	
Thermal Conductivity	ASTM E1952 @60C	0.2530 W/m <sup>2</sup> K 0.1462 BTU/(hr <sup>2</sup> ft <sup>2</sup> F)	
Thermal Conductivity	ASTM E1952 @90C	0.2567 W/m <sup>2</sup> K 0.1483 BTU/(hr <sup>2</sup> ft <sup>2</sup> F)	
Thermal Diffusivity	ASTM E1952 @0C	0.162 mm <sup>2</sup> /s 2.51*10 <sup>-4</sup> in <sup>2</sup> /s	
Thermal Diffusivity	ASTM E1952 @30C	0.150 mm <sup>2</sup> /s 2.33*10 <sup>-4</sup> in <sup>2</sup> /s	
Thermal Diffusivity	ASTM E1952 @60C	0.142 mm <sup>2</sup> /s 2.20*10 <sup>-4</sup> in <sup>2</sup> /s	
Thermal Diffusivity	ASTM E1952 @90C	0.134 mm <sup>2</sup> /s 2.08*10 <sup>-4</sup> in <sup>2</sup> /s	
Specific Gravity	ASTM D792 @23C	1.27	

1) HDT values reflected molded values, not as-printed.

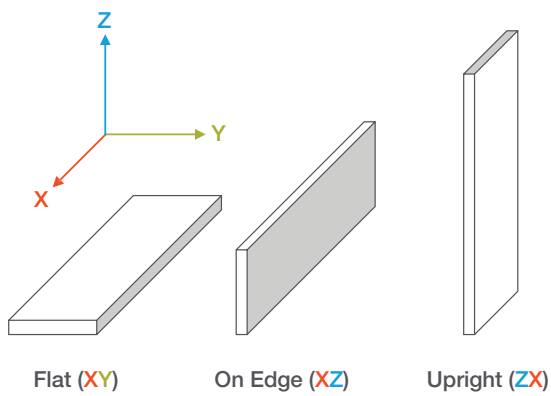
2) See ESD section.

## Mechanical Properties

Samples were printed with a 0.010 in. (0.254 mm) layer height on the Fortus 450mc and F900. For the full test procedure please see the [Stratasys Materials Test Procedure on www.stratasys.com](http://www.stratasys.com) (immediate download upon clicking the link).

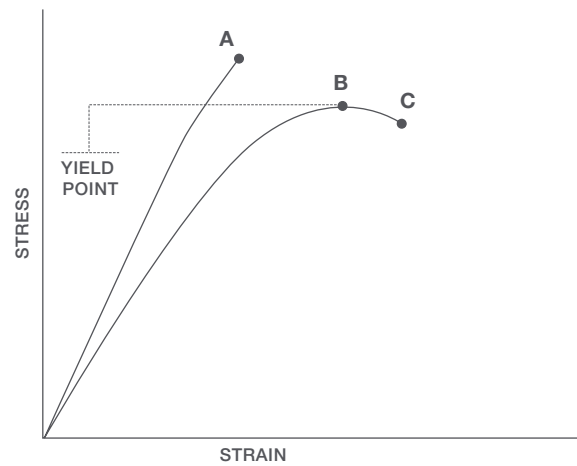
### Print Orientation

Parts created using FDM are anisotropic as a result of the printing process. Below is a reference of the different orientations used to characterize the material.



### Tensile Curves

Due to the anisotropic nature of FDM, tensile curves look different depending on orientation. Below is a guide of the two types of curves seen when printing tensile samples and what reported values mean.



- A = Tensile at break, elongation at break (no yield point)
- B = Tensile at yield, elongation at yield
- C = Tensile at break, elongation at break

## Mechanical Properties

**Table 4. Antero 840CN03 Mechanical Properties - 450mc - T20F tip (0.010 in layer height)**

		XZ Orientation <sup>1</sup>	ZX Orientation <sup>1</sup>
<b>Tensile Properties: ASTM D638</b>			
Yield Strength	MPa	94.9 (1.0)	56.0 (5.0)
	psi	13800 (140)	8110 (720)
Elongation @ Yield	%	4.9	2.0
Strength @ Break	MPa	No Break	55.8 (4.9)
	psi	No Break	8090 (710)
Elongation @ Break	%	No Break	2.0
Modulus (Elastic)	GPa	2.96 (0.03)	3.02 (0.046)
	ksi	430 (4.9)	438 (6.7)
<b>Flexural Properties: ASTM D790, Procedure A</b>			
Strength @ Break	MPa	No Break	89.0 (9.4)
	psi	No Break	12900 (1400)
Strength @ 5% Strain	Mpa	146 (1.7)	
	psi	21100 (240)	
Strain @ Break	%	No Break	3.2
Modulus	GPa	3.44 (0.04)	2.89 (0.08)
	ksi	499 (6.0)	419 (11)
<b>Compression Properties: ASTM D695</b>			
Yield Strength	MPa	106 (1.7)	109 (3.0)
	psi	15400 (240)	15700 (430)
Modulus	GPa	2.55 (0.04)	2.52 (0.05)
	ksi	369 (5.4)	365 (6.8)
<b>Impact Properties: ASTM D256, ASTM D4812</b>			
Notched	J/m	45.0 (6.0)	29.7 (5.9)
	ft*lb/in.	0.842 (0.11)	0.556 (0.11)
Unnotched	J/m	4060 (1600)	124 (30)
	ft*lb/in.	76.0 (29)	2.32 (0.56)

<sup>1</sup> Values in parentheses are standard deviations.

## Mechanical Properties

Table 5. Antero 840CN03 Mechanical Properties - F900 - T20F tip (0.010 in layer height)

		XZ Orientation <sup>1</sup>	ZX Orientation <sup>1</sup>
<b>Tensile Properties: ASTM D638</b>			
Yield Strength	MPa	93.9 (2.15)	53.1 (4.1)
	psi	13600 (310)	7690 (600)
Elongation @ Yield	%	4.8	1.9
Strength @ Break	MPa	54.1 (11)	52.6 (4.0)
	psi	7850 (1500)	7630 (580)
Elongation @ Break	%	12	1.9
Modulus (Elastic)	GPa	2.94 (0.05)	2.88 (0.07)
	ksi	426 (7.5)	418 (11)
<b>Flexural Properties: ASTM D790, Procedure A</b>			
Strength @ Break	MPa	No Break	85.3 (14)
	psi	No Break	12400 (2100)
Strength @ 5% Strain	MPa	144 (4.6)	
	psi	20800 (670)	
Strain @ Break	%	No Break	3.1
Modulus	GPa	3.43 (0.09)	2.80 (0.06)
	ksi	498 (13)	405 (9.2)
<b>Compression Properties: ASTM D695</b>			
Yield Strength	MPa	106 (3.3)	106 (3.1)
	psi	15400 (480)	15400 (440)
Modulus	GPa	2.60 (0.04)	2.56 (0.03)
	ksi	377 (6.0)	371 (4.5)
<b>Impact Properties: ASTM D256, ASTM D4812</b>			
Notched	J/m	45.8 (5.9)	30.7 (4.4)
	ft*lb/in.	0.858 (0.11)	0.575 (0.08)
Unnotched	J/m	1930 (950)	143.2 (32)
	ft*lb/in.	36.2 (18)	2.68 (0.61)

<sup>1</sup> Values in parentheses are standard deviations.

## Strength at Temperature

Antero 840CN03 was tested at various temperatures. Ten ASTM D638 upright (ZX) T20F dogbone coupons were tested in tensile. The percent change from the reported room temperature results are listed below. For more information, see the FDM Strength Performance Across Temperatures white paper.

**Table 6. Performance of Antero 840CN03 at Temperature**

Material	Yield Strength		Strength at Break	Elongation at Break	Modulus
	(F)	(C)			
Antero 840CN03 T20F	-65	-54	98%	89%	120%
	-40	-40	99%	89%	119%
	120	49	94%	100%	105%
	180	82	98%	111%	103%
	220	104	96%	126%	102%
	270	132	76%	132%	101%

## UV Aging

Antero 840CN03 was tested before and after UV exposure. 10 ASTM D638 upright (ZX) dogbones were tested in tensile after UV exposure and an additional 10 ASTM D638 ZX dogbones were the control (No UV Exposure). The UV exposed samples were cycled in the QUV chamber per ASTM G154-Standard Practice for Operation Fluorescent Light Apparatus for UV exposure of Nonmetallic Materials for 1000 hours, alternating for 8 hours at 60°C (140°F) and 4 hours at 50°C (122°F) with humidity and condensation. The increase in stress at break is from the control samples.

For more information see the Impact of UV Exposure on FDM Materials white paper.

**Table 7. Antero 840CN03 UV Exposure Test Results**

Material	Conditioning	Yield Strength		Stress at Break		Elongation at Break	Increase in Stress at Break	Modulus	
		(psi)	(MPa)	(psi)	(MPa)			(ksi)	(GPa)
Antero 840CN03	No UV Exposure	8270	57	8400	57.9	2.4		396	2.73
	UV Exposure	8050	55.5	8040	55.4	2.2	-4.30%	401	2.76

Antero 840CN03 coupons were built on the Fortus F900 using the T20F tip.

# ESD Properties

Antero 840CN03 was tested per ANSI ESD S20.20, S11.11, STM11.12 to determine the effect that build parameters and part geometries had on ESD properties. Different geometries printed in different orientations all fall into the ESD safe range ( $10^4$  to  $10^9$  ohms). For full details, see the [Antero 840CN03 ESD White Paper](#).

Figure 1a. 4 x 4 x 0.1 in plaque resistance on the Fortus 450mc in various build orientations.

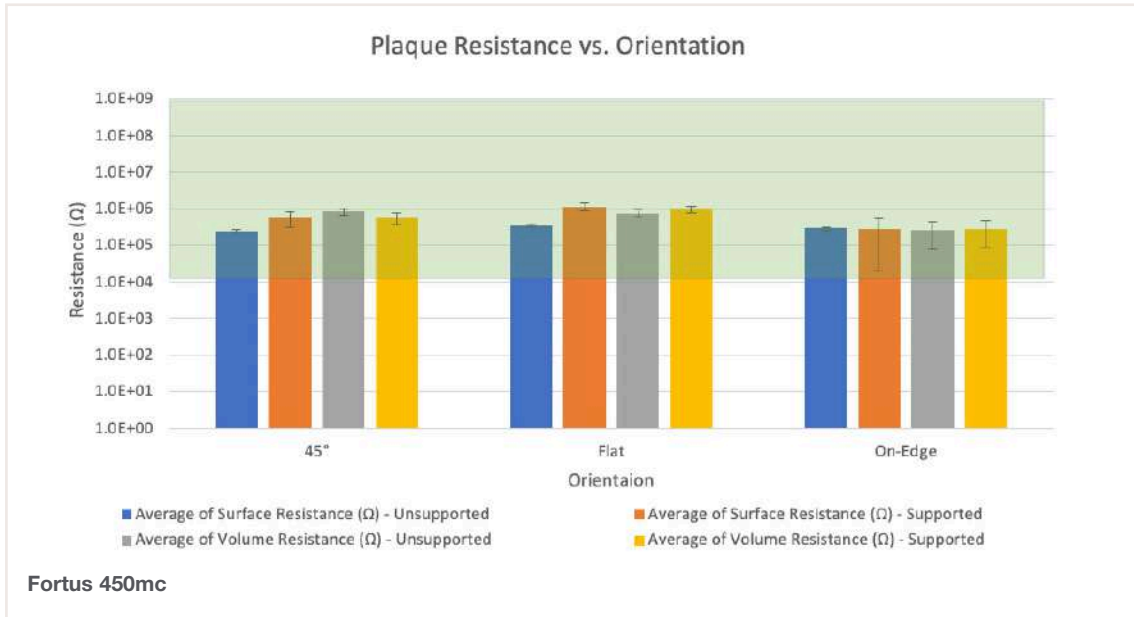


Figure 1b. 4 x 4 x 0.1 in plaque resistance on the F900 in various build orientations.

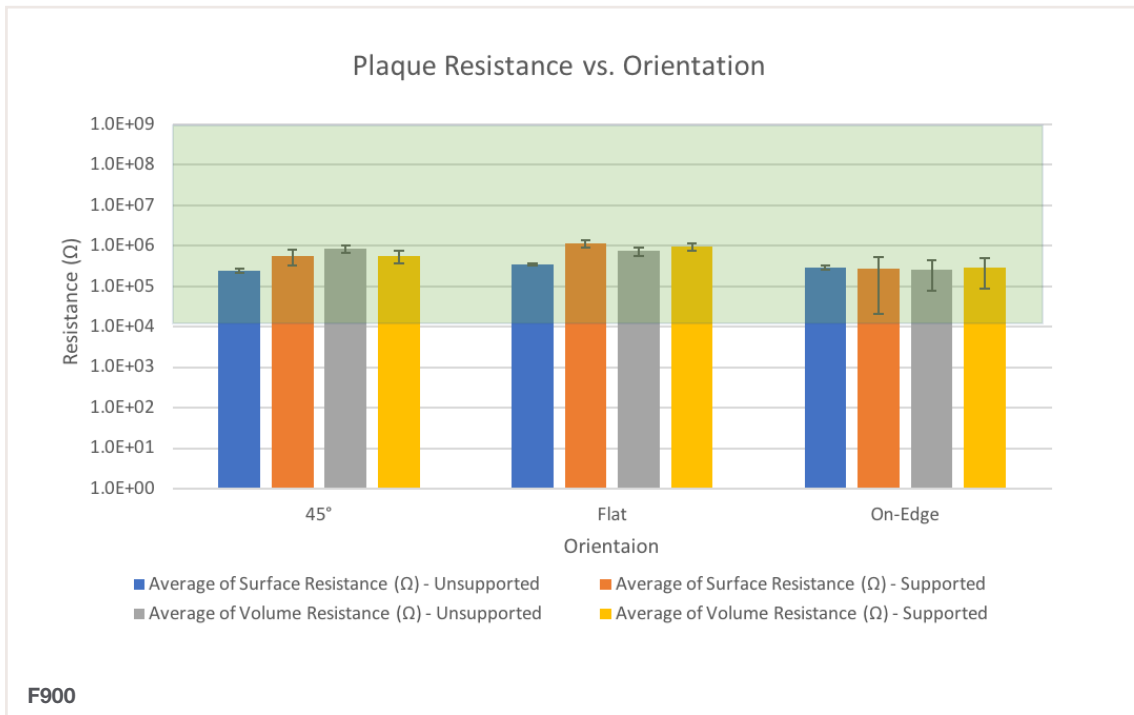


Figure 2a. Volume resistance of hollow cylinders with respect to wall thickness, build orientation, and location on the cylinder on the Fortus 450mc.

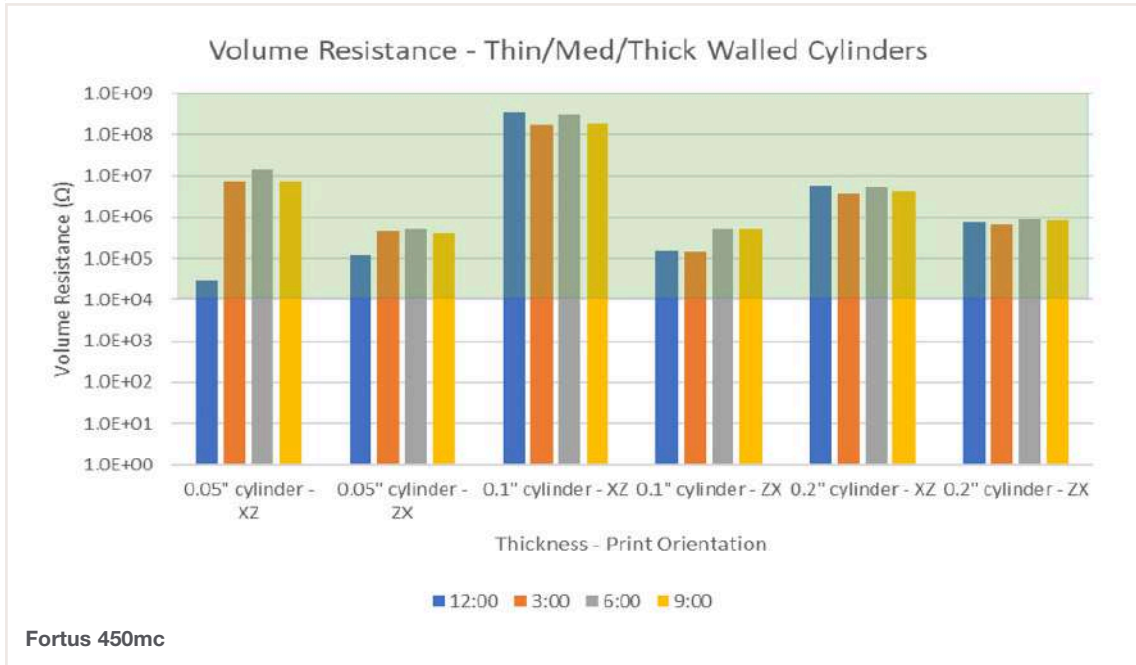
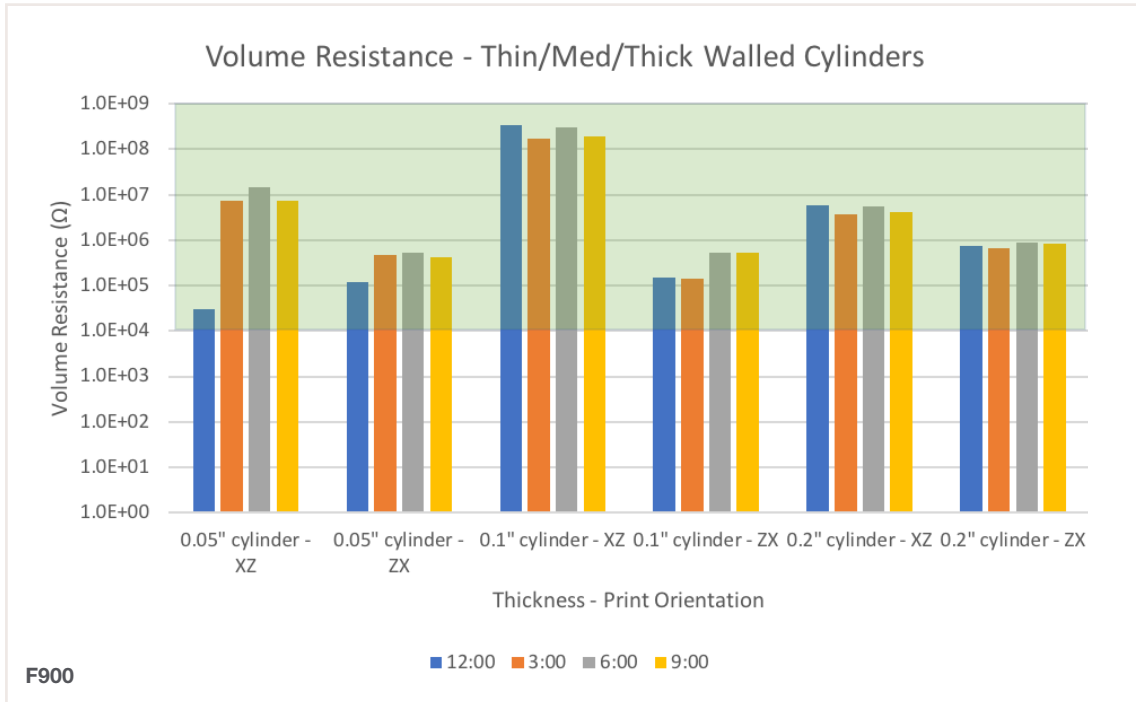


Figure 2b. Volume resistance of hollow cylinders with respect to wall thickness, build orientation, and location on the cylinder on the F900.



## Chemical Resistance

Antero 840CN03 was tested for resistance to chemical exposure per ASTM D543. Chemicals tested and percent change from control is listed below. For further details read the [Antero 840CN03 Chemical Resistance White Paper](#).

**Table 8. Antero 840CN03 Thermoplastic Filament Chemical Resistance Results**

Change in Mechanical Properties, Antero 840CN03 - 168 Hour Chemical Exposure (ASTM D543)			
	Reagent	XZ Orientation <sup>(1)</sup>	ZX Orientation <sup>(1)</sup>
Tensile Strength	Dichloromethane	-87.6%	-74.8%
	Ethyl Acetate	-2.9%	-2.3%
	Jet A	-2.1%	7.3%
	MEK	-0.7%	-2.1%
	Skydrol	-2.1%	6.3%
	Toluene	-5.0%	1.4%
	30% Nitric Acid	-5.7%	5.7%
	30% Sulfuric Acid	-9.3%	-10.1%
	60% Sodium Hydroxide	-1.4%	1.9%
	Concentrated Ammonia	-1.4%	11.0%
% Elongation @ break	Dichloromethane	714.8%	1,598.4%
	Ethyl Acetate	4.2%	16.2%
	Jet A	-0.4%	7.0%
	MEK	-4.4%	11.9%
	Skydrol	32.3%	9.7%
	Toluene	17.2%	32.4%
	30% Nitric Acid	61.4%	52.4%
	30% Sulfuric Acid	47.2%	-5.4%
	60% Sodium Hydroxide	5.2%	-1.6%
	Concentrated Ammonia	11.1%	10.8%
Tensile Modulus	Dichloromethane	-90.7%	-85.3%
	Ethyl Acetate	1.8%	6.4%
	Jet A	1.4%	5.3%
	MEK	3.1%	4.3%
	Skydrol	0.6%	6.7%
	Toluene	-0.4%	6.2%
	30% Nitric Acid	-0.8%	-6.2%
	30% Sulfuric Acid	-7.6%	-5.0%
	60% Sodium Hydroxide	0.2%	3.3%
	Concentrated Ammonia	-0.4%	5.0%

## Flame, Smoke, and Toxicity (Fortus 450mc)

Antero840CN03 was printed with a T20F tip on the Stratasys Fortus 450mc and tested per 14 CFR 25.853, BSS 7238 and 7238, and AITM 2.0007B, and 3.0005. The testing done establishes that this material, samples 0.040 inches thick unless otherwise noted, **meets requirements** for:

- 60s and 12s Vertical Burn
- 15s Horizontal Burn
- Toxic Gas Emission
- Smoke Density
- Heat Release Rate of Cabin Materials

**Table 9. Antero 840CN03 Flame, Smoke and Toxicity Test Results (Fortus 450mc)**

	Avg Time to Extinguish (seconds)	Avg Burned Length (inches)	Drip Time to Extinguish (seconds)
<b>12 Second Vertical Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(ii)</b>			
Antero 840CN03, Vertical - ZX	2.9	0.2	0 (No drips)
Antero 840CN03, Flat - XY	6.7	0.2	0 (No drips)
<b>60 Second Vertical Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(ii)</b>			
Antero 840CN03, Vertical - ZX	<1	0.4	0 (No drips)
Antero 840CN03, Flat - XY	<1	0.5	0 (No drips)
<b>Avg Burn Rate (in/min)</b>			
<b>15 Second Vertical Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(ii)</b>			
Antero 840CN03, Vertical - ZX		0	
Antero 840CN03, Flat - XY		0	
	Test Mode	Average $D_s$ (maximum) within 4 minutes, ( $D_{max}$ )	
<b>Smoke Density per BSS 7238, Rev C</b>			
Antero 840CN03, Vertical - ZX	Flaming	0	
Antero 840CN03, Flat - XY	Flaming	0	
<b>Smoke Density per AITM 2.0007B, Issue 3</b>			
Antero 840CN03, Vertical - ZX	Flaming	0	
Antero 840CN03, Flat - XY	Flaming	0	
Antero 840CN03, Vertical - ZX	Non-Flaming	0	
Antero 840CN03, Flat - XY	Non-Flaming	0	

**Table 10. Antero 840CN03 Flame, Smoke and Toxicity Test Results (Fortus 450mc)**

	Test Mode	CO ppm	SO <sub>2</sub> ppm	NO <sub>x</sub> ppm	HCN ppm	HCl ppm	HF ppm
<b>Toxic Gas Emission per BSS 7239, Rev. A</b>							
Antero 840CN03, Vertical - ZX	Flaming	5	0 (NI)	0 (NI)	0 (NI)	0 (NI)	0 (NI)
Antero 840CN03, Horizontal - XY	Flaming	<5	0 (NI)	0 (NI)	0 (NI)	0 (NI)	0 (NI)
<b>Toxic Gas Emission per AITM 3.0005, Issue 2</b>							
Antero 840CN03, Vertical - ZX	Flaming	5	0	0.1	0 (NI)	0 (NI)	0 (NI)
Antero 840CN03, Horizontal - XY	Flaming	3	0	0.3	0 (NI)	0 (NI)	0 (NI)
Antero 840CN03, Vertical - ZX	Non-Flaming	1	0	0	0 (NI)	0 (NI)	0 (NI)
Antero 840CN03, Horizontal - XY	Non-Flaming	1	0	0	0 (NI)	0 (NI)	0 (NI)
	Peak HRR (kW/m <sup>2</sup> )	Time to Peak Heat Release (seconds)	2 Minute Total HRR (kW-min/m <sup>2</sup> )				
<b>Heat Release Rate of Cabin Materials per 14 CFR 25.853(d), Appendix F, Part IV<sup>1</sup></b>							
Antero840CN03, Vertical - ZX Antero 840CN03	57.7	300	0				
Antero 840CN03, Horizontal - XY	59.9	269	0.1				

(1) Sample thickness: 0.150 in

## Flame, Smoke, and Toxicity (F900)

Antero 840CN03 was printed with a T20D tip on the Stratasys F900 and tested per 14 CFR 25.853, BSS 7238 and 7238, and AITM 2.0007B and 3.0005. The testing done establishes that this material, samples 0.040 inches thick unless otherwise noted, **meets requirements** for:

- 60s and 12s Vertical Burn
- 15s Horizontal Burn
- Toxic Gas Emission
- Smoke Density
- Heat Release Rate of Cabin Materials

**Table 11. Antero 840CN03 Flame, Smoke, and Toxicity Test Results (F900)**

	Avg Time to Extinguish (seconds)	Avg Burned Length (inches)	Drip Time to Extinguish (seconds)
<b>12 Second Vertical Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(ii)</b>			
Antero 840CN03, Vertical - ZX	3.2	0.3	0 (no drips)
Antero 840CN03, Horizontal - XZ	4.7	0.2	0 (no drips)
<b>60 Second Vertical Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(i)</b>			
Antero 840CN03, Vertical - ZX	<1	0.5	0 (no drips)
Antero 840CN03, Horizontal - XZ	<1	0.5	0 (no drips)
<b>Avg Burn Rate (in/min)</b>			
<b>15 Second Horizontal Ignition per 14 CFR 25.853(a), Appendix F, Part I, Paragraph (a)(1)(iv)(v)</b>			
Antero 840CN03, Vertical - ZX		0	
Antero 840CN03, Horizontal - XZ		0	
	Test Mode	Average $D_s$ (maximum) within 4 minutes, ( $^4D_{max}$ )	
<b>Smoke Density per BSS 7238, Rev. C</b>			
Antero 840CN03, Vertical - ZX	Flaming	0	
Antero 840CN03, Horizontal - XZ	Flaming	0	
<b>Smoke Density per AITM 2.0007B, Issue 3</b>			
Antero 840CN03, Vertical - ZX	Flaming	0	
Antero 840CN03, Horizontal - XZ	Flaming	0	
Antero 840CN03, Vertical - ZX	Non-Flaming	0	
Antero 840CN03, Horizontal - XZ	Non-Flaming	0	

**Table 12. Antero 840CN03 Flame, Smoke, and Toxicity Test Results (F900)**

	Test Mode	CO ppm	SO <sub>2</sub> ppm	NO <sub>x</sub> ppm	HCN ppm	HCl ppm	HF ppm
<b>Toxic Gas Emission per BSS 7239, Rev. A</b>							
Antero 840CN03, Vertical - ZX	Flaming	5	0	0	0	0	0
Antero 840CN03, Horizontal - XZ	Flaming	<5	0	0	0	0	0
<b>Toxic Gas Emission per AITM 3.0005, Issue 2</b>							
Antero 840CN03, Vertical - ZX	Flaming	4	0	0.1	0	0	0
Antero 840CN03, Horizontal - XZ	Flaming	3	0	0.3	0	0	0
Antero 840CN03, Vertical - ZX	Non-Flaming	0	0	0	0	0	0
Antero 840CN03, Horizontal - XZ	Non-Flaming	1	0	0	0	0	0
	Peak HRR (kW/m <sup>2</sup> )	Time to Peak Heat Release (seconds)	2 Minute Total HRR (kW-min/m <sup>2</sup> )				
<b>Heat Release Rate of Cabin Materials per 14 CFR 25.853(d), Appendix F, Part IV<sup>(1)</sup></b>							
Antero 840CN03, Horizontal - XZ	55.9	286.7	0				
Antero 840CN03, Vertical - ZX	55.1	293	0.1				

(1) Sample thickness: 0.150 in

## Outgassing

**Table 13. Antero 840CN03 Outgassing Test Results**

Sample	TML (%)	CVCM (%)	WVR (%)
Vertical Build - ZX	0.41	<0.01	0.17
Horizontal Build - XZ	0.45	0.01	0.15
<b>Testing Observations<sup>(1)</sup></b>			
Visible Condensate	Yes	Opaque	Yes
Percent Covered	10% (ZX), 25% (XZ)	Interference Fringes	No
Thin	Yes	Colored Fringes	No
Heavy	No	Sample Appearance After Test	No change
Transparent	No		

(1) For both orientations

# Appendix

Figure 3. 2nd heating scan, DSC, for Antero 840CN03.

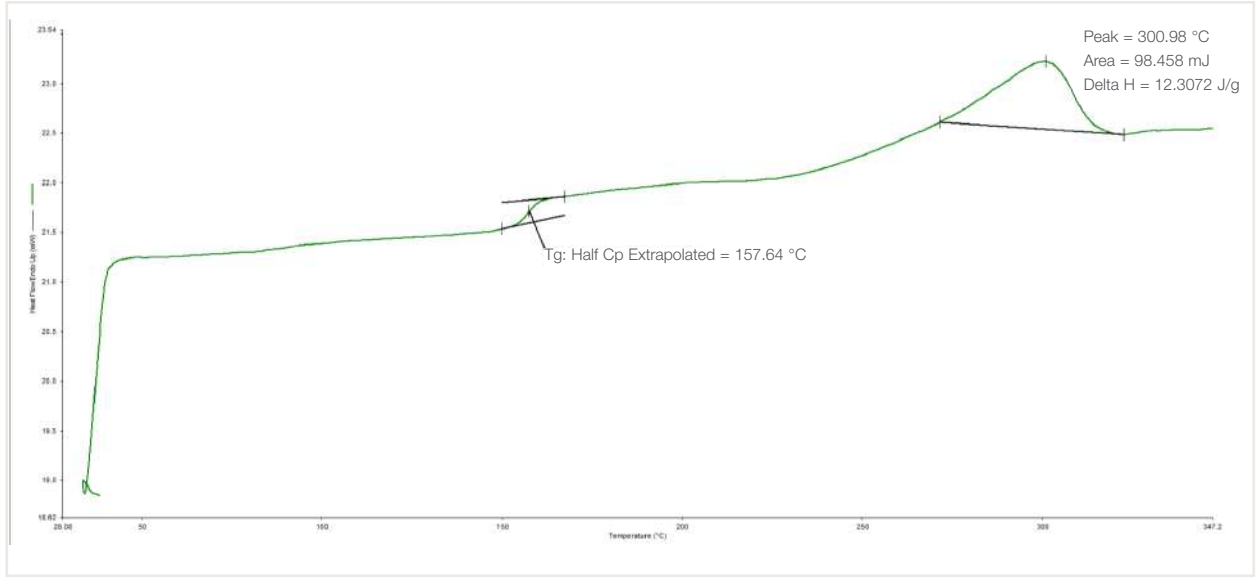


Figure 4. TMA CTE curve normal to the layers.

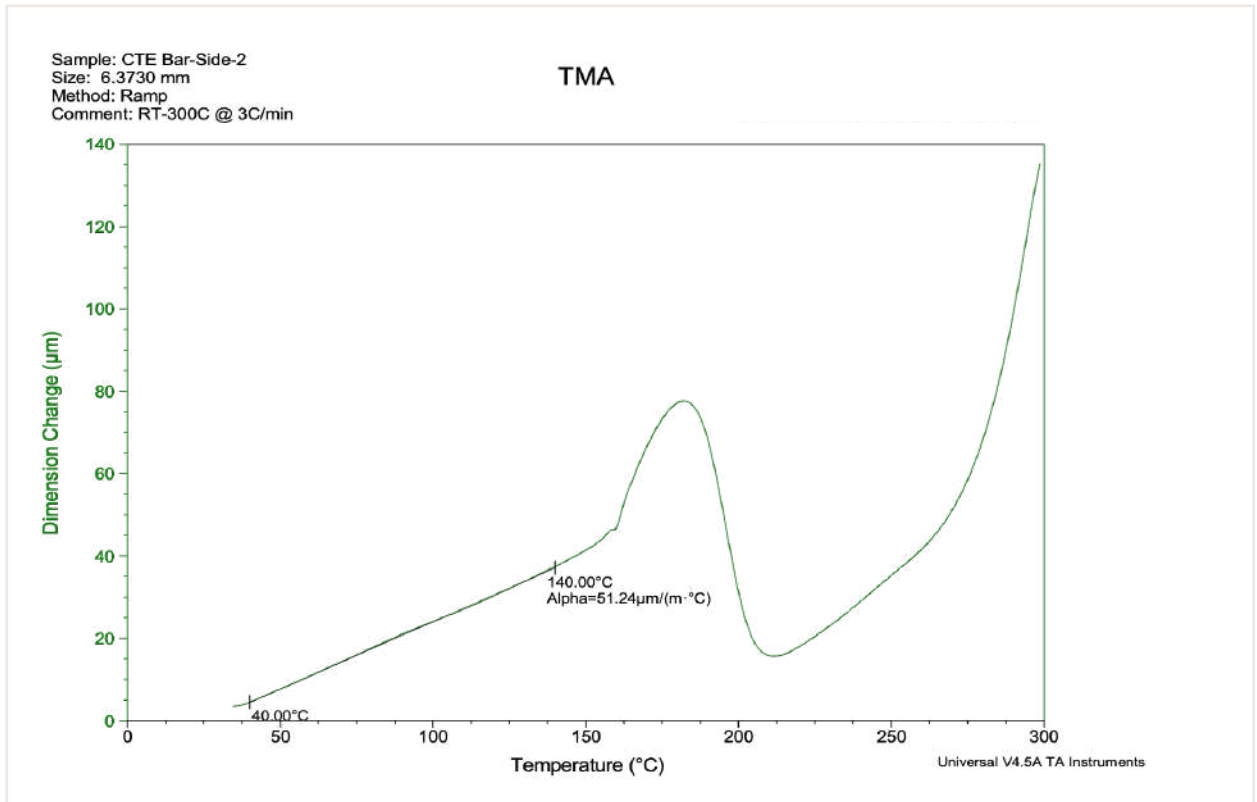
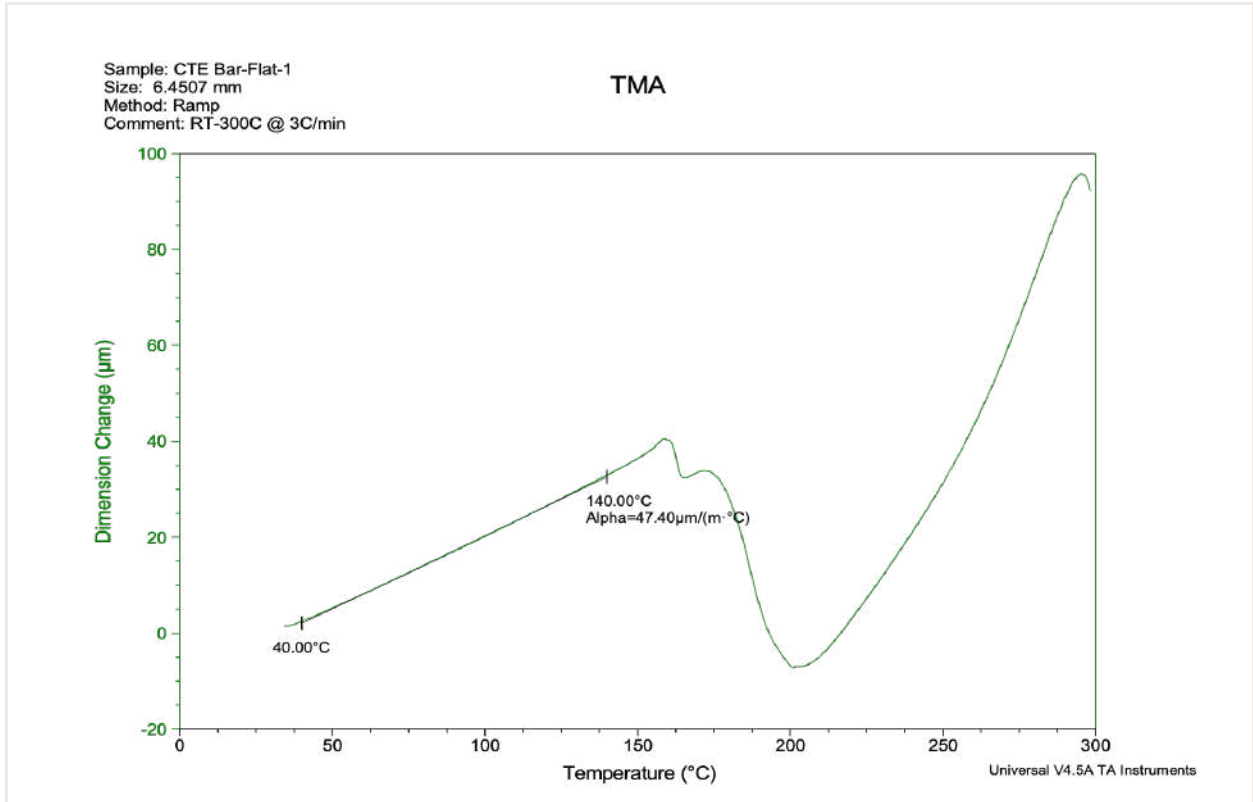


Figure 5. TMA CTE curve inplane with the layers.



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