Accura® AMX™ Tough FR V0 Black

Production Tough

A tough, production-grade stereolithography flame-retardant resin that passes UL94 V0 test standards

Stereolithography

PRINT LARGE, HIGH QUALITY, FLAME-RETARDANT PRODUCTION-GRADE PARTS

Accura AMX Tough FR V0 Black is an industry first flame-retardant material to address production applications with large format stereolithography. This high performance, fast printing material delivers enhanced part quality and resolution with a beautiful finish.

This material is recommended for a variety of industries including aerospace, automotive, transportation, boating, recreation vehicles, electronics packaging, and consumer products. Due to the outstanding surface quality, speed, and ease of printing, Accura AMX Tough FR V0 Black is an excellent choice for use as a general-purpose material.

HANDLING AND POST-PROCESSING GUIDELINES

Proper cleaning, drying and curing is required for this material. Post-processing information can be found at the end of this document.

Note: all properties are based on using the documented post-processing method. Any deviation from this method could yield a different result.

More details can be found at https://infocenter.3dsystems.com/bestpractices/sla-best-practices/accura-amx-rigid-black

APPLICATIONS

- Passes UL94 V0 above 3mm wall thickness and FAR25.853(a) above 2mm wall thickness
- Semiconductor equipment
- Printed circuit board enclosures
- Covers or housings requiring a UL94 V0 rating
- Flame retardant parts for trains and buses
- Components affiliated with batteries for electric vehicles
- Direct production of high-volume, end-use plastic parts

BENEFITS

- Self-extinguishing, flame-retardant material
- Prints large, production-grade, long-term stable parts
- Uniquely tough for a flame-retardant material
- Fast, easy to print material making it extremely versatile
- Achieve production efficiencies due to a shared base chemistry with Figure 4 version of Tough FR V0 Black

Note: Not all products and materials are available in all countries — please consult your local sales representative for availability.

3D SYSTEMS®

Accura AMX Tough FR V0 Black

MATERIAL PROPERTIES

The full suite of mechanical properties is given per ASTM and ISO standards where applicable. Properties like flammability, dielectric properties, and 24-hour water absorption are also provided for better understanding of material capabilities to help design decisions using the material. All parts are conditioned per ASTM recommended standards for a minimum of 40 hrs at 23°C, 50% RH. Solid material properties reported were printed along the vertical axis (ZX-orientation). As detailed in the Isotropic Properties section, stereolithography material properties are relatively uniform across print orientations. Parts do not need to be oriented in a particular direction to exhibit these properties.

LIQUID MATERIAL			
METRIC	**METHOD**	**METRIC**	**US**
Viscosity (@25C)	Brookfield Viscometer	1140 cPs	2758 lb/ft·h
Color		Black	
Liquid Density (@25C)	Kruss K11 Force Tensiometer	1.23 g/cm³	0.043 lb/in³
Default print layer thickness	Internal	100 µm	0 in

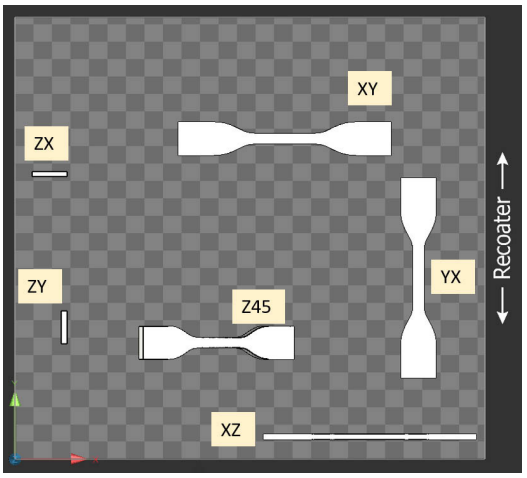
SOLID MATERIAL						
METRIC	**ASTM METHOD**	**METRIC**	**ENGLISH**	**ISO METHOD**	**METRIC**	**ENGLISH**
	PHYSICAL				**PHYSICAL**	
Solid Density	ASTM D792	1.31 g/cm³	0.047 lb/in³	ISO 1183	1.31 g/cm³	0.047 lb/in³
24 Hour Water Absorption	ASTM D570	1.3 %	1.3 %	ISO 62	1.3 %	1.3 %
	MECHANICAL				**MECHANICAL**	
Tensile Strength Ultimate	ASTM D638 Type IV	33 MPa	4800 psi	ISO 527 -1/2	32 MPa	4700 psi
Tensile Strength at Yield	ASTM D638 Type IV	33 MPa	4800 psi	ISO 527 -1/2	32 MPa	4700 psi
Tensile Modulus	ASTM D638 Type IV	1300 MPa	190 ksi	ISO 527 -1/2	1400 MPa	200 ksi
Elongation at Break	ASTM D638 Type IV	35.5 %	35.5 %	ISO 527 -1/2	32.6 %	32.6 %
Elongation at Yield	ASTM D638 Type IV	5.4 %	5.4 %	ISO 527 -1/2	4.9 %	4.9 %
Flex Strength	ASTM D790	38 MPa	5500 psi	ISO 178	31 MPa	4500 psi
Flex Modulus	ASTM D790	1000 MPa	150 ksi	ISO 178	900 MPa	127 ksi
Izod Notched Impact	ASTM D256	33 J/m	0.6 ft-lb/in	ISO 180-A	4 J/m²	0.0017 ft-lb/in²
Izod Unnotched Impact	ASTM D4812	460 J/m	9 ft-lb/in	ISO 180-U	30 J/m²	0.0156 ft-lb/in²
Shore Hardness	ASTM D2240	77 D	77 D	ISO 7619	77 D	77 D
	THERMAL				**THERMAL**	
Tg (DMA E")	ASTM E1640 (E"Peak)	10 C	50 F	ISO 6721-1/11 (E" Peak)	10 C	50 F
HDT 0.455MPa/66PSI	ASTM D648	63 C	146 F	ISO 75- 1/2 B	53 C	127 F
HDT 1.82MPa/264 PSI	ASTM D648	47 C	117 F	ISO 75-1/2 A	42 C	107 F
CTE -20 TO 50C	ASTM E831	156 ppm/C	87 ppm/F	ISO 11359-2	156 ppm/C	87 ppm/F
CTE 75 TO 180C	ASTM E831	115 ppm/C	64 ppm/F	ISO 11359-2	115 ppm/C	64 ppm/F
UL Flammability	UL94	V0 @ 3mm				
Vertical burn @ 12 sec	FAR 25.853(a)	Pass @ 2mm				
	ELECTRICAL				**ELECTRICAL**	
Dielectric Strength (V/mil) @ 3mm thickness	ASTM D149	373 V/mil				
Dielectric Constant @ MHz	ASTM D150	3.465				
Dissipation Factor @ MHz	ASTM D150	0.034				
Volume Resistivity (ohm-cm)	ASTM D257	2.26e14				

Accura AMX Tough FR V0 Black

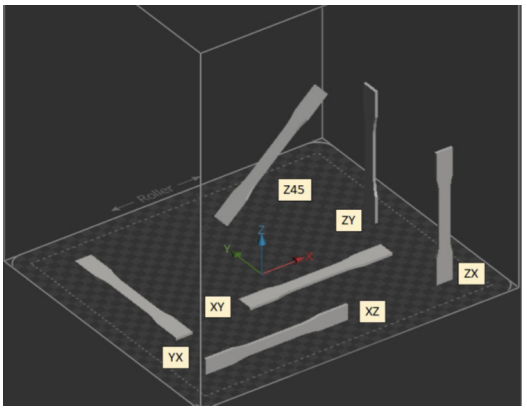
ISOTROPIC PROPERTIES

Stereolithography technology prints parts that are generally isotropic in mechanical properties meaning the parts printed along either the XYZ axis will give similar results.

Parts do not need to be oriented to get the highest mechanical properties, further improving the degree of freedom for part orientation for mechanical properties.

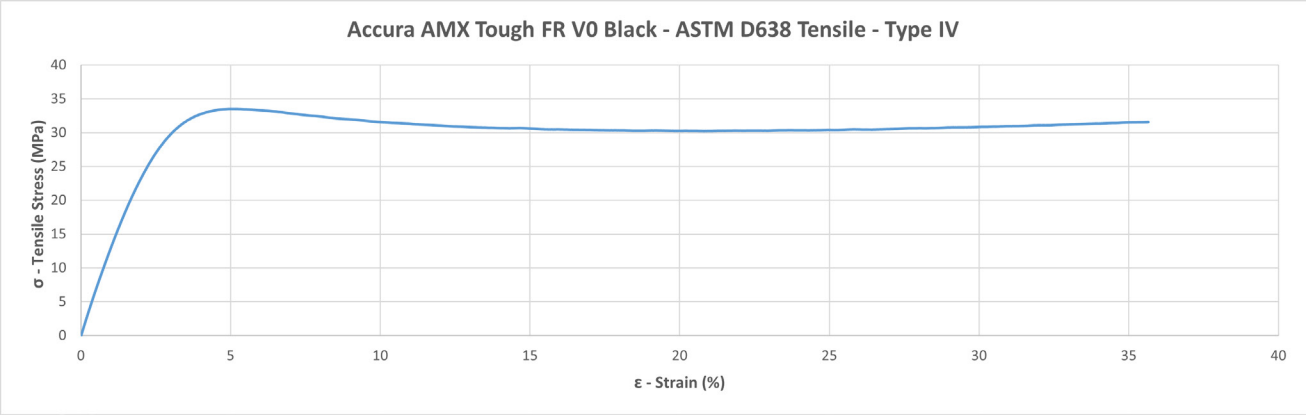


SOLID MATERIAL							
METRIC	METHOD	METRIC					
MECHANICAL							
		ZY	ZX	XZ	XY	YX	Z45
Tensile Strength Ultimate	ASTM D638 Type IV	33 MPa	34 MPa	33 MPa	34 MPa	33 MPa	32 MPa
Tensile Strength at Yield	ASTM D638 Type IV	33 MPa	34 MPa	33 MPa	34 MPa	33 MPa	32 MPa
Tensile Modulus	ASTM D638 Type IV	1300 MPa	1400 MPa	1400 MPa	1400 MPa	1400 MPa	1300 MPa
Elongation at Break	ASTM D638 Type IV	35.5 %	40 %	43 %	44.6 %	34 %	31.5 %
Elongation at Yield	ASTM D638 Type IV	5.4 %	5.1 %	5.1 %	5 %	5.2 %	5 %
Flex Strength	ASTM D790	38 MPa	35 MPa	39 MPa	42 MPa	37 MPa	33 MPa
Flex Modulus	ASTM D790	1000 MPa	1000 MPa	1100 MPa	1132 MPa	1000 MPa	900 MPa
Izod Notched Impact	ASTM D256	33 J/m	30 J/m	37 J/m	42 J/m	36 J/m	39 J/m
Izod Unnotched impact	ASTM D4812	460 J/m	278 J/m	207 J/m	357J/m	616 J/m	476J/m
Shore D Hardness	ASTM D2240	77 D	77 D	77 D	77 D	76 D	76 D



STRESS-STRAIN CURVE

Accura AMX Tough FR V0 Black exhibits thermoplastic behavior with a long plastic deformation ductile necking before fracturing which gives better snap and clip performance.



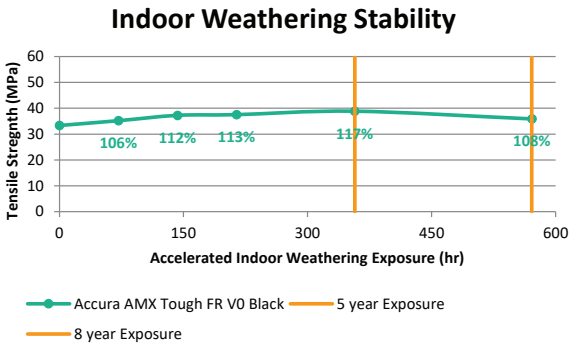
Accura AMX Tough FR V0 Black

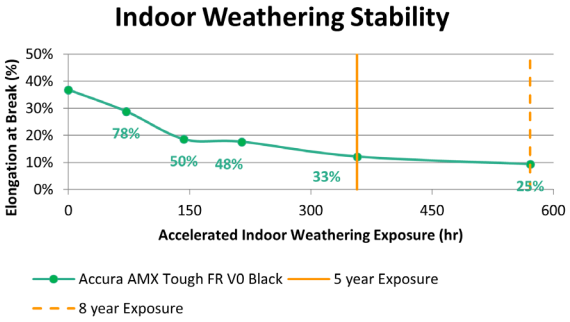
LONG TERM ENVIRONMENTAL STABILITY

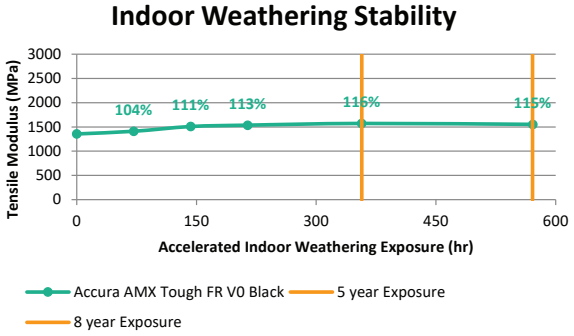
Accura AMX Tough FR V0 Black is engineered to give long term environmental UV and humidity stability. This means the material is tested for the ability to retain a high percent of the initial mechanical properties over a given period of time. This provides real design conditions to consider for the application or part. **Actual data value is on Y-axis, and data points are % of initial value.**

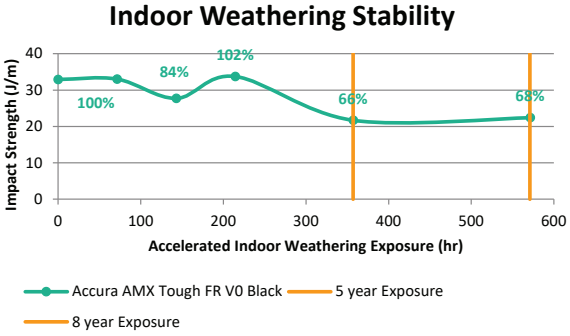
INDOOR STABILITY: Tested per ASTM D4329 standard method.

INDOOR STABILITY



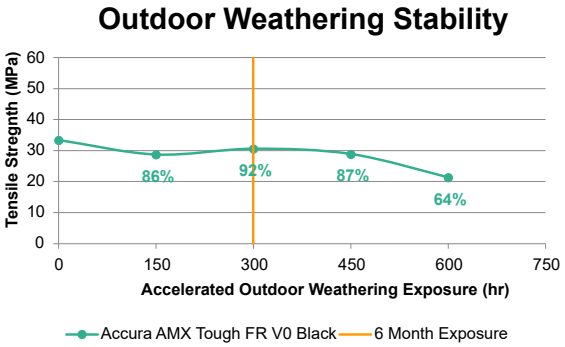


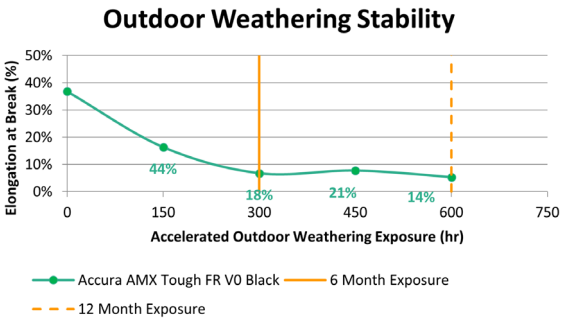


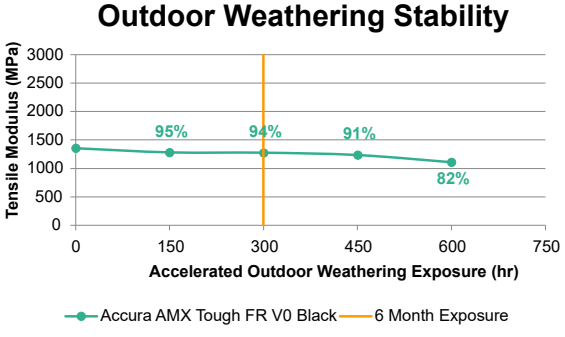


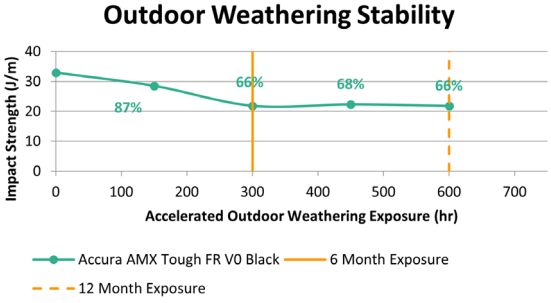
OUTDOOR STABILITY: Tested per ASTM G154 standard method.

OUTDOOR STABILITY









Accura AMX Tough FR V0 Black

AUTOMOTIVE FLUID COMPATIBILITY

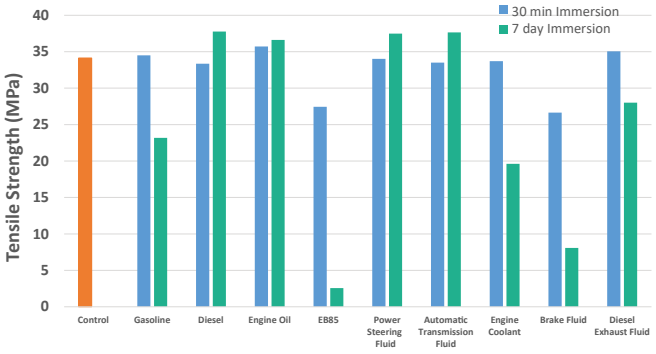
The compatibility of a material with hydrocarbons and cleaning chemicals is critical to part application. Accura AMX Tough FR V0 Black parts were tested for sealed and surface contact compatibility per USCAR2 test conditions. The fluids below were tested in two different ways per the specs.

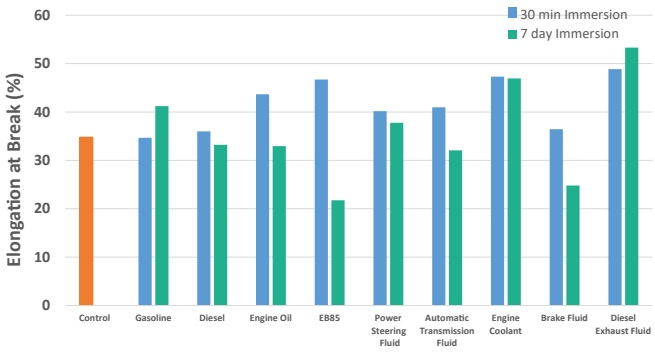
- Immerse for 7-days, then take mechanical property data for comparison
- Immerse for 30-minutes, remove, and take mechanical property data for comparison in 7-days

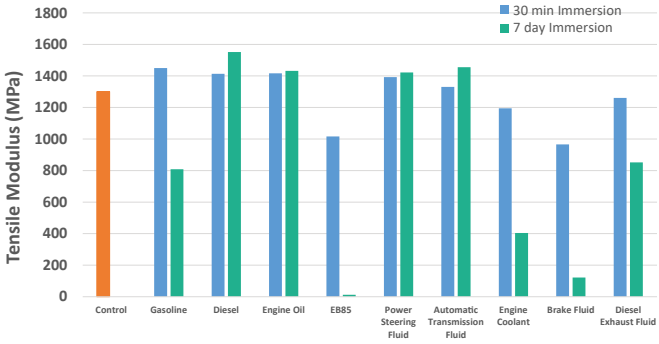
Data reflects the measured value of properties over that period of time.

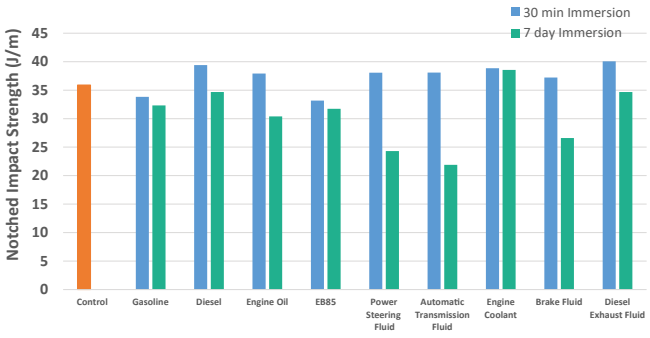
AUTOMOTIVE FLUIDS		
FLUID	**SPECIFICATION**	**TEST TEMP °C**
Gasoline	ISO 1817, liquid C	23 ± 5
Diesel Fuel	905 ISO 1817, Oil No. 3 + 10% p-xylene*	23 ± 5
Engine Oil	ISO 1817, Oil No. 2	50 ± 3
Ethanol	85% Ethanol + 15% ISO 1817 liquid C*	23 ± 5
Power Steering Fluid	ISO 1917, Oil No. 3	50 ± 3
Automative Transmission Fluid	Dexron VI (North American specific material)	50 ± 3
Engine Coolant	50% ethylene glycol + 50% distilled water*	50 ± 3
Brake Fluid	SAE RM66xx (Use latest available fluid for xx)	50 ± 3
Diesel Exhaust Fluid (DEF)	API certified per ISO 22241	23 ± 5

*Solutions are determined as percent by volume









Accura AMX Tough FR V0 Black

CHEMICAL COMPATIBILITY

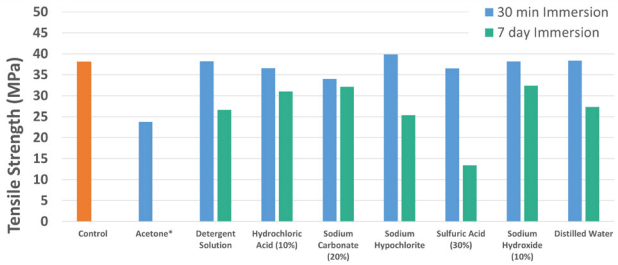
The compatibility of a material with cleaning chemicals is critical to part application. Accura AMX Tough FR V0 Black parts were tested for sealed and surface contact compatibility per ASTM D543 test conditions. The fluids below were tested in two different ways per the specs.

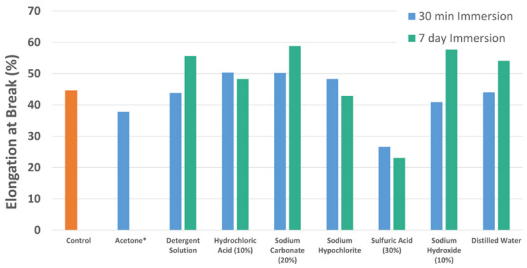
- Immerse for 7-days, then take mechanical property data for comparison
- Immerse for 30-minutes, remove, and take mechanical property data

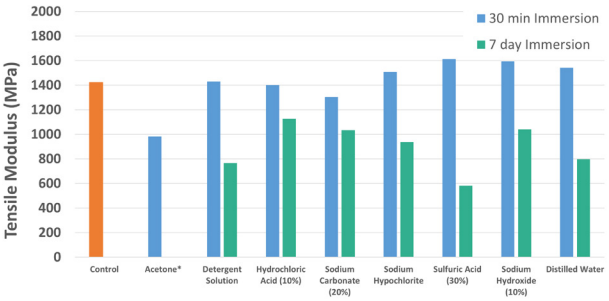
Data reflects the measured value of properties over that period of time.

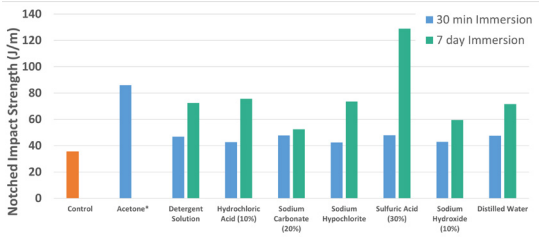
*Denotes materials did not go through 7-day soak conditioning.

CHEMICAL COMPATIBILITY
6.3.3 Acetone*
6.3.12 Detergent Solution, Heavy Duty
6.3.23 Hydrochloric Acid (10%)
6.3.38 Sodium Carbonate Solution (20%)
6.3.44 Sodium Hypochlorite Solution
6.3.46 Sulfuric Acid (30%)
6.3.42 Sodium Hydroxide Soln (10%)
6.3.15 Distilled Water









POST-PROCESSING INSTRUCTIONS

CLEANING INSTRUCTIONS

- Clean with 2 solvents of 1-TPM, 1-IPA (wash and rinse)
- Agitate parts in 'wash' TPM for 20 minutes manually or in automated cleaning system
- Submerge, and manually rinse in 'clean' IPA for 10 minutes while agitating part
  - DO NOT EXCEED more than 10 minutes submerged exposure to IPA to preserve mechanical properties
- Using a soft brush can be used to aid cleaning on down facing surfaces. Use care when handling parts to prevent marking the surfaces
- Refresh solvents when cleaning becomes ineffective

DRYING INSTRUCTIONS

- Oven dry at 35 degrees °C or at ambient temperature on a mesh wire drying rack in a ventilated area for at least 60 minutes

SPECIAL CONSIDERATION

- UL94 V0 certification was achieved by applying recommended cleaning instructions with final cure in the ProCure 1050 utilizing the Accura AMX Tough FR V0 Black Standard cure setting

POST CURE SYSTEMS

3D Systems **ProCure 1050** UV Post-Curing Unit utilizing the **standard cure setting** was used to get data sheet properties as listed in the tables above. The table below compares mechanical property output of legacy cure devices including the Procure 350 and Procure 750.

- Optimal post cure temperature is at 60 °C
- The times for legacy post cure systems is 180 minutes and was used to gather the data in the table below:

PROPERTY	ASTM METHOD	1050 CURE	350 CURE	750 CURE
Solid Density g/cm3	ASTM D792	1.31 g/cm³	1.3 g/cm³	1.3 g/cm³
Tensile Strength Ultimate (MPa)	ASTM D638 Type IV	33 MPa	29 MPa	31 MPa
Tensile Strength at Yield (MPa)	ASTM D638 Type IV	33 MPa	29 MPa	31 MPa
Tensile Modulus (MPa)	ASTM D638 Type IV	1300 MPa	1200 MPa	1300 MPa
Elongation at Break (%)	ASTM D638 Type IV	35.5 %	39 %	39 %
Elongation at Yield (%)	ASTM D638 Type IV	5.4 %	4.8 %	4.8 %
Flex Strength (MPa)	ASTM D790	38 MPa	33 MPa	34 MPa
Flex Modulus (MPa)	ASTM D790	1000 MPa	942 MPa	935 MPa
Izod Notched Impact (J/m)	ASTM D256	33 J/m	34 J/m	38 J/m
Izod unnotched impact (J/m)	ASTM D4812	460 J/m	174 J/m	150 J/m
Tg (DMA, E")	ASTM E1640 (E"at 1C/min)	10 C	7 C	11 C
HDT @ 0.455MPa/66PSI	ASTM D648	63 C	60 C	59 C
HDT @ 1.82MPa/264 PSI	ASTM D648	47 C	47 C	46 C
Shore Hardness	ASTM D2240	77 D	75 D	76 D
24 Hour water absorption (%)	ASTM D570	1.3 %	1.4 %	1.4 %
CTE below Tg (ppm/C)	ASTM E831	156 ppm/C	157 ppm/C	147 ppm/C
CTE above Tg (ppm/C)	ASTM E831	115 ppm/C	124 ppm/C	120 ppm/C

ALSO CERTIFIED TO IEC REQUIREMENTS

We worked with UL Solutions to obtain 3rd party, science-backed flammability certification for our Accura AMX Tough FR V0 Black in accordance with IEC 60695-11-10; Fire Hazard Testing-Part 11-10: Test Flames-50 W Horizontal and Vertical Flame Test Methods.