Roboze

TECHNICAL DATA SHEET

Roboze ULTEM™ AM9085F



Overview

ULTEM™ AM9085F is a high temperature, thermoplastic polymer composed of polyetherimide (PEI) polymer and a polycarbonate (PC) copolymer.
ULTEM™ AM9085F can be associated to the category of high performance technopolymers, or superpolymers for its resistance to hydrolysis and acid solutions, advanced thermal performances (supporting repeated cycles in autoclaves) and strong mechanical characteristics. In addition, ULTEM™ AM9085F presents good electrical properties in a wide range of temperatures and frequencies (including microwaves).

Applications

ULTEM™ AM9085F has been certified for several aerospace applications with FAR 25.853 and OSU 55/55 certifications and used for components like brackets, vents, electrical housings, air filter boxes, and ducts.
ULTEM™AM9085F is also used in automotive for its good resistance to automotive fluids, hydrocarbons, alcohols, and aqueous solutions. Generally, it is perfect for lightweight applications that require a high mechanical resistance at high temperature.

Design phase

The preparation of the samples and the execution of the individual tests followed the guidelines imposed by the associated regulations.[1]

1 Although data measured in a controlled environment can provide an indication of the chemical/physical and mechanical properties of the material and thus enable comparison between different materials, the results of these tests may not be the same as those observed in the final component.

This phenomenon may be caused by the presence of geometric features or manufacturing conditions that may contribute to modifying the material behaviour. Furthermore, the properties of polymeric materials are a function of both temperature and environmental factors (solar radiation, humidity, etc.), which is why the effect of these variables should also be considered during the design phase, both in the case of short-term and long-term exposure.

In view of the above, it is recommended that a prototype be made in advance during the design phase to empirically verify its properties in the operating conditions required by the specific application.

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Printing procedure information

Specimens were manufactured on a Roboze ARGO 500, using a filament with 1.75 ± 0.05 mm of diameter and an extruder nozzle of 0.6mm . The material was dried at 120°C for 8 hours in HT Dryer. The printing parameter were maximized in order to obtain the best compromise between mechanical properties, surface finishing and the maximum value of specific gravity in a standard ASTM D638 type IV sample.

It is possible to identify three different orientations of the printed samples, named as follow:

- Flat (or XY)
- On Edge (or XZ)
- Upright (or ZX)

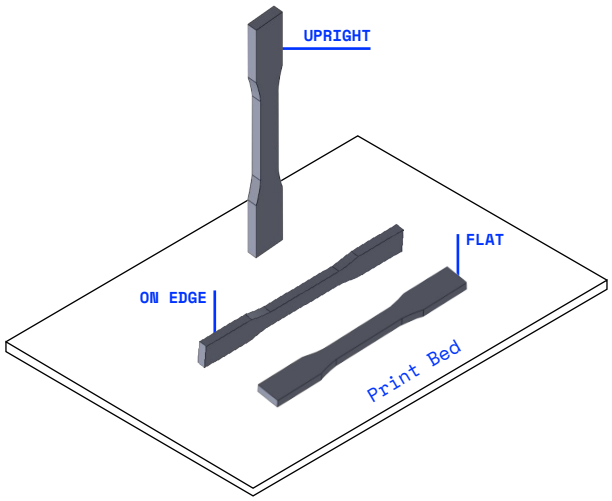


Figure 1 Example of On Edge, Upright and Flat orientation on the building plate

Five samples in XY and XZ – direction were printed in one process to characterize the material. As for the ZX- oriented samples, wall with dimensions of 120x3.2x60mm were printed and, subsequently, milled to obtain two specimens per wall with dimensions defined by the standard. This peculiar procedure in ZX specimens allowed to minimize the influence of a post-processing directly on the samples and, therefore, on their mechanical properties. The infill orientation of XY specimens is ± 45°, conversely, for XZ and ZX-oriented samples the infill is at 0°.
At the end of the printing process, the XY and XZ- oriented samples were subjected to the phase of manual removal step of the support structures. Before testing the material, the samples were conditioned in an oven for 4 hours at 120°C and tested once room temperature is reached.
The results of the tensile tests show the average value of the five samples and their standard deviation.

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Mechanical Properties: test parameters

Tensile Properties

The ASTM D638 standard was used to perform tests with a speed of 1mm/min to calculate the tensile modulus and, subsequently, at 50 mm/min until the samples are broken. It is important to consider that the results of the tensile tests can be influenced by parameters used during testing. The graph below shows the stress-strain curves of the specimens and the table reports the measured values.

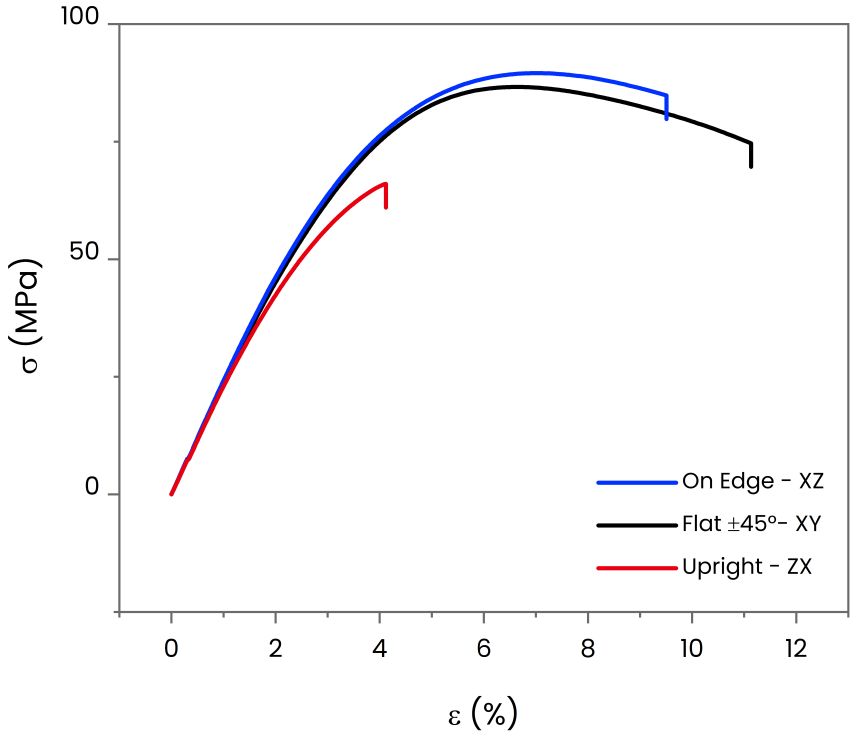


Figure 2 Stress-strain curve of ULTEM™ AM9085F in different printing orientations

Table 1 Tensile properties of ULTEM™ AM9085F measured at 25°C for different specimen orientations

TENSILE TEST ASTM D638		ORIENTATION		
	UNITS	XZ	XY ±45°	ZX
Tensile Strength	MPa	89 ± 0.4	86 ± 0.9	66 ± 0.4
Elongation at maximum load	%	6.8 ± 0.07	6.6 ± 0.06	4.2± 0.09
Young's Modulus	GPa	2.5 ± 0.03	2.5 ± 0.1	2.4 ± 0.08

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Flexural Properties

The flexural behavior of ULTEM was evaluated according to ASTM D790. The samples have dimensions of 127mm x 12.7mm x 3.2mm.
The testing speed was set at 1.35 mm/min and the support span was 50.8 mm. In the case of unbroken sample the load at 5% deformation is assumed as the flexural strength value.

Table 3 Results of flexural properties of ULTEM™ AM9085F

FLEXURAL TEST ASTM D790		ORIENTATION		
	UNITS	XZ	XY ±45°	ZX
Flexural modulus E_F	GPa	2.3	2.3	1.4
Flexural strength σ_F	MPa	62.5	57	48
Flexural strain ε_F	%	unbroken	unbroken	4

Compression Properties

The ASTM D695 standard was used for the determination of the compression properties of the ULTEM™ AM9085F with specimens of diameter 12.7mm and height 25.4mm in XZ and ZX orientations. The testing speed was set at 1.3 mm/min and the results of the tests are reported below.

Table 4 ULTEM™ AM9085F compressive strength at 25°C

COMPRESSION TEST ASTM D790		ORIENTATION	
	UNITS	XZ	ZX
Compressive strength σ_M	MPa	93	98

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Summary of the ULTEM™AM9085F properties

MECHANICAL PROPERTIES

PROPERTY	OPERATING CONDITIONS	UNITS	ORIENTATION			TEST METHOD
			XZ	XY ±45°	ZX	
Tensile Strength	25°C	MPa	89	86	66	ASTM D638
Young Modulus	25°C	GPa	2.5	2.5	2.4	ASTM D638
Strain at Tensile Strength	25°C	%	5.2	5.3	5.2	ASTM D638
Flexural strength	25°C	MPa	62.5	57	48	ASTM D695
Flexural modulus	25°C	GPa	2.3	2.3	1.4	ASTM D695
Flexural strain at break	25°C	%	unbroken	unbroken	4	ASTM D695
Compressive strength	25°C	MPa	93		98	ASTM D790
Izod impact, notched	25°C	J/m	100	104	33	ASTM D256
Izod impact, un-notched	25°C	J/m	1003	763	120	ASTM D4812
Poisson's ratio	25°C				0.37	ASTM D638

PHYSICAL PROPERTIES

PROPERTY	OPERATING CONDITIONS	UNITS	ORIENTATION			TEST METHOD
			XZ	XY ±45°	ZX	
Density		g/cm^3	1.27			ASTM D792
Glass Transition Temperature		°C	177			DSC
Heat Deflection Temperature	1.82 MPa	°C	175	175	165	ASTM D648
Coefficient of Thermal Expansion	Flow	10^{-6} K^{-1}	60.6	57	62.1	ASTM E831
Coefficient of Thermal Expansion	X-Flow	10^{-6} K^{-1}	61.1	58.3	62.9	ASTM E831
Thermal Conductivity	25°C	W/m-K	0.21			ASTM E1952
Volume Resistivity		Ω • cm	1 • 10^{15}	1 • 10^{15}		ASTM D257
Dielectic Constant	100 MHz		2.73	2.54		ASTM D150
Dielectic Constant	500 MHz		2.72	2.53		ASTM D150
Dielectic Constant	1000 MHz		2.71	2.52		ASTM D150
Dissipation factor	100 MHz		0.003	0.00233		ASTM D150
Dissipation factor	500 MHz		0.00567	0.005		ASTM D150
Dissipation factor	1000 MHz		0.004	0.004		ASTM D150
Flammability Test FAA	1.5 mm				PASSED	FAR 25.853
Heat Release Rate – Test OSU	2 minute test 1.5 mm	kW-min/m²			44	FAR 25.853
Heat Release Rate – Test OSU	5 minute test 1.5 mm	kW-min/m²			45	FAR 25.853
Color			Beige			

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CHEMICAL COMPATIBILITY

CHEMICAL	RESISTANCE			
	EXCELLENT	GOOD	LIMITED	LOW
Acetone			X	
Acids with pH <3			X	
Acids with pH 3:6		X		
Alcohols		X		
Alkyl halides				X
Antifreeze		X		
Bases with pH >10		X		
Bases with pH 8:10	X			
Benzene		X		
Brake system fluid			X	
Butane		X		
Butanone			X	
Demineralized water	X			
Ethanol		X		
Ester		X		
Methane		X		
Mineral oil		X		
Petroleum fuels	X			
Petroleum greases		X		
Phenols				X
Propane		X		
Silicone greases/oils		X		
Transmission fluids			X	
Windshield washer fluid	X			