xPRO9400-FR

Basic Properties

Measurement	Unit	Test Method	2x30min in XiP Cure, 1x60min in xCure	2x10min 100% in xCure Desktop	2x30min in XiP Cure, 1x60min in xCure + 3hrs @150°C	2x10min 100% in xCure Desktop + 3hrs @150°C
Tensile Properties						
Young's Modulus	MPa	ASTM D638	3470	3820	4060	4060
Ultimate Tensile Strength	MPa	ASTM D638	71	71	78	78
Elongation at Break	%	ASTM D638	3.1	2.4	2.5	2.5
Thermal Properties						
HDT at 1.82 Mpa	°C	ASTM D648	69	92	141	137
HDT at 0.45 Mpa	°C	ASTM D648	>174	248	>236	253
FST Property						
Flammability		UL94	V0 (2mm) V1 (1.5mm) HB (1.0mm)			
General Properties						
Viscosity at 25°C (77°F)	cP	ASTM D7867	830			
Viscosity at 30°C (86°F)	cP	ASTM D7867	490			
Liquid Density	g/cm^3	ASTM D4052-18a	1.21			
Solid Density	g/cm^3	ASTM D792	1.32			

BASF Extended Properties

Measurement	Unit	Test Method	Post Processed
Flexural Properties			
Flexural Modulus	MPa	ASTM D790	3400
Flexural Stress	MPa	ASTM D790	115
Impact Properties			
IZOD Impact (Notched)	J/m	ASTM D256	20
IZOD Impact (unnotched)	J/m	ASTM D256	176
Charppy (Notched)	kJ/m^2	ISO179-1	0.9
Advanced Thermal Properties			
Glass Transition Temperature (DMA, tan(d))	°C	ASTM D4065	175
Degradation temperature (TGA, 5% mass loss, air)	°C	ISO 11358	330
C.T.E. (-40°C to 0°C)	µm/(m·K)	ASTM E831	49
C.T.E. (0°C to 50°C)	µm/(m·K)	ASTM E831	81
C.T.E. (50°C to 100°C)	µm/(m·K)	ASTM E831	137
C.T.E. (100°C to 150°C)	µm/(m·K)	ASTM E831	111

Specific heat capacity, 23°C	J/(g·K)	DIN EN ISO 11357-4	1.22
Specific heat capacity, 23°C	J/(g·K)	DIN EN ISO 11357-4	1.99
Advanced FST Properties			
Hot-Wire Ignition (HWI)	UL 746 A	PLC 0 (≥ 120s) (2.0mm)	
Fire classification Railway (R22)	DIN EN 45545-2	compliant to HL1 (2mm, 2.5mm)	
Fire classification Railway (R23, R24)	DIN EN 45545-2	compliant to HL2 (2mm, 2.5mm)	
Smoke Generation and Density	ISO 5659-2	Ds (4) < 600 VOF4 < 1200 Ds (max) < 600 (2mm, 2.5mm)	
Limiting Oxygen Index	ISO 4589-2	LOI ≥ 28	
Smoke Gas Toxicity	NF X70-100	CIT_{NLP} : 0.43	
Glow-wire Test	IEC 60695-2-12-13 (2.1mm)	GWIT: 825°C GWFI: 960°C	
Electrical Properties			
Volume Resistivity	Ω·cm	DIN EN 62631-3-1	2.20E+13
Surface Resistivity	Ω	DIN EN 62631-3-2	4.50E+13
Electric Strength	kV/mm	DIN EN 60243-1	31
Comparative tracking index, CTI	V	DIN EN 60112	PLC 0 (≥600V)
RTI (Elec, Imp., Str.)	°C	UL 746 B	50
Other Properties			
Water Absorption (24hr)	%	ASTM D570	0.65
Water Absorption (>1500hrs)	%	ASTM D570	>5%
Shore Hardness	D	ASTM D2240	88

Preheating

Nexa3D xPRO9400-FR will slowly form crystals and solidify after longer periods of storage, especially if kept at colder temperatures. Therefore, a preheating of the material is required before starting any prints.

- **Step 1:** Preheat the material for 5 hours at 60°C.
- **Step 2:** Check if there are any crystals or lumps present. If there are, continue preheating.
- **Step 3:** Shake the bottle/canister to be sure everything is mixed well.
- **Step 4:** Pour it slowly into the vat and wait a couple of minutes, until a smooth, bubble-free surface is obtained before starting the print job.

Printing Process

If the material is kept/used at room temperature (23°C), it will stay fully liquid for about 3 days. After this, small crystals may start forming again, so a new preheating step will be required before starting another print.

The 3D printer examples and settings stated above are only for general guidance. The fully optimized settings should always be determined by the users themselves, according to their specific needs. Please always refer to the user manual of the employed 3D printer for instructions on printer settings and handling.

Remove the parts from the build platform with a suitable tool, for more information, refer to the user manual of the used 3D printer.

Washing

xPRO9400-FR requires post processing to achieve specified properties. Prior to post curing, the part should be washed. Nexa3D recommends using xClean followed by IPA as standard cleaning procedure. Parts should not be submerged in xClean for longer than 2 minutes or in IPA for longer than 5 minutes to avoid any impact on performance.

Examples of Additional Thermal Treatment After UV Post-Curing (Optional)

	Thermal Oven	
Ramp up phase	2 hours	Room temperature to 150 °C
Holding phase	3 hours	150 °C
Ramp down phase	2 hours	150 °C to Room temperature

These proceedings are only general guidelines. In the end, the user has to determine the optimum post-curing procedure based on their specific requirements and the equipment used.

UV Ageing

Durability is a key feature for the components utilized within many industries, as they expect the materials used to withstand years of exposure to the elements. Through the effects of UV radiation, photopolymers can degrade over time. The ageing can be caused by the influence of UV light, heat and water. The degree of aging depends on duration and intensity.

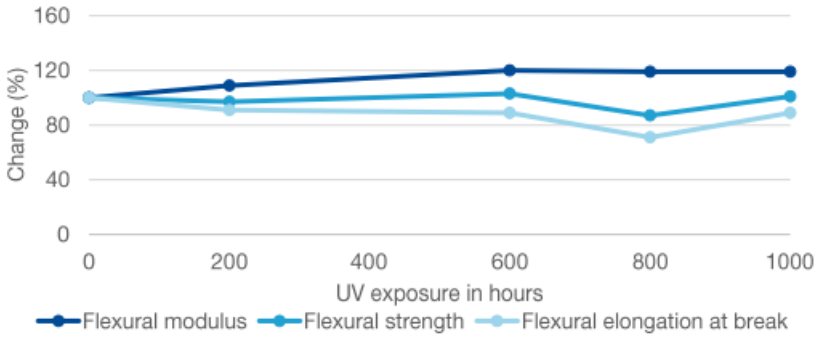
Test Method and Specimens

The aging tests were performed with ASTM D638 type IV tensile bars and color cones as per ISO 4892-2:2013 method A, cycle 1. Exposed samples were always removed at the end of a dry cycle, and conditioned for 24 hours at 22°C before mechanical testing.

Cycle No.	Exposure period	Irradiance		Black standard temperature in °C	Chamber temperature in °C	Relative humidity in %
		Broadband (300 nm to 400 nm) in W/m^2	Narrowband (340 nm in W/(m^{2}nm)			
1	102 min dry	60 ± 2	0.51 ± 0.02	65 ± 3	38 ± 3	50 ± 10
	18 min water spray	60 ± 2	0.51 ± 0.02	-	-	-

Testing conditions for ISO 4892-2 method A, cycle 1

Mechanical Testing



Change in mechanical properties after accelerated weathering

The final values after 1000 hours of long-term UV exposure can be found below.

Property	Before long-term UV exposure	After 1000 hours of UV exposure
E modulus	3400 MPa	4030 MPa
Ultimate tensile strength	115 MPa	116 MPa
Elongation at break	3.5%	3.1%

Mechanical properties before and after accelerated 1000 hours of UV exposure as per ISO 4892:2 method A

Coloration

After being exposed up to 1000 hours, xPRO1100-Black did not show significant change in color.

Effect of UV exposure on color of the specimens

Flammability Testing

In addition to mechanical properties and color, also UL94 flammability was evaluated after long-term UV exposure. Sample (2mm thickness) exposed for respectively 400h and 1000h were tested, and both obtained the V-0 flammability rating. So it appears the UV weathering did not affect the flame retardant properties of the material.

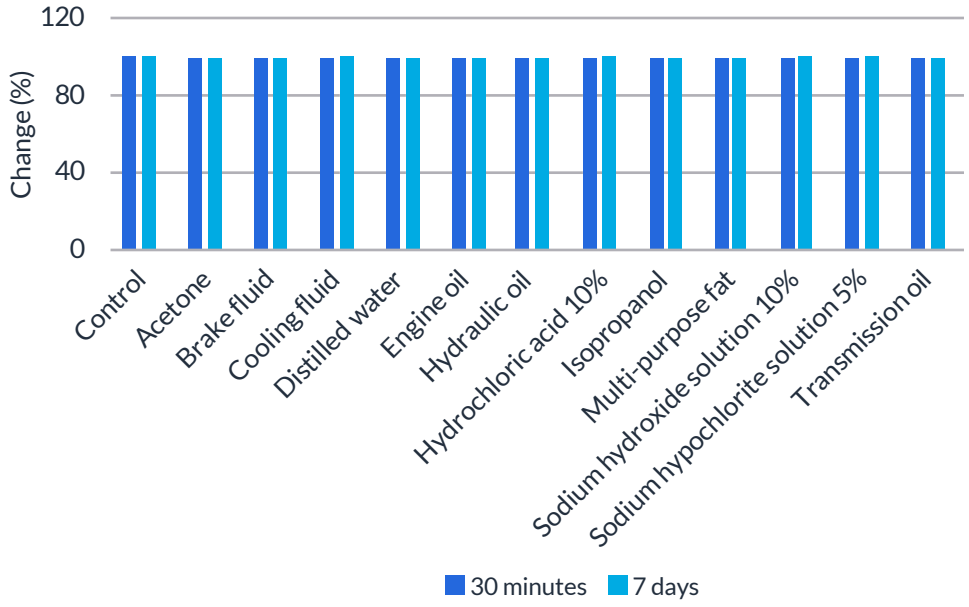
Industrial Chemical Resistance

The resistance of resin materials against chemicals, solvents and other contact substances is an important criterion of selection for many industrial applications. General chemical resistance depends on the period of exposure, the temperature, the quantity, the concentration and the type of the chemical substance. When exposed to industrial chemicals, the chemical bonds of photopolymers can break or degrade, causing a change in the mechanical properties.

Test Method and Specimens

ASTM D638 type IV tensile bars were soaked in each fluid at room temperature, one set for 30 minutes and one set for 7 days. Upon completion of the soaking time, the parts were removed from the test fluid and were dried to measure the weight and the mechanical properties.

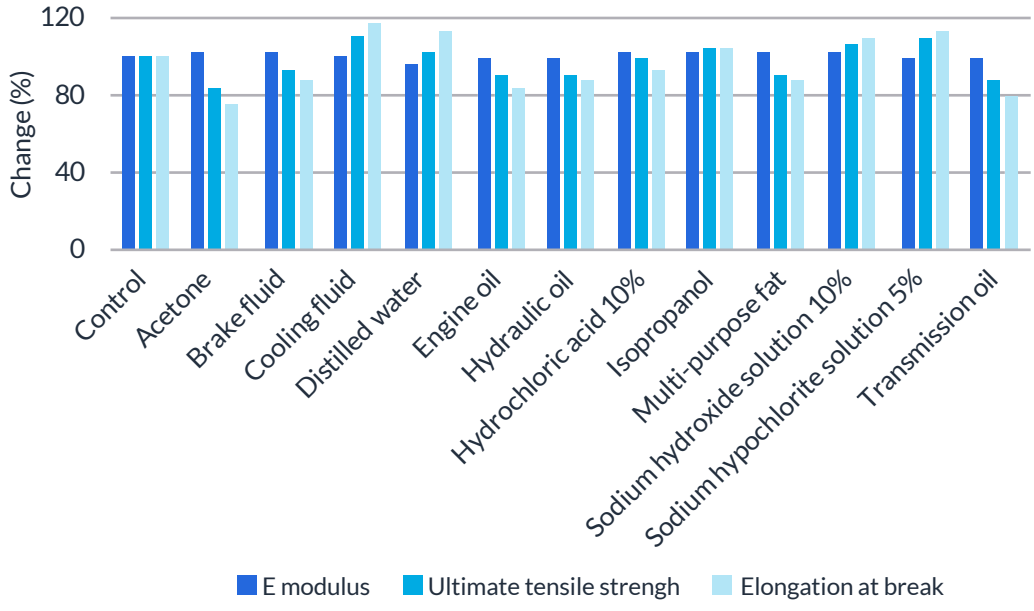
Weight Measurement



Change in weight after immersion time

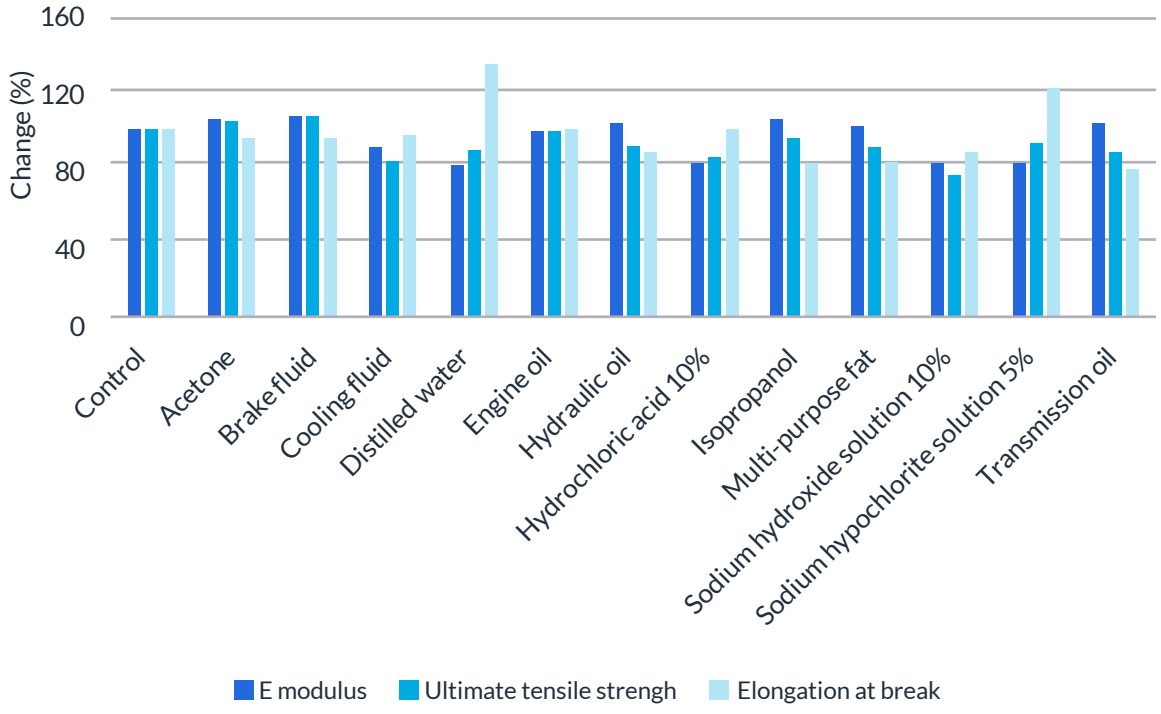
Mechanical Testing

30 minutes



Change in mechanical properties after 30 minutes immersion

7 days



Change in mechanical properties after 7 days immersion

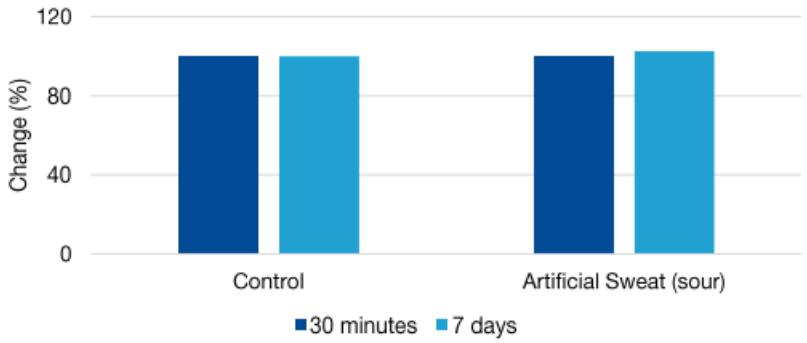
Consumer Chemical Resistance

Similar to the industrial sector, different consumer applications may also require resistance against various chemicals, sovlents and other contact substances. Testing for these application-specific requirements helps to evaluate the suitability of photopolymers for the intended use.

Test Method and Specimens

ASTM D638 type IV tensile bars were soaked in each fluid at room temperature, one set for 30 minutes and one set for 7 days. Upon completion of the soaking time, the parts were removed from the test fluid and were dried to measure the weight and the mechanical properties.

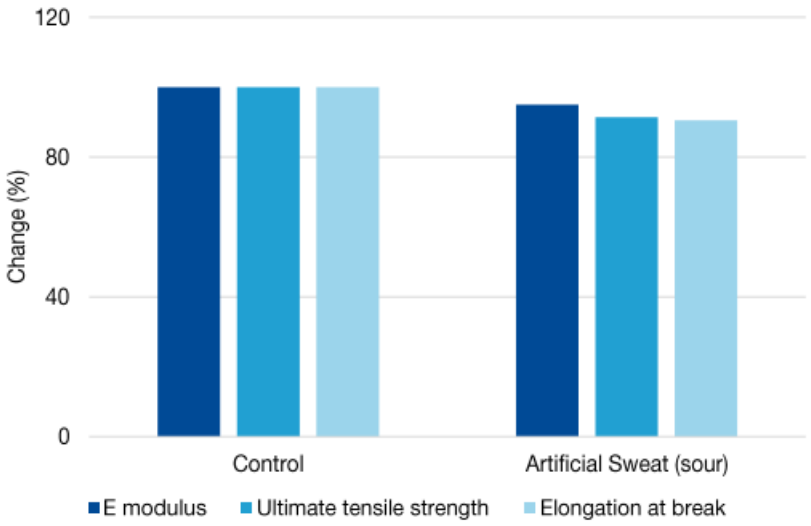
Weight Measurement



Change in weight after immersion time

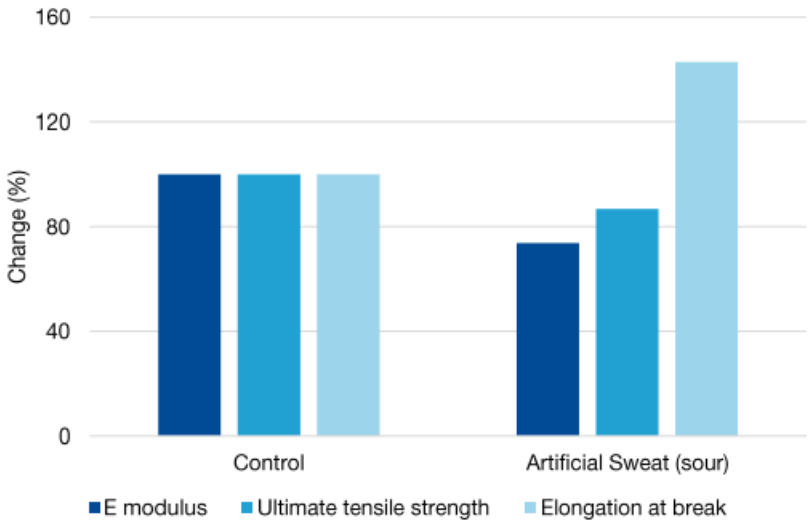
Mechanical Testing

30 minutes



Change in mechanical properties after 30 minutes immersion

7 days



Change in mechanical properties after 7 days immersion

V0 certification

Sample preparation condition

- Machine: Nexa3D XiP
- Layer thickness: 100um
- Exposure time: 4.5s
- Cleaning solvent: xClean + IPA
- Post Curing: 2x10min @100% xCure Desktop

Test Result

*** Flame testing ***
Flammability V acc. to UL 94 : 2024

Information about test procedure and test specimens

M 0 0323			Measurements & observations										Classification
Dimensions of test specimens			1st flame application, 10 s				2nd flame application, 10 s					Total	
127 * 12,7 * d mm³			After-flame time t1 [s]	Cotton indicator ignited?	Burning up to holding clamp?	Obser-vations	After-flame time t2 [s]	Cotton indicator ignited?	Burning up to holding clamp?	Obser-vations	Afterflame & Afterglow time t2 + t3 [s]	Afterflame time t1 + t2 [s]	
Requirements			≤ 10	no	no	---	≤ 10	no	no	---	≤ 30	≤ 50	= V-0
			≤ 30	no	no	---	≤ 30	no	no	---	≤ 60	≤ 250	= V-1
			≤ 30	yes	no	---	≤ 30	yes	no	---	≤ 60	≤ 250	= V-2
Pre-conditioning	Spec no.	Thickn [mm]	Abbrev.: A=dripping parts, K=edge-burning, T=dripping parts, R=rolls up										
Conditioning chamber (2d / 23°C / 50%)	1	2.02	2	No	No		3	No	No		3		
	2	2.02	2	No	No		2	No	No		2		
	3	2.01	2	No	No		2	No	No		2		
	4	2.01	2	No	No		4	No	No		4		
	5	2.01	2	No	No		3	No	No		4	24	V-0
			First test				2024-04-15 8:31 - 2024-04-15 8:39						
Drying oven (7d / 70°C)	1	2.02	2	No	No		3	No	No		3		
	2	2.03	2	No	No		3	No	No		3		
	3	2.04	7	No	No		5	No	No		5		
	4	2.02	2	No	No		4	No	No		4		
	5	2.03	2	No	No		3	No	No		3	33	V-0
			First test				2024-04-16 10:15 - 2024-04-16 10:22						
Conditioning chamber (2d / 23°C / 50%)	1												
	2												
	3												
	4												
	5												
			Repeated test				-						
Drying oven (7d / 70°C)	1												
	2												
	3												
	4												
	5												
			Repeated test				-						V-0 @2.0mm

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