EPU 46

The EPU 46 platform provides color and stiffness flexibility for high energy return elastomeric materials that contain 40% biobased content.

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EPU 46 Platform Overview

EPU 46 platform offers flexibility in color and the stiffness of the final parts through the EPU 46 Color Base (EPU 46 CB) part A resin and the choices of Part B options

	EPU 46 Black	EPU 46 Color Base	EPU 46 SOFT	EPU 46 EXTRA SOFT
Part A	EPU 46 Black Part A	EPU 46 Color Base Part A*	EPU 46 Black Part A EPU 46 Color Base Part A*	EPU 46 Black Part A EPU 46 Color Base Part A*
		*Color Base must be tinted prior to printing. See Coloration Instructions to blend tint bases.		
Part B	EPU 46 Part B	EPU 46 Part B	1:1 by mass EPU 46 Part B : Jeffamine® D230	Jeffamine® D230
A:B Ratio (by mass)	12:1			
Package options	Part A: 5L, 19L, 180L, 950L Part B: 5L	Part A: 19L, 180L, 950L Part B: 5L	Part A: 5L (Black only), 19L, 180L, 950L Part B: 5L Jeffamine® D230: customer must source	
Recommended supplier options	EPU 46 Part B: If higher volumes are needed, contact your Carbon customer support team member for sourcing information.		EPU 46 Part B: if higher volumes are needed, contact your Carbon customer support team member. Jeffamine® D230: Huntsman Jeffamine® D230	Jeffamine® D230: Huntsman Jeffamine® D230
Printers	M1, M2, M3, M3 Max, L1			
Print Dropdown	EPU 46 Black	EPU 46 Coloration	EPU 46 Black Soft EPU 46 Coloration Soft	EPU 46 Black Extra Soft EPU 46 Coloration Extra Soft
Print Script	Default (any printers using software version 1.39 or lower can use L1B1 EPU Default Script when printing with L1/B1 printer/cassette)			
Washing	Spinning recommended. IPA exposure can lead to a change in material properties such as shorter elongation at break and stiffer parts, so it is recommended to minimize exposure as much as possible and test the properties of parts if washing is necessary to clean the part.			
Baking	Inert bake recommended Programmable oven schedule: •Hold at **30° C for 30 MIN,** ramp to **130° C over 30 MIN.** •Hold at **130° C** for **120 MIN,** ramp to **150° C** over **30 MIN.** •Hold at **150° C** for **90 MIN.**			

EPU 46

EPU 46 platform offers flexibility in color of the final parts through the EPU 46 Color Base (EPU 46 CB) part A resin. Properties reported here were obtained with EPU 46 Black Part A and EPU 46 Part B. Other colors may have small deviations in results.

Tensile Properties	Test Standard	Metric	US
Tensile Modulus	ASTM D412 Die C 500 mm/min 0.8 mm thickness	15 MPa	2200 psi
Elongation at Break		330%	330%
Stress at 50% Elongation		4 MPa	600 psi
Stress at 100% Elongation		7 MPa	1000 psi
Stress at 200% Elongation		19 MPa	2800 psi
Ultimate Tensile Strength		26 MPa	3800 psi
Tensile Modulus	ASTM D412 Die C 500 mm/min 2 mm thickness	14 MPa	2000 psi
Elongation at Break		300%	300%
Stress at 50% Elongation		4 MPa	600 psi
Stress at 100% Elongation		7 MPa	1000 psi
Stress at 200% Elongation		19 MPa	2800 psi
Ultimate Tensile Strength		23 MPa	3300 psi

Other Mechanical Properties	Test Standard	Metric	US
Tear Strength, 0.8 mm thickness	ASTM D624 Die C (die cut)	44 kN/m	251 lbf/in
Tear Strength, 2 mm thickness		34 kN/m	194 lbf/in
Ross Flex, 23°C	ASTM D2632, 2 mm thickness, 90° bending	>100,000 cycles	
Ross Flex, -10°C		>100,000 cycles	
Compression Set	ASTM D395-B 23 °C, 72 h	26%	

Thermal Properties	Test Standard	Metric	US
T_g (DMA, tan(d))	ASTM D4065, 2 °C/min, 1Hz	-6 °C	21 °F

Dielectric/Electric Properties	Test Standard	
Dielectric Constant	ASTM D150	5.4
Dissipation Factor		0.00145
Dielectric Strength	ASTM D149	18 kV/mm
Volume Resistivity	ASTM D257	3.45 x 10^{11} ohm-cm

General Properties	Test Standard	
Shore A Hardness	ASTM D2240	80 (Instant), 78 (5 sec)
Bayshore Resilience	ASTM D2632	36%
Bulk Density	ASTM D792	1.06 g/mL
Relative Abrasion Volume Loss	ISO-4649 A	72 mm^3

Parts were processed using an L series printer and centrifugal spinner. The cleaned parts were baked following the EPU 46 baking schedule

EPU 46 Soft

EPU 46 platform offers flexibility in color of the final parts through the EPU 46 Color Base (EPU 46 CB) part A resin. Properties reported here were obtained with EPU 46 Black Part A and 1:1 by mass ratio of EPU 46 Part B : Jeffamine® D230. Other colors may have small deviations in results.

Tensile Properties	Test Standard	Metric	US
Tensile Modulus	ASTM D412 Die C 500 mm/min 0.8 mm thickness	11 MPa	1600 psi
Elongation at Break		300%	300%
Stress at 50% Elongation		3 MPa	450 psi
Stress at 100% Elongation		6 MPa	850 psi
Stress at 200% Elongation		17 MPa	2500 psi
Ultimate Tensile Strength		21 MPa	3000 psi
Tensile Modulus	ASTM D412 Die C 500 mm/min 2 mm thickness	9 MPa	1300 psi
Elongation at Break		300%	300%
Stress at 50% Elongation		3 MPa	450 psi
Stress at 100% Elongation		5 MPa	750 psi
Stress at 200% Elongation		16 MPa	2300 psi
Ultimate Tensile Strength		19 MPa	2800 psi

Other Mechanical Properties	Test Standard	Metric	US
Tear Strength, 0.8 mm thickness	ASTM D624 Die C (die cut)	37 kN/m	211 lbf/in
Tear Strength, 2 mm thickness		29 kN/m	166 lbf/in
Ross Flex, 23°C	ASTM D2632, 2 mm thickness, 90° bending	>100,000 cycles	
Ross Flex, -10°C		>100,000 cycles	
Compression Set	ASTM D395-B 23 °C, 72 h	35%	

Thermal Properties	Test Standard	Metric	US
T_g (DMA, tan(d))	ASTM D4065, 2 °C/min, 1Hz	0 °C	32 °F

Dielectric/Electric Properties	Test Standard	
Dielectric Constant	ASTM D150	5.5
Dissipation Factor		0.00116
Dielectric Strength	ASTM D149	17 kV/mm
Volume Resistivity	ASTM D257	2.36 x 10^{11} ohm-cm

General Properties	Test Standard	
Shore A Hardness	ASTM D2240	71 (Instant), 71 (5 sec)
Bayshore Resilience	ASTM D2632	35%
Bulk Density	ASTM D792	1.06 g/mL
Relative Abrasion Volume Loss	ISO-4649 A	84 mm^3

Parts were processed using an L series printer and centrifugal spinner. The cleaned parts were baked following the EPU 46 baking schedule

EPU 46 Extra Soft

EPU 46 platform offers flexibility in color of the final parts through the EPU 46 Color Base (EPU 46 CB) part A resin. Properties reported here were obtained with EPU 46 Black Part A and Jeffamine® D230. Other colors may have small deviations in results.

Tensile Properties	Test Standard	Metric	US
Tensile Modulus	ASTM D412 Die C 500 mm/min 0.8 mm thickness	4.5 MPa	650 psi
Elongation at Break		250%	250%
Stress at 50% Elongation		2 MPa	300 psi
Stress at 100% Elongation		4 MPa	600 psi
Stress at 200% Elongation		14 MPa	2000 psi
Ultimate Tensile Strength		15 MPa	2200 psi
Tensile Modulus	ASTM D412 Die C 500 mm/min 2 mm thickness	4 MPa	600 psi
Elongation at Break		270%	270%
Stress at 50% Elongation		1 MPa	150 psi
Stress at 100% Elongation		3 MPa	450 psi
Stress at 200% Elongation		13 MPa	1900 psi
Ultimate Tensile Strength		13 MPa	1900 psi

Other Mechanical Properties	Test Standard	Metric	US
Tear Strength, 0.8 mm thickness	ASTM D624 Die C (die cut)	22 kN/m	126 lbf/in
Tear Strength, 2 mm thickness		21 kN/m	120 lbf/in
Ross Flex, 23°C	ASTM D2632, 2 mm thickness, 90° bending	>100,000 cycles	
Ross Flex, -10°C		>100,000 cycles	
Compression Set	ASTM D395-B 23 °C, 72 h	45%	

Thermal Properties	Test Standard	Metric	US
T_g (DMA, tan(d))	ASTM D4065, 2 °C/min, 1Hz	7 °C	45 °F

Dielectric/Electric Properties	Test Standard	
Dielectric Constant	ASTM D150	5.4
Dissipation Factor		0.00179
Dielectric Strength	ASTM D149	18 kV/mm
Volume Resistivity	ASTM D257	1.81 x 10^{11} ohm-cm

General Properties	Test Standard	
Shore A Hardness	ASTM D2240	59 (Instant), 56 (5 sec)
Bayshore Resilience	ASTM D2632	37%
Bulk Density	ASTM D792	1.06 g/mL
Relative Abrasion Volume Loss	ISO-4649 A	123 mm^3

Parts were processed using an L series printer and centrifugal spinner. The cleaned parts were baked following the EPU 46 baking schedule

EPU 46 Liquid Properties

	EPU 46 Black	EPU 46 CB
Liquid Density (Part A)	1.04 g/mL	1.04 g/mL
Liquid Density (Part B)	0.94 g/mL	0.94 g/mL
Liquid Density (Part A+B)	1.03 g/mL	1.03 g/mL
Part A:B Volume Ratio (Mass Ratio)	10.8 (12.0)*	10.8 (12.0)
25 °C Viscosity (Part A)	8600 cP	8600 cP
25 °C Viscosity (Part B)	80 cP	80 cP
25°C Viscosity (Part A+B)	6700 cP	6700 cP

*Same mixing ratio for Soft and Extra Soft.

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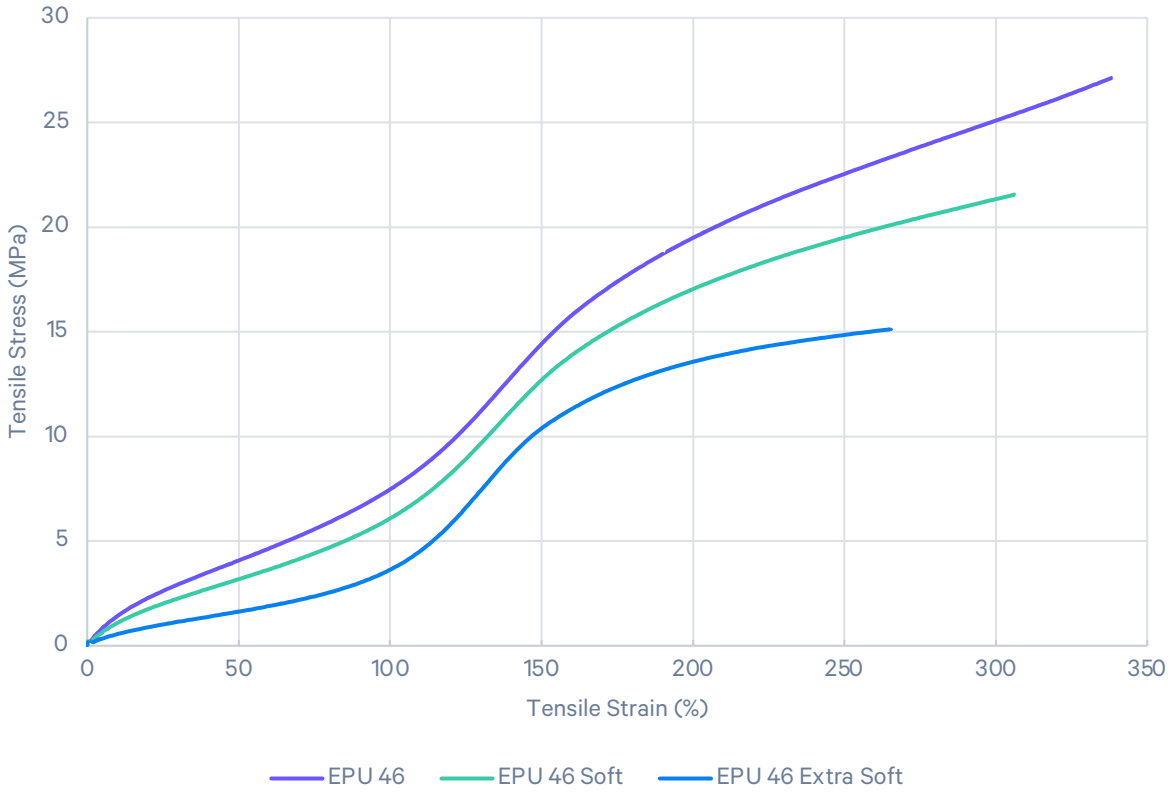
EPU 46

Extended TDS

EPU 46 Mechanical Properties

Representative Tensile Curve & comparison ASTM D412, Die C, 500 mm/min



EPU 46 Black Part A and respective Part B options were used to obtain the data

Parts were processed using an L series printer and centrifugal spinner. The cleaned parts were baked following the EPU 46 baking schedule

EPU 46 – IPA Wash

Mechanical Properties with Alternative Post Processing

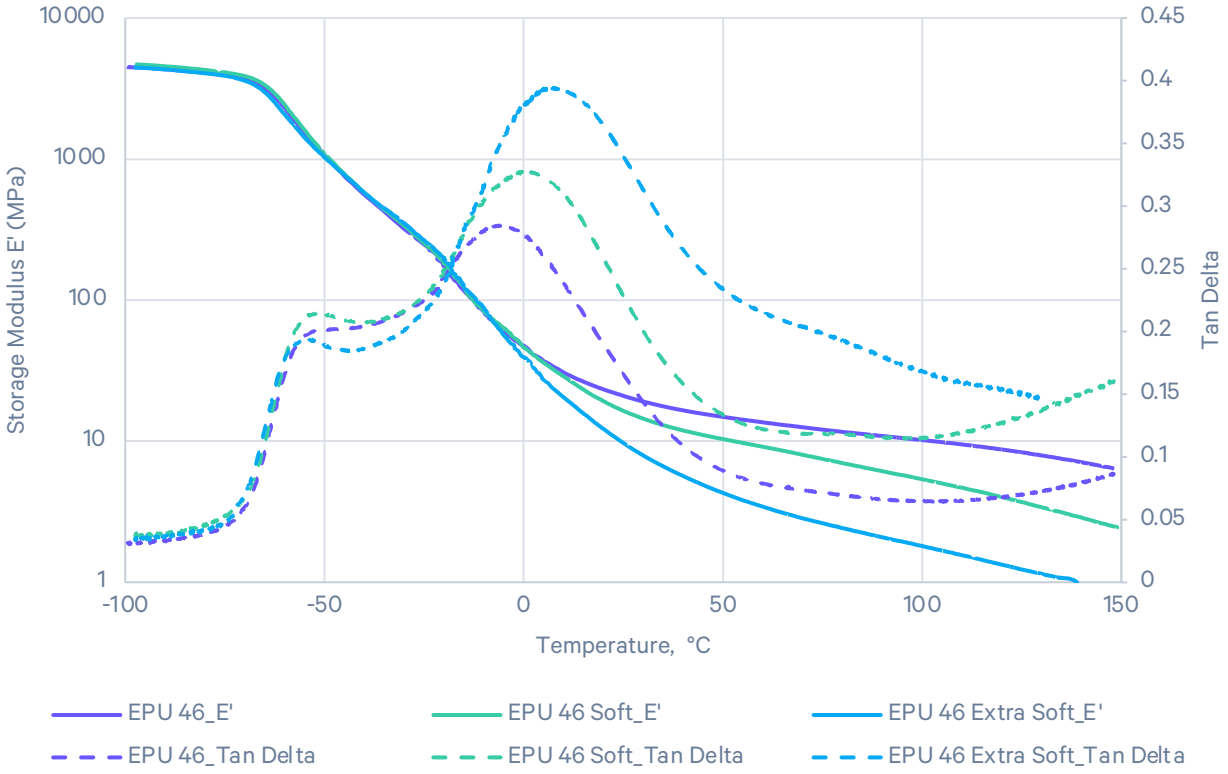
Tensile Properties	Test Standard	EPU 46		EPU 46 Soft		EPU 46 Extra Soft	
		Metric	US	Metric	US	Metric	US
Tensile Modulus	ASTM D412 Die C 500 mm/min 0.8 mm thickness	18 MPa	psi	13 MPa	psi	5.5 MPa	psi
Elongation at Break		250%	%	250%	%	200%	%
Stress at 50% Elongation		4.5 MPa	psi	3.5 MPa	psi	2 MPa	psi
Stress at 100% Elongation		8 MPa	psi	7 MPa	psi	4 MPa	psi
Stress at 200% Elongation		21 MPa	psi	19 MPa	psi	15 MPa	psi
Ultimate Tensile Strength		25 MPa	psi	22 MPa	psi	15 MPa	psi
Tensile Modulus	ASTM D412 Die C 500 mm/min 2 mm thickness	15 MPa	psi	9 MPa	psi	4.5 MPa	psi
Elongation at Break		250%	%	220%	%	200%	%
Stress at 50% Elongation		4 MPa	psi	3 MPa	psi	1.5 MPa	psi
Stress at 100% Elongation		7 MPa	psi	5 MPa	psi	3 MPa	psi
Stress at 200% Elongation		20 MPa	psi	17 MPa	psi	13 MPa	psi
Ultimate Tensile Strength		23 MPa	psi	18 MPa	psi	13 MPa	psi
Tear Strength, 0.8 mm thickness	ASTM D624 Die C (die cut)	50 kN/m	lbf/in	37 kN/m	lbf/in	24 kN/m	lbf/in
Tear Strength, 2 mm thickness		36 kN/m	lbf/in	29 kN/m	lbf/in	22 kN/m	lbf/in
Ross Flex, 23°C	ASTM D2632, 2 mm thickness, 90° bending	>100,000 cycles		>100,000 cycles		>100,000 cycles	
Ross Flex, -10°C		>100,000 cycles		>100,000 cycles		>100,000 cycles	

EPU 46 Black Part A and respective Part B options were used to obtain the data

Parts were processed using an L series printer and washed by isopropanol. The cleaned parts were baked following the EPU 46 baking schedule

Dynamic Mechanical Analysis (DMA)

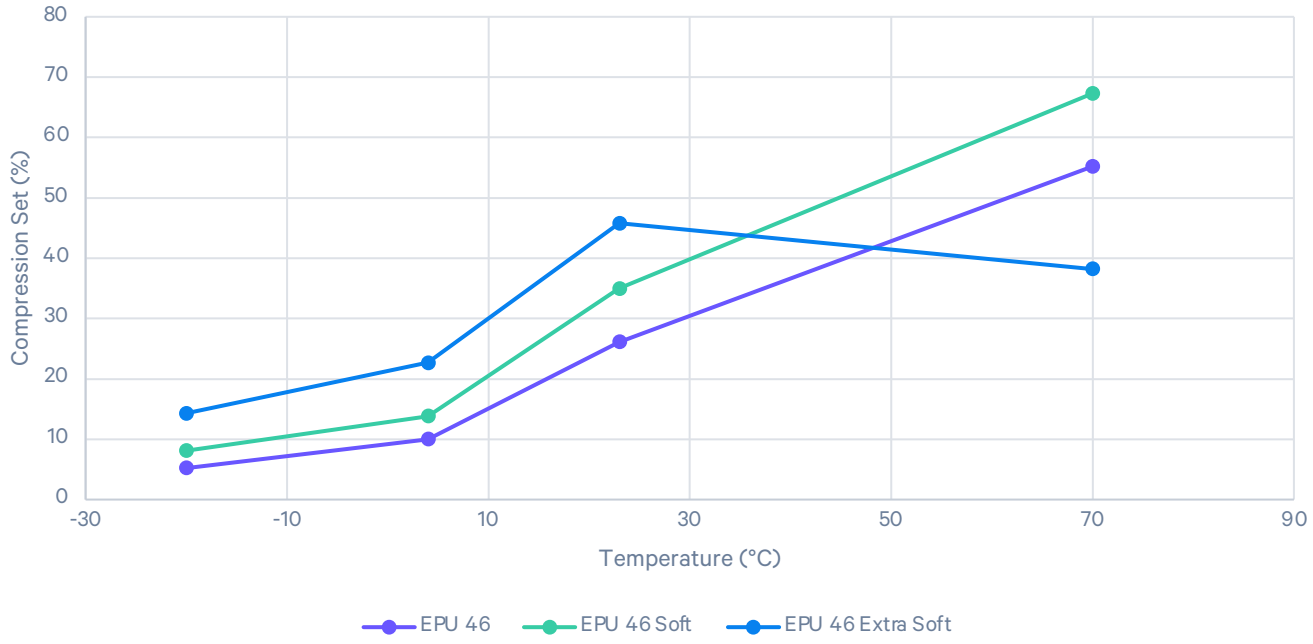
The figure below shows the thermomechanical behavior of EPU 46 , EPU 46 Soft and EPU 46 Extra Soft. Aside from the storage modulus difference between the three, the glass transition temperatures are also different, with Extra Soft (6°C) > Soft (0°C) > EPU 46 (-6°C).



EPU 46 Black Part A and respective Part B options were used to obtain the data
Parts were processed using an L series printer and wiped clean. The cleaned parts were baked following the EPU 46 baking schedule
Test method: ASTM D4065, 2 °C/min, 1Hz

EPU 46 Compression Set

In many elastomeric applications, compression set is an important property that reflects the amount of residual deformation after holding compression at a fixed time, temperature and displacement. EPU 46, Soft and Extra Soft were compressed to 25% of its original sample height and held at various temperatures (-20, 23, and 70 °C) for 72 hours. The compression set measurement is the residual deformation of a test specimen where 0% represents full recovery of the original thickness and 100% indicates no recovery. The image below summarizes the compression set results.



EPU 46 Black Part A and respective Part B options were used to obtain the data
Parts were processed using an L series printer and wiped clean. The cleaned parts were baked following the EPU 46 baking schedule
Test Method: ASTM D394-14 Method B

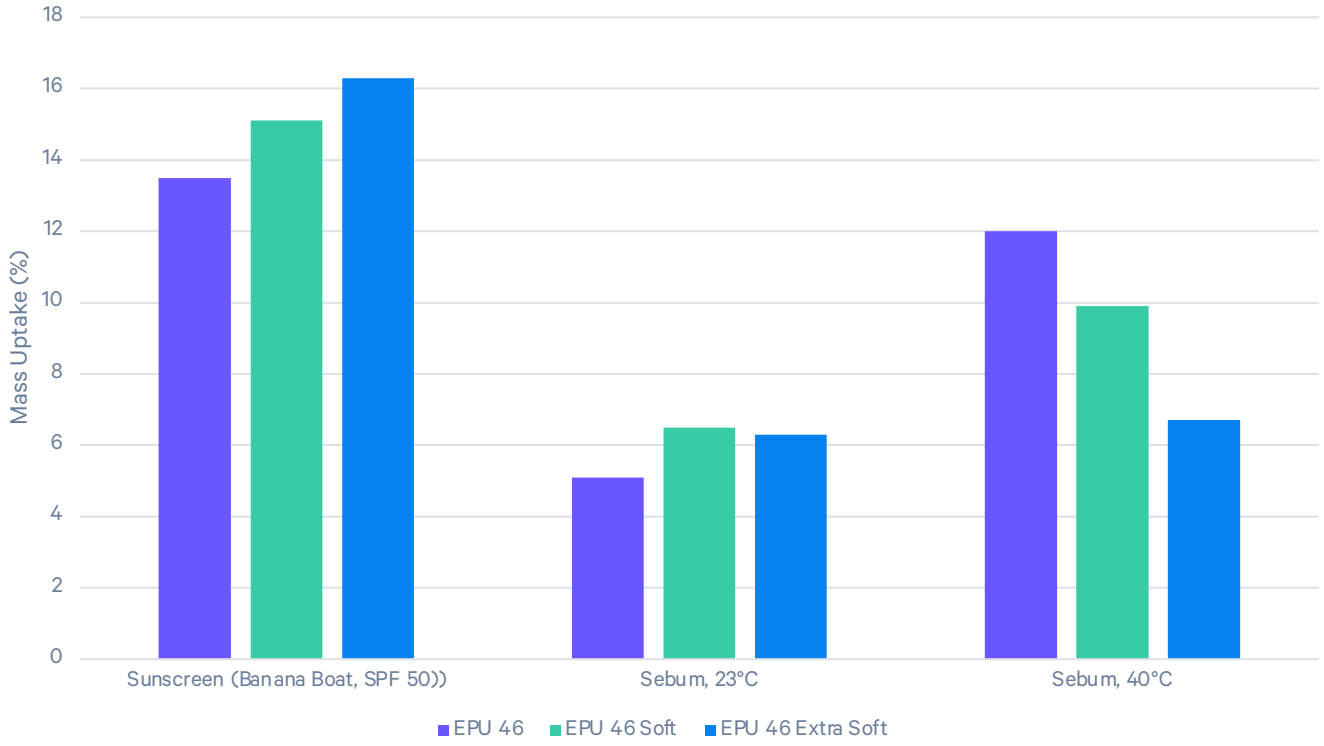
EPU 46 Chemical Compatibility

	Mass Gain* (%)
Household Chemicals	
Bleach (NaClO, 5%)	< 5%
Sanitizer (NH_4Cl, 10%)	5 - 15%
Distilled Water	5 - 15%
Sunscreen (Banana Boat, SPF 50)	5 - 15%
Detergent (Tide, Original)	5 - 15%
Windex Powerized Formula	15 - 30%
Hydrogen Peroxide (30%)	> 30%
Ethanol (95%)	> 30%
Industrial Fluids	
Diesel (Chevron #2)	< 5%
Strong Acid/Base	
Sulfuric Acid (30%)	5 - 15%
Sodium Hydroxide (10%)	< 5%

Parts were processed using an L series printer and wiped clean. The cleaned parts were baked following the EPU 46 baking schedule

*Percent weight gained after one week submersion following ASTM D543. Values do not represent changes in dimension or mechanical properties.

EPU 46 Sebum & Sunscreen Resistance



Parts were processed using an L series printer and wiped clean. The cleaned parts were baked following the EPU 46 baking schedule

Percent weight gained after one week submersion following ASTM D543. Values do not represent changes in dimension or mechanical properties.

EPU 46 Biocompatibility

Biocompatibility Testing

Selected versions of the EPU 46 family have been tested for biocompatibilities. Test articles in the form of printed parts were provided to NAMSA for evaluation and met the requirements of the following test:

Material	Color*	**ISO 10993-5:** Biological evaluation of medical devices – Part 5: Tests for in vitro cytotoxicity (MEM extract)	**ISO 10993-10:** Biological evaluation of medical devices – Part 10: Tess for skin sensitization (Closed Patch Sensitization Study in Guinea Pigs)	**ISO 10993-23:** Biological evaluation of medical devices – Part 23: Tests for irritation (Skin Irritation Study in rabbits)
EPU 46	Black	Met the requirements**	Met the requirements**	Met the requirements**
EPU 46 Soft	Gray	Met the requirements***	Met the requirements**	Met the requirements**
EPU 46 Extra Soft	Gray	Met the requirements***	Met the requirements**	Met the requirements**

*Depending on the color pigment used, results may vary
**Test articles were processed using an L series printer and a centrifugal spinner.
***Test articles were processed using an L series printer and a centrifugal spinner, followed by isopropanol wash for 1 min.

All articles were baked according to EPU 46 baking schedule: Hold at 30ºC for 30 min, ramp to 130ºC over 30 min; hold at 130ºC for 120 min, ramp to 150ºC over 30 min; hold at 150ºC for 90 min.

Additional details about the tests are available upon request.

Disclaimer

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