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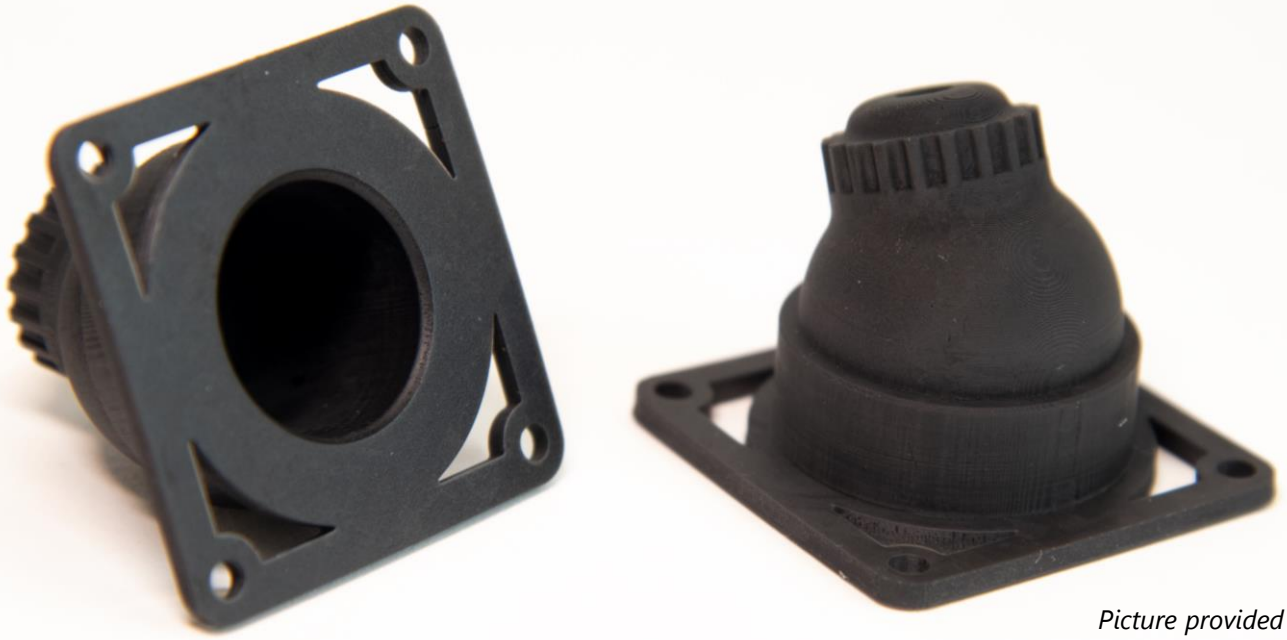

Picture provided by Stratasys

LOCTITE® 3D 3955™

HDT280 FST Photopolymer Black

LOCTITE®
Henkel Corporation
loctite3dp@henkel.com

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LOCTITE 3D 3955™

LOCTITE 3D 3955 is a halogen free, high performance, high modulus material with excellent flexural and tensile physical properties.

LOCTITE 3D 3955 passes UL94 V-0 flammability requirements and FST (AITM2-0002, AITM2-0007, AITM3-0005) and its high HDT allows it to withstand harsh environments with negligible deformation.

Parts printed with LOCTITE 3D 3955 showcase an outstanding surface finish making it ideal for connector and interior parts for aerospace and rail.

Benefits:

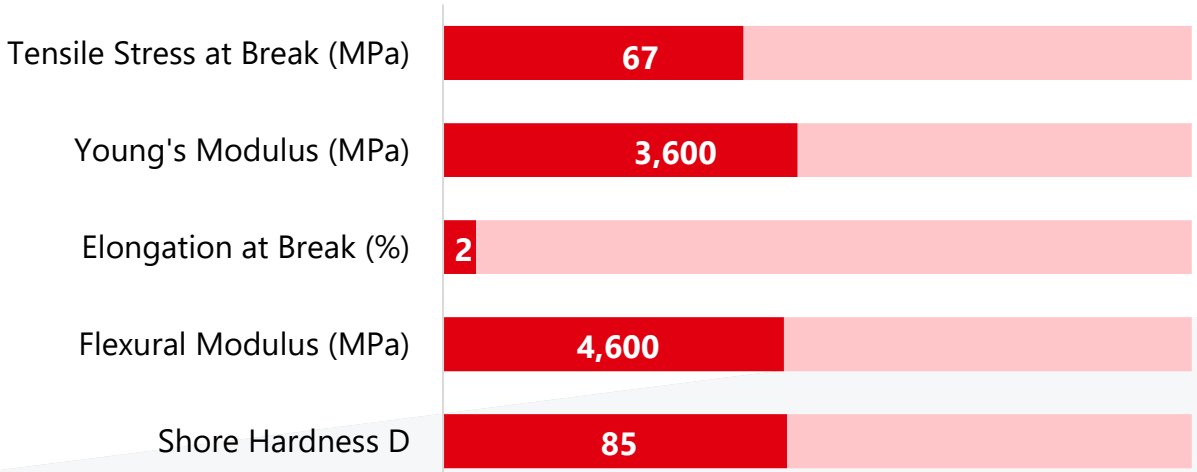
- Fire Safety Material
- Halogen Free
- Excellent flexural and tensile physical properties

Ideal for:

- HVAC Components for Aircraft
- Clips and Plugs for Control Systems/Cabinets
- Connectors, Electronic Housings

Markets:

Industry | Automotive | Aerospace



**Values shown are linked to LOCTITE 3955 Black as reference, please refer to the specific mechanical properties for each of the colors shown in this document*

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PROPERTIES

Mechanical Properties	Measure	Method	Green	Post Processed
Tensile Stress at Yield	MPa	ASTM D638	-	66.7 ± 4.7 [1]
Tensile Stress at Break	MPa	ASTM D638	-	65.5 ± 5.4 [1]
Young's Modulus	MPa	ASTM D638	-	3556 ± 194 [1]
Elongation at Break	%	ASTM D638	-	2.1 ± 0.3 [1]
Flexural Modulus	MPa	ASTM D790	-	4643 ± 228 [2]
Flexural Elongation at Break	%	ASTM D790	-	2.6 ± 0.6 [2]
Flexural Stress at Break	MPa	ASTM D790	-	112 ± 20 [2]
IZOD Impact (Notched)	J/m	ASTM D256	-	22.5 ± 2.8 [3]
Shore Hardness (0s, 3s)	D	ASTM D2240	-	84, 82 [4]
Other Properties				
Solid Density	g/cm^3	ASTM 792	-	1.39 [5]
Biocompatibility				
Cytotoxicity		ISO10993-5	-	Comply [8]

Liquid Properties	Measure	Method	Value
Viscosity at 65°C	cP	ASTMD7867	830 [6]
Liquid Density at 65°C	g/cm^3	ASTMD1475	1.26 [7]

Test parameters:
"All specimen are printed unless otherwise noted. All specimen were conditioned in ambient lab conditions at 19-23°C / 40-60% RH for at least 24 hours." ASTM Methods: D638 Type IV, 5 mm/min, D790-B, 2 mm/min, D648, D256 Notched IZOD (Printed Notch), 6 mm x 12 mm, D570 0.125" x 2" Disc 24hr@ 25°C, D2240, Type "D" (0, 3 seconds), D7867, D1475

Internal Data Sources:
[1] FOR17914, 18058, 18045 [2] FOR18044, 18059 [3] FOR12561 [4] FOR20025 [5] FOR15859 [6] FOR29635 [7] FOR12989 [8] FOR356632

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PROPERTIES

Thermal Properties	Measure	Method	Green	Post Processed
HDT at 0.455 MPa	°C	ASTM D648	-	>300 [1]
HDT at 1.82 MPa	°C	ASTM D648	-	214 [1]
Thermal Conductivity	W/(m-K)	ASTM D5390	-	0.22 [4]
Heat Capacity	J/(g-K)	ASTM D5390		1.5 [4]
CTE (24°C to 140°C)	µm/(m·K)	ASTM E831	-	81.2 ± 3.3 [2]
CTE (140°C to 280°C)	µm/(m·K)	ASTM E831	-	136.4 ± 2.8 [2]
Thermal Ageing (105°C for 1000 hours)	%	ASTM D790-D	-	<5% [3]

Internal Data Sources:
[1] FOR20579 [2] FOR14194 [3] FOR13830 [4] FOR40670

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PROPERTIES

Electrical Properties	Measure	Method	Green	Post Processed
Dielectric Strength	kV/mm	ASTM D149	-	24.9 ± 1.0 [1]
Volume Resistivity (XY)	Ω·cm	ASTM D257	-	2.8 E+17 [2]
Volume Resistivity (Z)	Ω·cm	ASTM D257	-	4.3 E+16 [2]
Surface Resistivity (XY)	Ω·cm	ASTM D257	-	1.4 E+17 [2]
Surface Resistivity (Z)	Ω·cm	ASTM D257	-	2.3 E+17 [2]
AC Relative Permittivity (Dielectric Constant)[3]				
at 50 Hz (XY)	none	ASTM D150	-	2.9
at 1 kHz (XY)	none	ASTM D150	-	3
at 1 MHz (XY)	none	ASTM D150	-	2.9
at 50 Hz (Z)	none	ASTM D150	-	3.5
at 1 kHz (Z)	none	ASTM D150	-	3.5
at 1 MHz (Z)	none	ASTM D150	-	3.3
AC Loss Characteristic (Dissipation Factor)[3]				
at 50 Hz (XY)	none	ASTM D150	-	0.001
at 1 kHz (XY)	none	ASTM D150	-	0.007
at 1 MHz (XY)	none	ASTM D150	-	0.015
at 50 Hz (Z)	none	ASTM D150	-	0.004
at 1 kHz (Z)	none	ASTM D150	-	0.009
at 1 MHz (Z)	none	ASTM D150	-	0.017
Comparative Tracking Index	V	ASTM D3638	-	600[4]

Internal Data Sources:
[1] FOR31592 [2] FOR31594 [3] FOR31593, [4] FOR123412

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PROPERTIES

Flame, Smoke, Toxicity	Measure	Method	Green	Post Processed
Flammability, Vertical	V Rating	UL 94	-	V-0 at 3 mm [9]
Flammability, 12 sec	P/F	AITM2-0002	-	Pass at 6 mm [1]
Flammability, 60 sec	P/F	AITM2-0002	-	Pass at 6 mm [2]
Smoke (Gas Components)	P/F	AITM3-0005	-	Pass at 6 mm [3]
Smoke Density	P/F	AITM2-0007	-	Pass at 6 mm [4]
Rate of Smoke Generation	P/F	ASTM E662	-	Pass [5]
Toxic Gas Generation	-	BSS 7239	-	Pass [5]
Caloric Content	MJ/kg	ASTM E1354	-	13 [5]
Flammability	R22	EN 45545-2	-	compliant to HL1 at 3 mm
Flammability	R23, R24	EN 45545-2	-	compliant to HL2 at 3 mm
Glow Wire Ignition Temperature	GWIT	IEC 60695-2-13	-	850°C at 1.5mm, 2mm[11]

Chemical Compatibility	Measure	Method	Green	Post Processed
168hr Soak in Gasoline @ 25°C	%	Weight Change	-	< 0.2 [6]
168hr Soak in Diesel @ 25°C	%	Weight Change	-	< 0.2 [7]
168hr Soak in Kerosene @ 25°C	%	Weight Change	-	< 0.2 [8]
24hr Soak in Water @ 25°C	%	Weight Change	-	0.3 [10]
96hr Soak in Water @ 25°C	%	Weight Change	-	1.0 [10]
Fungal Resistance	N/A	MIL-STD-810H, Method 508.8	-	No fungal growth to light fungal growth [12]

Internal Data Sources:
[1] FOR9674 [2] FOR9673 [3] FOR12856 [4] FOR12855 [5] GEN527 [6] FOR23214 [7] FOR23215 [8] FOR23216 [9] FOR20590 [10] FOR71108 [11] FOR123413 [12] FOR147612

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WORKFLOW

Validated workflows need to be followed to achieve properties as provided in the TDS. Examples of validated workflow steps are listed below. Users should defer to the most current workflow information for best results which can be found at https://www.loctiteam.com/printer-validation-settings

PRE-MELT REQUIREMENTS

LOCTITE 3D 3955 BK requires pre-melt of material before use. It is recommended to heat it in the provided 1kg container at 80°C for 4 hours or until the resin is fully liquified in the container. Shake container before pouring material into tray.

Pre-Melt material should be kept at 60°C to maintain fluidity and should be used within 2 weeks of melting for best results.

PRINTER SETTINGS

LOCTITE 3D 3955 BK is formulated to print optimally on industrial DLP printer. Read the safety data sheet carefully to get details about health and safety instructions. Recommended print parameters:

- Temperature: **This material must be printed at or above 55°C**.
- Intensity: 3 mW/cm^2 to 7 mW/cm^2

Exposure time for an intensity of 5 mW/cm^2		
Layer Thickness (µm):	50	100
Base Cure Time (s):	20	25
Model Layer Cure Time (s):	2.3	5

CLEANING

LOCTITE 3D 3955 BK requires post processing to achieve specified properties. Prior to post curing, support structures should be removed from the printed part, and the part should then be washed. Use compressed air to remove residual solvent from the surface of the material between intervals.

Post Process Step	Agent	Method	Duration	Intervals	Additional Info
Cleaning Step #1	LOCTITE 3D Cleaner T (at 60°C)	Ultrasonic or manual	30 sec	1 or 2	Preheat LOCTITE 3D Cleaner T to 60°C
Dry	n.a.	Compressed air	10 to 60 sec	1	Air pressure (30psi)
Optional Step #2	Acetone	Rinse (don't soak)	10 sec	1	Rinse residual LOCTITE 3D Cleaner T off parts
Wait before post curing	n.a.		60 min	1	Room temperature

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WORKFLOW

Validated workflows need to be followed to achieve properties as provided in the TDS. Examples of validated workflow steps are listed below. Users should defer to the most current workflow information for best results which can be found at https://www.loctiteam.com/printer-validation-settings

POST CURING

LOCTITE 3D 3955 BK requires post processing to achieve specified properties. A thermal cure is the only curing method required.

1. Place in room temperature oven (25°C) and power on oven
2. Start heating oven with 3°C per minute ramp from 25°C to 190°C
3. Hold temperature of 190°C for 6 hours
4. Increase oven temperature by 3°C per minute ramp from 190°C to 210°C
5. Hold oven temperature for 1 hour at 210°C
6. Turn off oven and allow enclosed oven to cool

- Do not quench or expose to cold air until oven temperature is below 40°C
- If parts have large cross-sectional areas or large solid cross-sections, we recommend slower ramping speeds

ADDITIONAL REMARKS

- User must wear suitable respiratory protection during cleaning process.
- Note: Glycol Ether TPM can be used in lieu of Loctite 3D Cleaner T
- Glycol Ether TPM oxidizes at elevated temperatures over time. Consult the MSDS of TPM and contact the supplier for further guidance. Use appropriate antioxidants and regularly measure peroxide concentration.

LIMITATIONS

Vat Printer: LOCTITE 3D 3955 BK is not compatible with SLA printing process

LCD printers: LOCTITE 3D 3955 BK formula shows limited path forward for LCD projector

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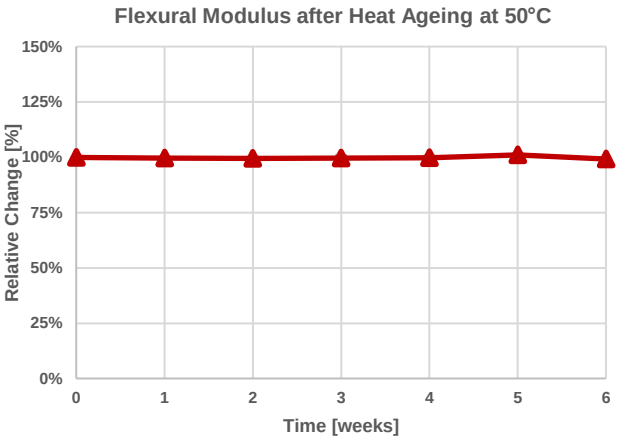
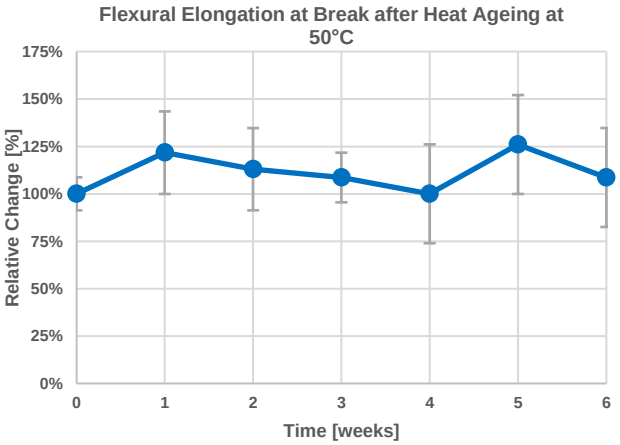
AGEING AND ENVIRONMENTAL EFFECTS – HEAT AGEING

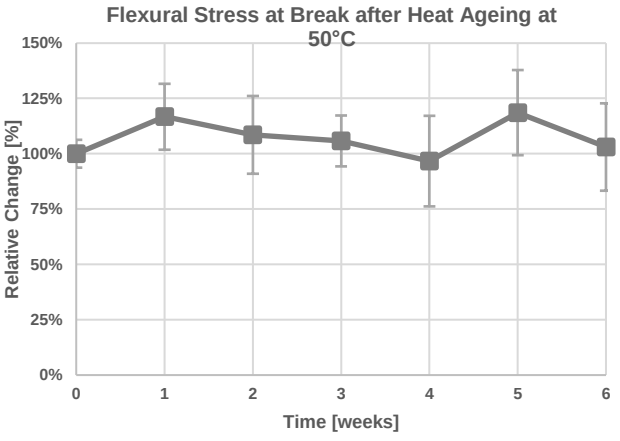
LOCTITE 3D 3955 BK was heat aged without load according to ASTM D3045. Test samples were exposed for a defined time at 50°C and conditioned for 24 hours at 22°C before mechanical testing. Control samples were stored at a constant 22°C. All samples were printed in the same print job using a validated workflow. Mechanical testing was conducted according to ASTM D790 at standard lab conditions (22°C).

"0 weeks" represents non-aged samples stored at 22°C and tested 24 hours after post-processing.

Based on temperature dependence of reaction rates a test time of 6 weeks at 50°C can be interpreted as approximately 12 months at ambient temperature.







Test parameters:
ASTM D790: Test speed: 1.3 mm/min, Test specimens: 85x12x3 mm, Flexural modulus measured at 0.1-1.0% (regression), 22°C

Internal Data Sources:
FOR104205, FOR104206

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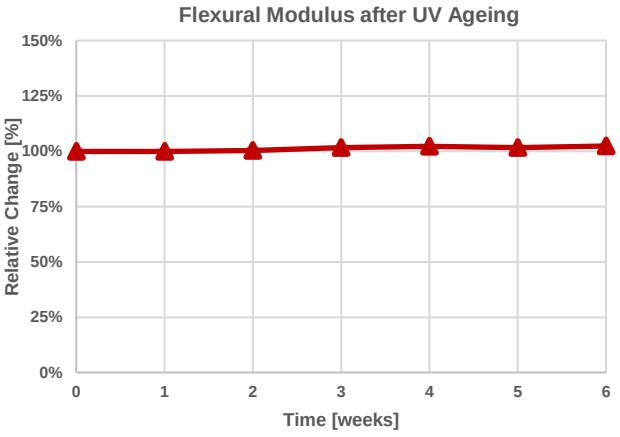
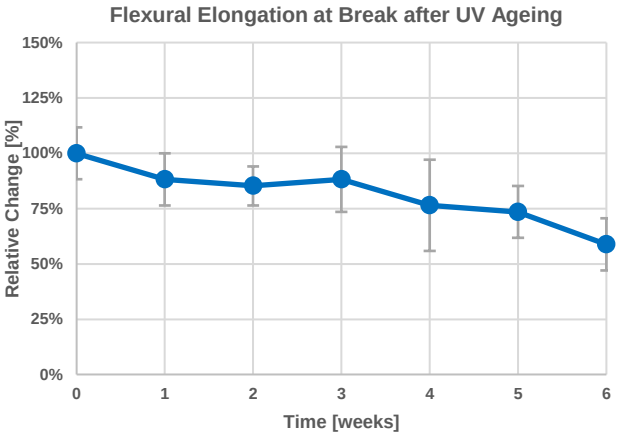
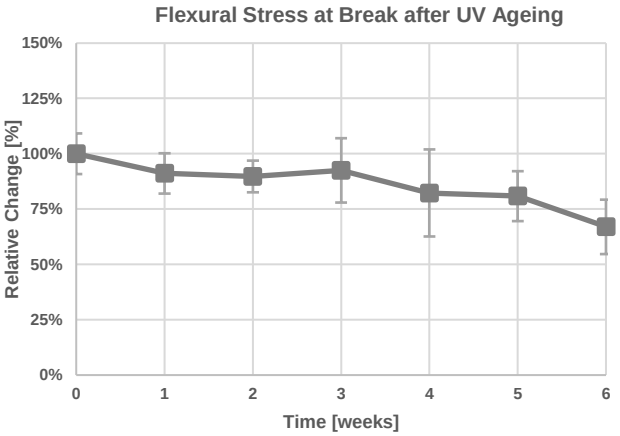
AGEING AND ENVIRONMENTAL EFFECTS – ACCELERATED WEATHERING (UV AGEING)

LOCTITE 3D 3955 BK has been tested after accelerated outdoor weathering according to ASTM D4329 (Cycle A). Test samples were exposed to defined conditions of heat, water condensation and UV light. Exposed samples were conditioned for 24 hours at 22°C before mechanical testing. Control samples were stored at a constant 22°C. All samples were printed in the same print job using a validated workflow. Mechanical testing was conducted according to ASTM D790 at standard lab conditions (22°C). "0 weeks" represents non-aged samples stored at 22°C and tested 24 hours after post-processing.

Please note, accelerated weathering testing can never fully represent real outdoor conditions and complexity. It is therefore recommended to conduct additional (outdoor) testing relevant for your specific application needs.







Test parameters:
ASTM D790: Test speed: 1.3 mm/min, Test specimens: 85x12x3 mm, Flexural modulus measured at 0.1-1.0% (regression), 22°C
ASTM D4329: cycle A for general applications, QUV/se, UVA 340 nm, 0.89 W/m2·nm, 8 hours UV light at 60°C followed by 4 hours at 50°C condensation in the dark. To reduce any sample warpage during test time samples were placed in tailor-made holders without any fixation clamps or mechanical load. Exposed samples were always removed from QUV before next condensation cycle to avoid samples that are soaked excessively with water before testing.

Internal Data Sources:
FOR139389, FOR139395

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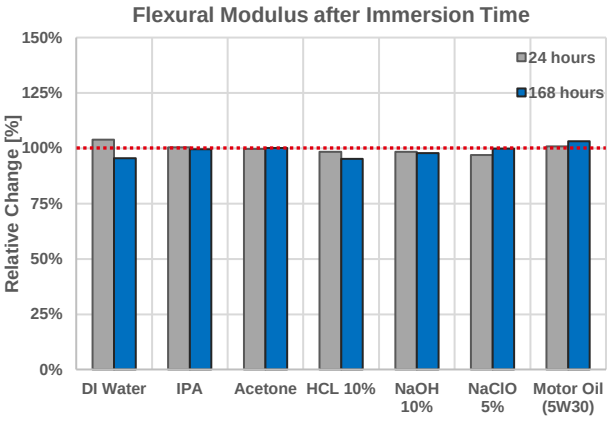
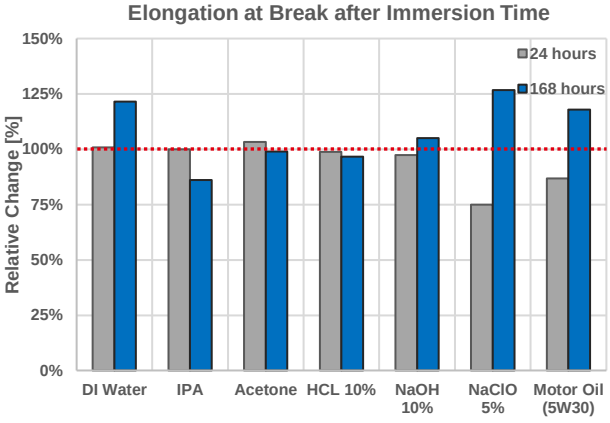
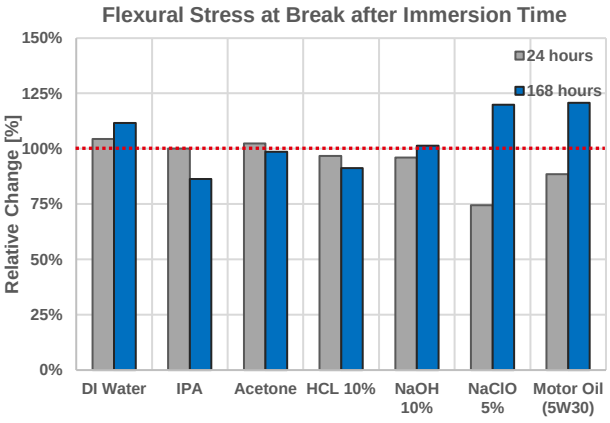
AGEING AND ENVIRONMENTAL EFFECTS – CHEMICAL RESISTANCE (1/2)

LOCTITE 3D 3955 has been tested after chemical ageing according to ASTM D543. The influence of chemicals was tested by measuring mechanical properties after different test times (Immersion test for 24 and 168 hours). Exposed samples were stored in containers and fully immersed in different chemicals. Samples were stirred every 24 hours using a shaker. After removal, exposed samples were washed and conditioned for 24 hours at 22°C before mechanical testing. All samples were printed using a validated workflow. Mechanical testing was conducted according to ASTM D790 at standard lab conditions (22°C). "100%" represents non-aged samples stored at 22°C and tested 24 hours after post-processing.







Test parameters:
ASTM D790: Test speed: 1.3 mm/min, Test specimens: 85x12x3 mm, Flexural modulus measured at 0.1-1.0% (regression), 22°C
ASTM D543: Samples immersed in different chemicals were stored at 22°C. Samples immersed in Motor Oil were stored at 50°C.
Properties of media used: pH(HCl, 10%) = 1; pH(NaOH, 10%) = 14; pH(NaClO, 5%) = 13

Internal Data Sources:
FOR180227, FOR180230, FOR180229, FOR180232, FOR180134, FOR180136, FOR194318

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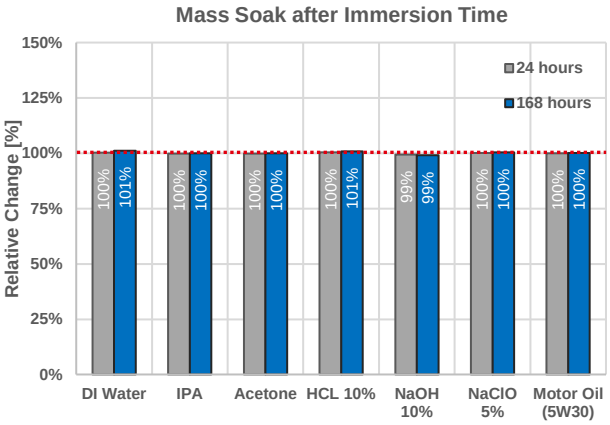
AGEING AND ENVIRONMENTAL EFFECTS – CHEMICAL RESISTANCE (2/2)

LOCTITE 3D 3955 BK has been tested after chemical ageing according to ASTM D543. The influence of chemicals was tested by measuring the mass change after different test times (Immersion test for 24 and 168 hours). Exposed samples were stored in containers and fully immersed in different chemicals. Samples were stirred every 24 hours using a shaker. After removal exposed samples were washed, dried and immediately weighed. All samples were printed using a validated workflow. "100%" represents the initial weight 24 hours after post-processing.



Test parameters:
ASTM D543: Samples immersed in different chemicals were stored at 22°C. Samples immersed in Motor Oil were stored at 50°C.
Properties of media used: pH(HCl, 10%) = 1; pH(NaOH, 10%) = 14; pH(NaClO, 5%) = 13

Internal Data Sources:
FOR180221, FOR180223, FOR180225, FOR180224, FOR180140, FOR180142, FOR194317

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NOTE

The information provided in this Technical Data Sheet (TDS) including the recommendations for use and application of the product are based on our knowledge and experience of the product as at the date of this TDS. The product can have a variety of different applications as well as differing application and working conditions in your environment that are beyond our control. Henkel is, therefore, not liable for the suitability of our product for the production processes and conditions in respect of which you use them, as well as the intended applications and results. We strongly recommend that you carry out your own prior trials to confirm such suitability of our product.
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