

**LOCTITE®**



# **LOCTITE® 3D IND403™**

HDT80 High Modulus

Photo plastic

Black

**LOCTITE®**

Henkel Corporation

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## IND403™

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### LOCTITE 3D IND403™

LOCTITE 3D IND403 is a high temperature resistance material that allows the production of parts with high surface quality and outstanding dimensional accuracy.

LOCTITE 3D IND403 is ideal for tooling production for processes such as silicone casting, low pressure molding and open mold PU molding. The material can withstand mechanical stresses while maintaining dimensional stability for multiple cycles, for fast product development and rapid process iteration.



#### Benefits:

- High heat deflection temperature, HDT 80°C
- Tough with good dimensional stability
- Good surface finish



#### Ideal for:

- Tooling and molds
- Interior applications in automotive



#### Markets:



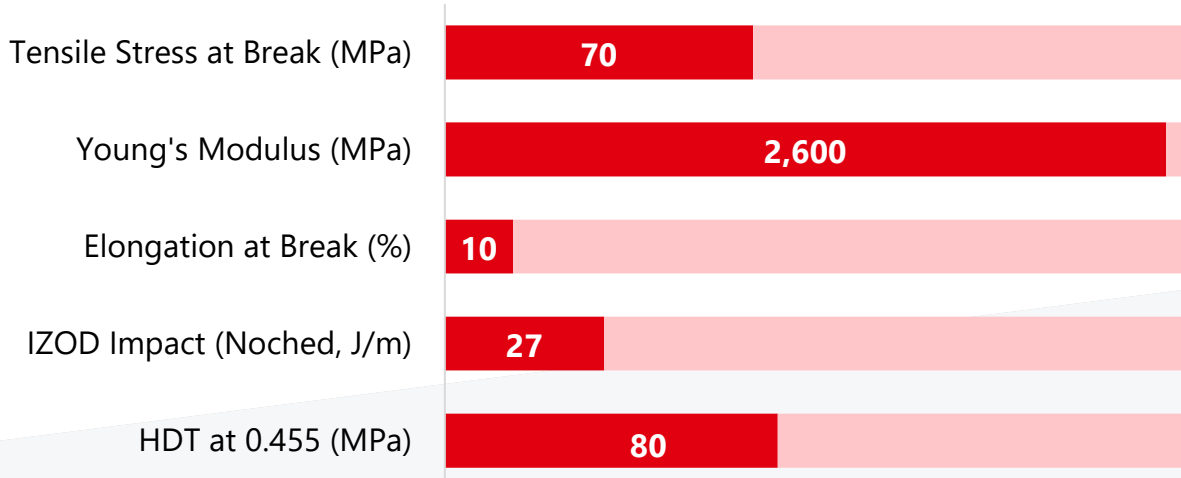
Industry



Automotive



Consumer Goods



*\*Values shown are linked to LOCTITE IND403 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  | 40 ± 3 [1]    | 72 ± 2 [2]     |
| Tensile Stress at Break      | MPa               | ASTM D638  | 32 ± 3 [1]    | 67 ± 3 [2]     |
| Young's Modulus              | MPa               | ASTM D638  | 1777 ± 97 [1] | 2572 ± 31 [2]  |
| Elongation at Break          | %                 | ASTM D638  | 21 ± 3 [1]    | 10 ± 3 [2]     |
| Flexural Modulus             | MPa               | ASTM D790  | 1879 ± 34 [3] | 2654 ± 66 [4]  |
| Flexural Elongation at Break | %                 | ASTM D790  | >5 [3]        | >5 [4]         |
| Flexural Stress at Break     | MPa               | ASTM D790  | -             | -              |
| <b>Other Properties</b>      |                   |            |               |                |
| IZOD Impact (Notched)        | J/m               | ASTM D256  | -             | 27 ± 5 [5]     |
| Shore Hardness (3s)          | D                 | ASTM D648  | 76 [6]        | 78 [7]         |
| Solid Density                | g/cm <sup>3</sup> | ASTM D792  | 1.17 [8]      | 1.20 [8]       |
| Water absorption (24h)       | %                 | ASTM D570  | -             | 1.8 ± 0.2 [9]  |
| Water absorption (72h)       | %                 | ASTM D570  | -             | 4.0 ± 0.3 [9]  |
| Water absorption (168h)      | %                 | ASTM D570  | -             | 5.0 ± 0.1 [9]  |
| T <sub>G1</sub> (Primary)    | °C                | ASTM E831  | -             | 50 – 62 [10]   |
| T <sub>G2</sub> (Secondary)  | °C                | ASTM E831  | -             | 92 – 94 [10]   |
| CTE (< T <sub>G1</sub> )     | µm/(m·K)          | ASTM E831  | -             | 72 – 76 [10]   |
| CTE (> T <sub>G2</sub> )     | µm/(m·K)          | ASTM E831  | -             | 134 – 146 [10] |
| <b>Liquid Properties</b>     |                   |            |               |                |
| Viscosity at 25°C (77°F)     | cP                | ASTM D7867 | -             | 100 – 200 [11] |
| Liquid Density               | g/cm <sup>3</sup> | ASTM D1475 | -             | 1.08 [12]      |

**Test parameters:**

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

**Internal Data Sources:**

[1] FOR22924 [2] FOR22926 [3] FOR16923 [4] FOR20444 [5] FOR16913 [6] FOR16912 [7] FOR16911 [8] FOR16928 [9] FOR51810 [10] FOR90709 [11] FOR16921 [12] FOR16910





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## PROPERTIES

| Thermal Properties   | Measure  | Method     | Green | Post Processed              |
|----------------------|----------|------------|-------|-----------------------------|
| HDT at 0.455 MPa     | °C       | ASTM D648  | -     | 82 ± 1 <sup>[13]</sup>      |
| HDT at 1.82 MPa      | °C       | ASTM D648  | -     | 65 ± 1 <sup>[14]</sup>      |
| Thermal Conductivity | mW/(m·K) | ASTM D5930 | -     | 222 ± 2 <sup>[15]</sup>     |
| Heat Capacity        | J/(g·K)  | ASTM D5930 | -     | 1.46 ± 0.08 <sup>[15]</sup> |

| Electrical Properties                          | Measure | Method    | Green | Post Processed           |
|--|---------|-----------|-------|--------------------------|
| Dielectric Strength                            | kV/mm   | ASTM D149 | -     | 25 ± 1 <sup>[16]</sup>   |
| Volume Resistivity                             | Ω·cm    | ASTM D257 | -     | 2.5 E+15 <sup>[17]</sup> |
| Surface Resistivity                            | Ω       | ASTM D257 | -     | 1.9 E+15 <sup>[17]</sup> |
| AC Relative Permittivity (Dielectric Constant) |         |           |       |                          |
| at 50 Hz                                       | none    | ASTM D150 | -     | 4.7 <sup>[18]</sup>      |
| at 1 kHz                                       | none    | ASTM D150 | -     | 4.5 <sup>[19]</sup>      |
| at 1 MHz                                       | none    | ASTM D150 | -     | 4.0 <sup>[20]</sup>      |
| AC Loss Characteristic (Dissipation Factor)    |         |           |       |                          |
| at 50 Hz                                       | none    | ASTM D150 | -     | 0.014 <sup>[18]</sup>    |
| at 1 kHz                                       | none    | ASTM D150 | -     | 0.014 <sup>[19]</sup>    |
| at 1 MHz                                       | none    | ASTM D150 | -     | 0.040 <sup>[20]</sup>    |

Internal Data Sources:

<sup>[13]</sup> FOR19730 <sup>[14]</sup> FOR16920 <sup>[15]</sup> FOR26106 <sup>[16]</sup> FOR25879 <sup>[17]</sup> FOR25878 <sup>[18]</sup> FOR254522 <sup>[19]</sup> FOR25877 <sup>[20]</sup> FOR254521



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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>

## PRINTER SETTINGS

LOCTITE 3D IND403 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:

- Shake resin bottle well before usage
- Temperature: 20°C to 45°C
- Intensity: 3 mW/cm<sup>2</sup> to 7 mW/cm<sup>2</sup>

| Settings: 385nm at 6 mW/cm <sup>2</sup> | Measure | Method   | Value |
|---|---------|----------|-------|
| Layer Thickness                         | µm      | Internal | 100   |
| First Layer                             | s       | Internal | 120   |
| Burn-in Region                          | s       | Internal | 15    |
| Model Layer Cure Time                   | s       | Internal | 6.5   |

| Settings: 385nm at 5 mW/cm <sup>2</sup> | Measure            | Method   | Value                |
|---|--------------------|----------|----------------------|
| E <sub>C</sub>                          | mJ/cm <sup>2</sup> | Internal | 7.26 <sup>[21]</sup> |
| D <sub>p</sub>                          | mm                 | Internal | 0.12 <sup>[21]</sup> |

| Settings: 385nm at 5 mW/cm <sup>2</sup> | Measure | Method   | Exposure time |
|---|---------|----------|---------------|
| D <sub>C</sub> = 50µm                   | s       | Internal | 2.3*          |
| D <sub>C</sub> = 100µm                  | s       | Internal | 3.40*         |

Internal Data Sources:  
<sup>[21]</sup> GEN198946  
Exposure times are calculated without a safety factor





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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>

## CLEANING

**LOCTITE 3D IND403 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                | IPA   | Ultra sonic bath  | 2 min      | 1 or 2    | Allow parts to dry between intervals |
| Dry                     | n.a.  | Compressed air    | 10 to 60 s | 1 or 2    | Air pressure (50psi)                 |
| Wait before post curing | n.a.  | Ambient condition | 60 min     | 1         | Room temperature                     |

## POST CURING

**LOCTITE 3D IND403 BK** requires post curing to achieve specified properties. It is recommended that either an LED or wide spectrum lamp be used to post cure parts.

| UV Curing Unit      | UV Source                         | Intensity                        | Cure time per side | Additional Settings (Shelf, Output Energy) |
|---------------------|-----------------------------------|----------------------------------|--------------------|--|
| Loctite CL36        | 405nm LED                         | 80 mW/cm <sup>2</sup> at 405 nm  | 20 min             | 100% top & side                            |
| Loctite UVALOC 1000 | Mercury Arc Bulb (broad spectrum) | 30 mW/cm <sup>2</sup> at 365 nm  | 5 min              | 500 W, lowest shelf                        |
| Dymax 5000 EC Flood | Mercury Arc Bulb (broad spectrum) | 150 mW/cm <sup>2</sup> at 380 nm | 4 min              | 400W, Shelf K                              |

## STORAGE

Store **LOCTITE 3D IND403 BK** in the unopened container in a dry location. Optimal Storage: 8°C to 30°C. Storage below 8°C or above 30°C can adversely affect product properties. Material removed from containers may be contaminated during use. For this reason, filter used resin with 190µm mesh filter before placing back into proper storage container.





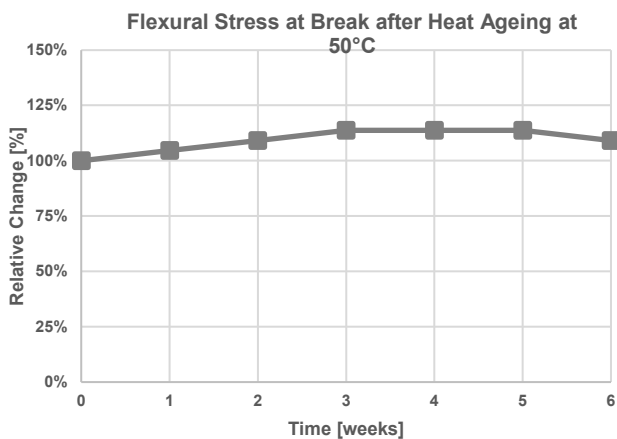
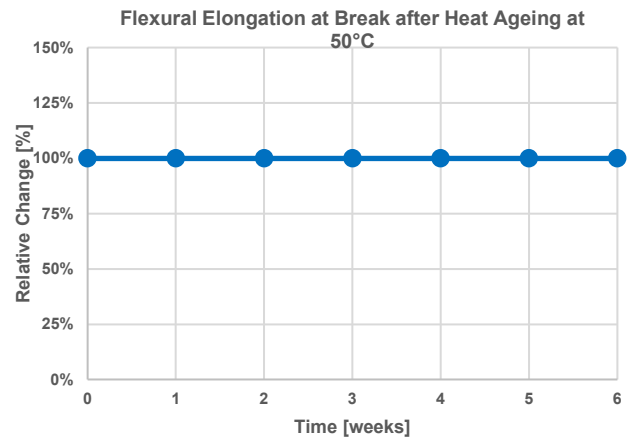
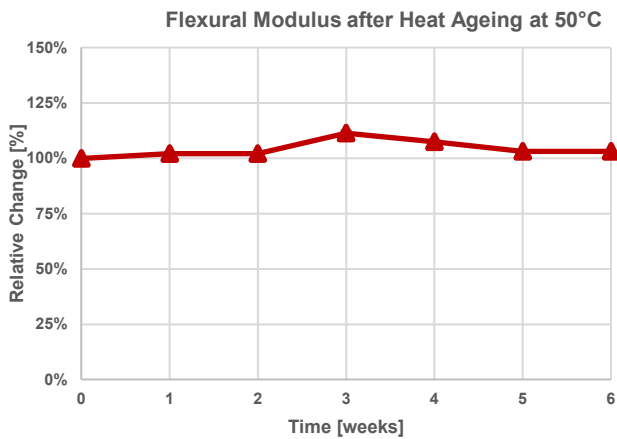
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## AGEING AND ENVIRONMENTAL EFFECTS – HEAT AGEING

LOCTITE 3D IND403 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:  
[FOR103717](#), [FOR103718](#)





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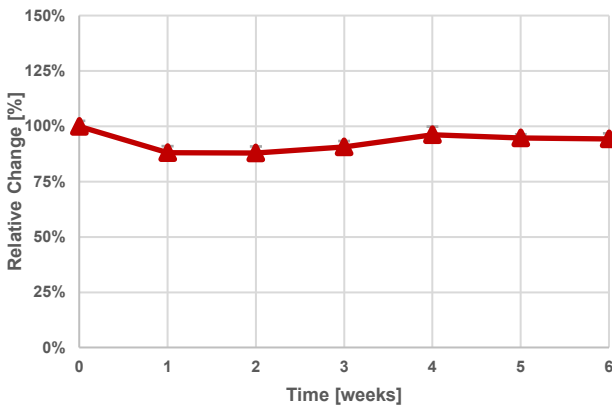


## AGEING AND ENVIRONMENTAL EFFECTS – ACCELERATED WEATHERING (UV AGEING)

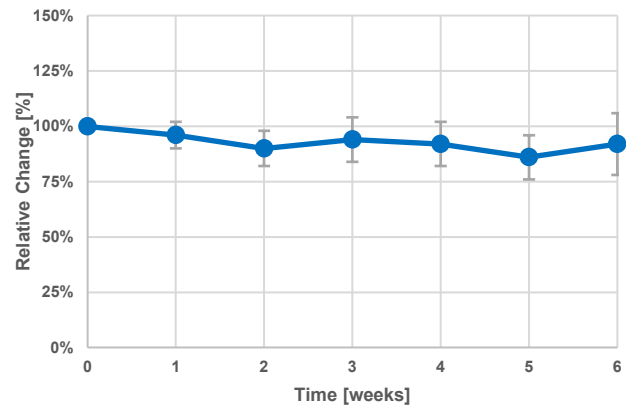
LOCTITE 3D IND403 BK has been tested after accelerated outdoor weathering according to ASTM D4329 (Cycle A). Test samples were exposed to defined conditions of heat, water condensation and UV light. Exposed samples were conditioned for 24 hours at 22°C before mechanical testing. Control samples were 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.

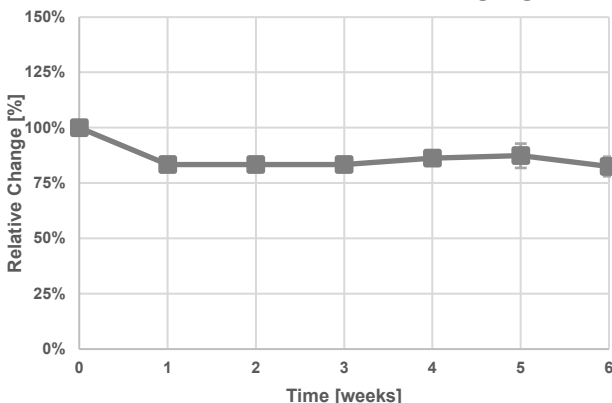
Flexural Modulus after UV Ageing



Flexural Elongation at Break after UV Ageing



Flexural Stress at Break after UV Ageing



### 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/m<sup>2</sup>·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:  
[FOR148177](#), [FOR148236](#)







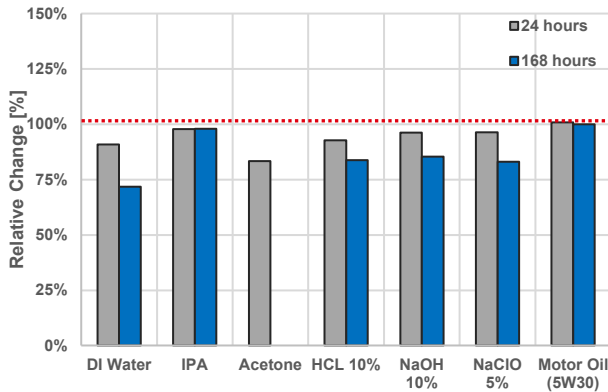
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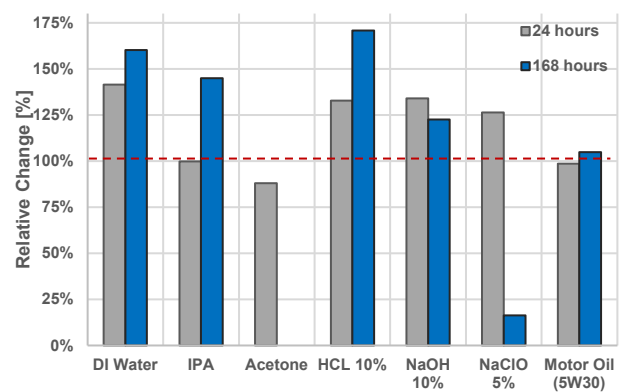
## AGEING AND ENVIRONMENTAL EFFECTS – CHEMICAL RESISTANCE (1/2)

LOCTITE 3D IND403 BK 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 D638 at standard lab conditions (22°C). "100%" represents non-aged samples stored at 22°C and tested 24 hours after post-processing.

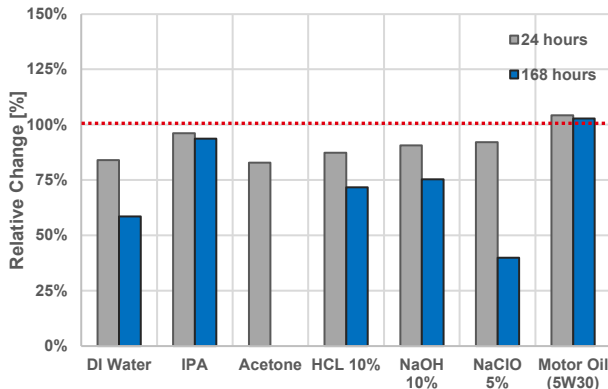
Young's Modulus after Immersion Time



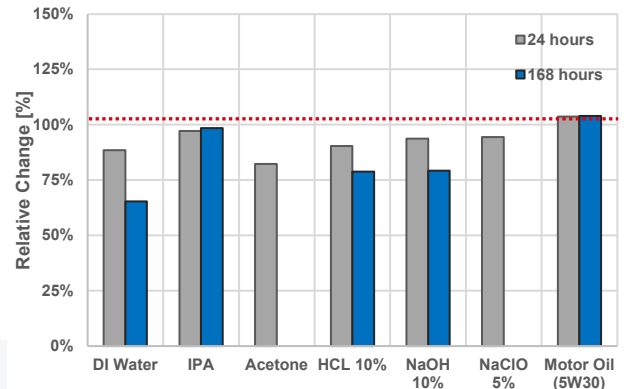
Elongation at Break after Immersion Time



Stress at Break after Immersion Time



Stress at Yield after Immersion Time



### Test parameters:

ASTM D638: Type IV, Pull speed: 5 mm/min, 22°C

ASTM D543: Samples immersed in different chemicals were stored at 22°C. Samples immersed in Motor Oil were stored at 50°C

**Comment:** The samples after 168 h after the immersion in Acetone were not possible to test, therefore there is no value for this immersion time

### Internal Data Sources:

[FOR282116](#), [FOR282127](#), [FOR282131](#), [FOR282134](#), [FOR288317](#), [FOR288318](#), [FOR288320](#)



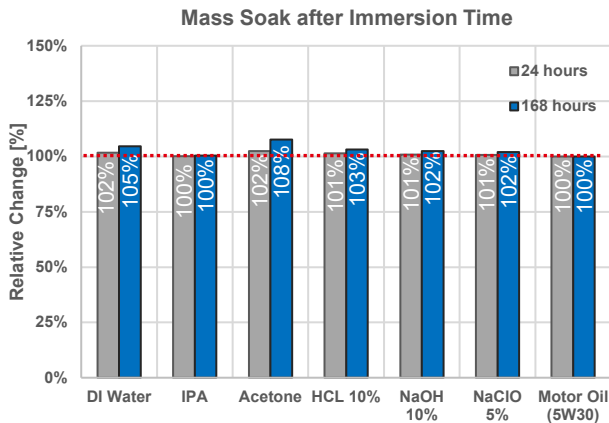


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## AGEING AND ENVIRONMENTAL EFFECTS – CHEMICAL RESISTANCE (2/2)

LOCTITE 3D IND403 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.

### Internal Data Sources:

[FOR282136](#), [FOR282146](#), [FOR282148](#), [FOR282174](#), [FOR288321](#), [FOR288322](#), [FOR288323](#)





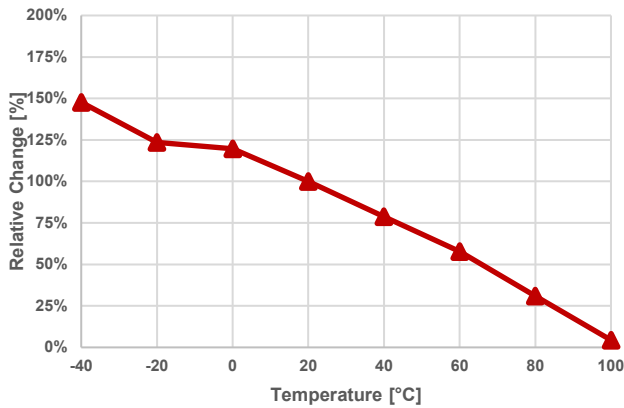
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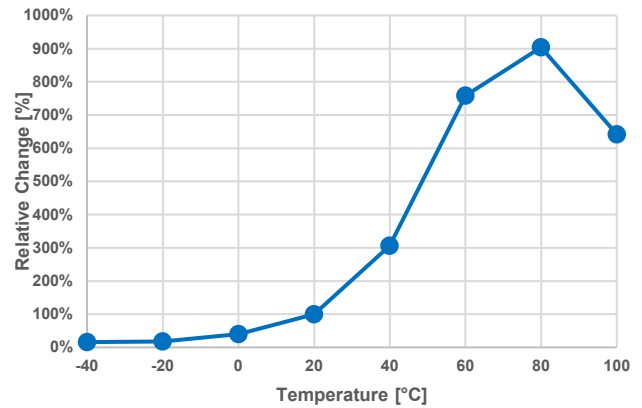
## THERMAL INFLUENCE ON MECHANICAL PROPERTIES

LOCTITE 3D IND403 BK has been tested according to ASTM D638 at varied environmental temperatures, from -40°C to 100°C. All samples were printed in the same print job using a validated workflow. Mechanical testing was conducted according to ASTM D638. Before each test series samples were conditioned for 60 minutes at the specific test temperature.

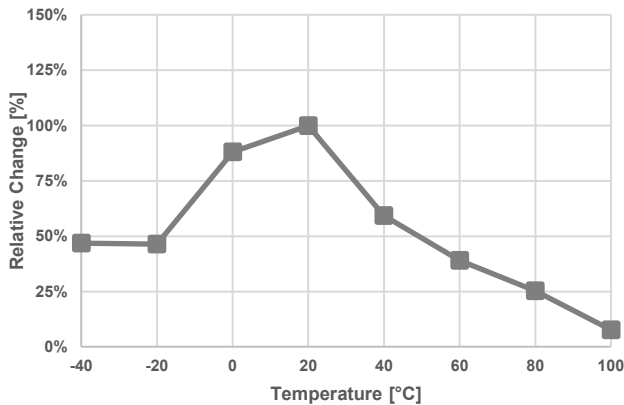
Young's Modulus at -40°C to 100 °C



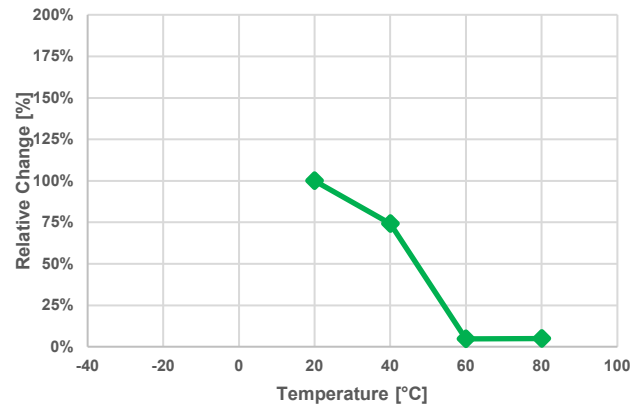
Elongation at Break at -40°C to 100 °C



Stress at Break at -40°C to 100 °C



Stress at Yield at -40°C to 100 °C



### Test parameters:

ASTM D638, Type IV, Pull speed: 5 mm/min, Young's modulus measured at 0.1-1% (regression),

Internal Data Sources:  
[FOR101977](#)



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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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