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Ultracur3D® RG 35

Rigid | HDT 80 | Clear

Extended TDS

Complete Technical Documentation and Testing Summary

Version 3.1

Contents

Are you looking for an updated TDS version? Check out the latest online version here.

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Technical Data Sheet

Rigid resin with optimum combination of strength, stiffness and temperature resistance.

General Properties	Method	Typical Values
Appearance	-	Clear
Viscosity, 25°C	Cone/Plate Rheometer[1)]	900 mPas
Viscosity, 30°C	Cone/Plate Rheometer[1)]	600 mPas
Density (Printed Part)	ASTM D792	1.2 g/cm³
Density (Liquid Resin)	ASTM D4052-18a	1.12 g/cm³

Tensile Properties[2)]	Method	Typical Values
E Modulus	ASTM D638	2600 MPa
Ultimate Tensile Strength	ASTM D638	80 MPa
Elongation at Break	ASTM D638	6%

Flexural Properties	Method	Typical Values
Flexural Modulus	ASTM D790	2400 MPa
Flexural Strength	ASTM D790	110 MPa

Impact Properties	Method	Typical Values
Notched Izod (Machined), -30°C	ASTM D256	11 J/m
Notched Izod (Machined), 23°C	ASTM D256	23 J/m
Unnotched Izod, 23°C	ASTM D4812	115 J/m
Notched Charpy (Machined), 23°C	ISO 179-1	0.6 kJ/m²

Thermal Properties	Method	Typical Values
HDT at 0.45 MPa	ASTM D648	83°C
HDT at 1.82 MPa	ASTM D648	64°C
Glass transition temperature (DMA, tan(d))	ASTM D4065	119°C

Fire, Smoke, Toxicity (FST) properties	Method	Typical Values
Flammability	UL 94	HB (1.5 mm)
Glow-wire Test	IEC 60695-2-12/-13 (2 mm)	GWIT: 650°C GWFI: 625°C

Dielectric/Electric Properties	Method	Typical Values
Dielectric Strength	DIN EN 60243-1	37 kV / mm

Biocompatibility	Method	Typical Values
Cytotoxicity – Neutral Red	EN ISO 10993-5 (2009)	PASS[4)]
Human Skin Irritation[3)]	EN ISO 10993-10 (2013)	PASS[4)]
In Vivo Sensitization – Local Lymph Node Assay	ISO 10993-10 (2013); OECD Guideline No. 429	PASS[4)]
In Vitro Skin Irritation	OECD Guideline No. 439	PASS[4)]
Systemic Toxicity – In Vitro Endotoxins and Pyrogens Detection	EN ISO 10993-11 (2018)	PASS[4)]

Other	Method	Typical Values
Hardness Shore D	ASTM D2240	85
Water Absorption, Short-Term (24 hours)	ASTM D570	0.33%
Water Absorption, Long-Term (>4000 hours)	ASTM D570	2.40%

Mechanical properties overview

1) Determined with TA-Instrument DHR rheometer, cone/plate, diameter 60 mm, shear rate 100 s^{-1}
2) Tensile type ASTM D638 type IV, Pulling speed 50 mm/min
3) Patch test on 10 volunteers
4) For the statement on Biocompatibility data see Chapter: Biocompatibility.
5) If not noted otherwise, all specimens are 3D printed. Samples were tested at room temperature, 23°C. ASTM sample size (L x W x H): ASTM D790 80 x 4 x10 mm, ASTM D256 63 x 3.2 x 12 mm, ASTM D4812 63 x 3.2 x 12 mm, ASTM D648 127 x 3.2 x 13 mm, ISO 179-1 80 x 4 x 10 mm, UL 94 125 x 1.5 x 13 mm, IEC 60695-2-12/-13 60 x 2 x 60 mm.

International Material Data System (IMDS)

This material is listed in the IMDS (International Material Data System), which contains information on materials used in the automotive industry. Access to the database can be granted on request by sharing the IMDS ID with us (sales@forward-am.com).

Printing Performance

The combination of 3D printer and material has a huge impact on the quality of the parts produced. The measured design characteristics as well as the printing speed can be found in the Printing Evaluation Guideline of Ultracur3D® Resins.

Material Model & FEA Simulation

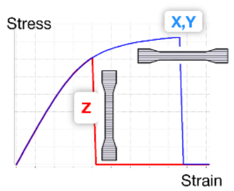
FEA simulation can be used to predict how different parameters such as temperature and mechanical stress affect the final printed parts. This information can be used to significantly expedite application development, and to optimize the part design to ensure all performance requirements for the application are met. In order to run simulations with a specific material, a material model is required. This model is generated based on a wide range of testing data under different loads and at different temperatures and other relevant conditions.

We can support you with 3D simulation in different ways, ranging from simply supplying you with raw test data, to doing the full simulation for you. These are the 3 options we offer:

Raw Material Data

Starter:

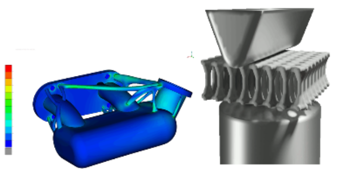
Get the curves behind our TDS data to start basic simulation work.



3D Simulation

Premium:

We run the simulation for you. We help you to speed up your engineering process and increases confidence in part performance using a digital twin of your part.

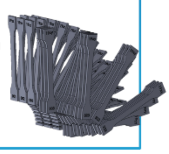


Material Model as a Service

Enterprise:

Use our in-house developed material models for 3D-Printing incl. anisotropy of the process and FEA support of our experienced virtual engineers.

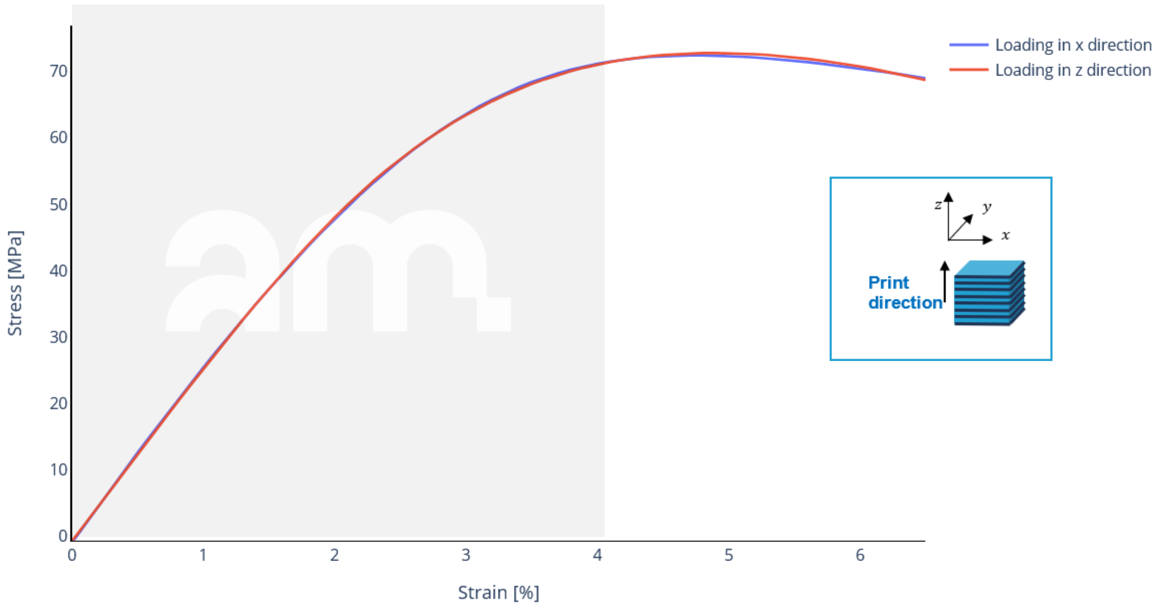
- Anisotropic
- Nonlinear
- Strain-rate sensitive
- Tensile-compression asymmetry
- Failure modelling
- Temperature dependent



For Ultracur3D® RG 35, below you can find some of the data we have available in our Ultrasim® Material Model or that we could provide to you for your own simulations. More information is available on request (sales@forward-am.com).

	Available temperatures			Strain rate / loads	
	Low	23°C	High	Quasi static	High speed
Ultracur3D® RG 35		●		●	

● Validated, available as Material Data Set (can be converted into a Ultrasim® Material Model)
● Validated, available via Ultrasim® Material Model
○ ○ Preliminary



Stress-strain response of Ultracur3D® RG 35 under quasi static load, at room temperature.

Warning: The description of polymer materials under large strains with standard hyperelastic material models (Mooney-Rivlin, Ogden, Polynomial type) offered by common FEM programs/solvers can lead to significant deviations from the experimentally observed mechanical response. To achieve realistic simulation results extended models have to be considered to account for effects like strain rate dependence, viscous behavior, strain softening (Mullins Effect) and permanent deformation. Forward AM has developed such models which are made available via Ultrasim® to support our customers with high confidence simulations.

Additional material data available on request

- **Quasi static Raw data (.csv/ASCII)**
- **Low temperature performance**
- **High temperature performance**
- **Higher strain rate performance**
- **Additional load cases (x,y,z,xy)**

Request raw data for internal use via
sales@forward-am.com
or your key account

See full material overview under:
Material data overview

For more information visit :
Ultrasim® 3D Simulation (FEA) (forward-am.com)

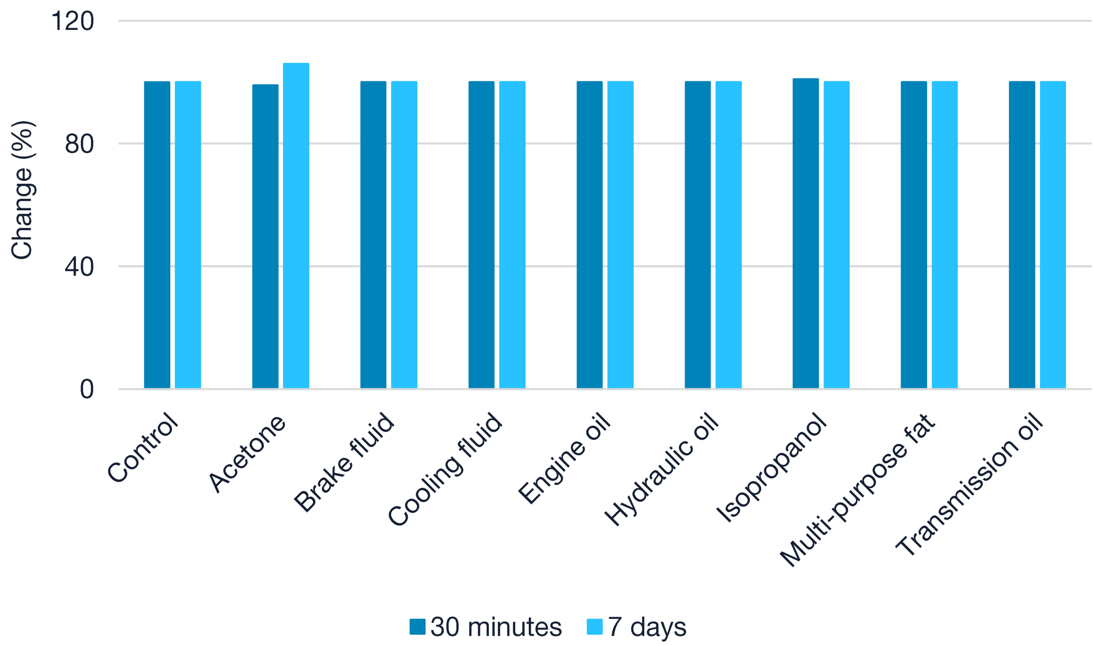
Industrial Chemical Resistance

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.

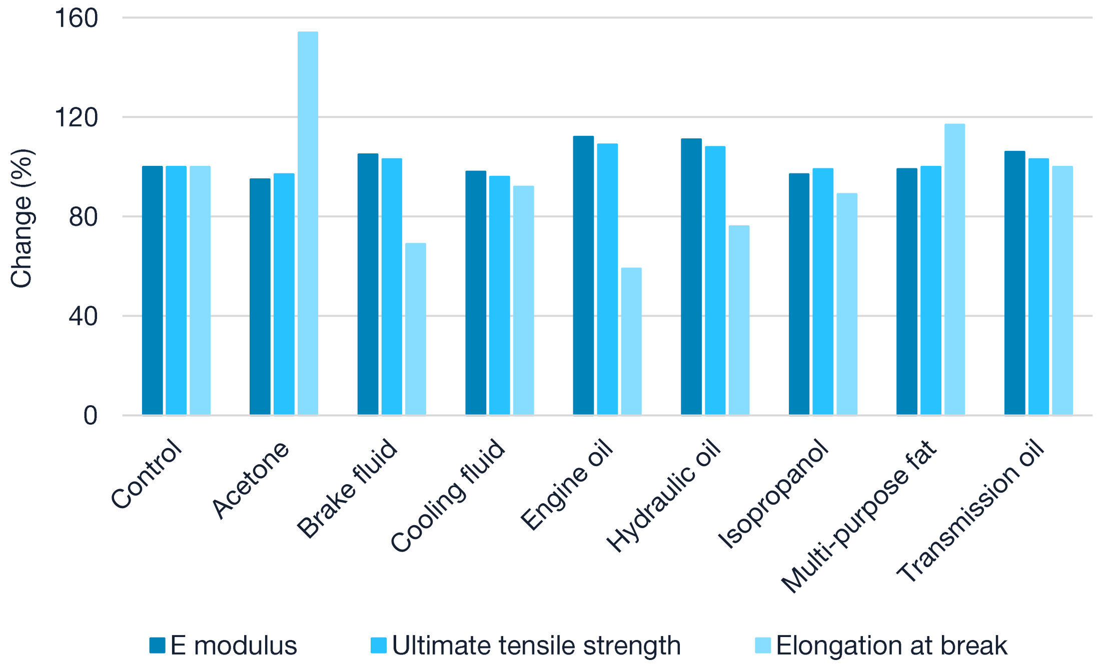
Weight Measurement



Change in weight after immersion time

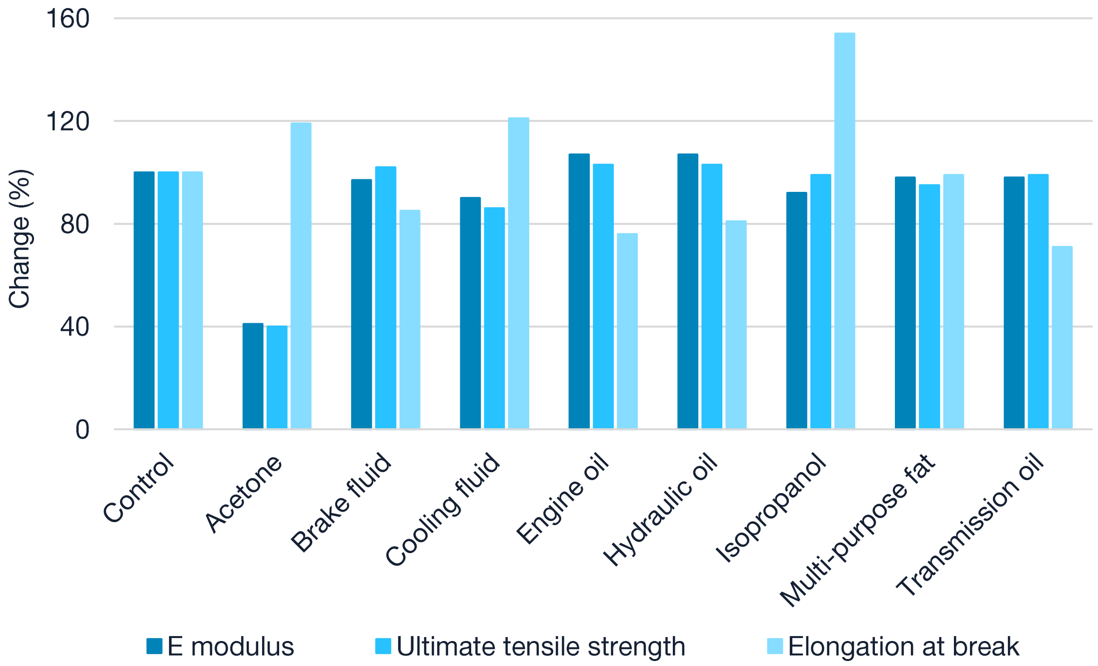
Mechanical Testing

30 minutes



Change in mechanical properties after 30 minutes immersion

7 days



Change in mechanical properties after 7 days immersion

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Long-Term UV

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 aging can be caused by the influence of UV light, heat and water. The degree of ageing depends on duration and intensity.

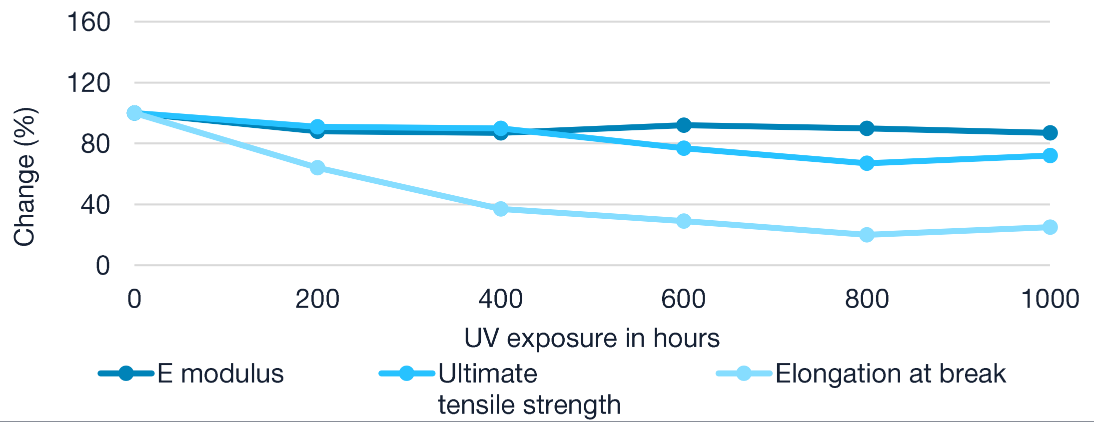
Test Method and Specimens

The ageing tests were performed with ASTM D638 type IV tensile bars and color cones as per ISO 4892-2:2013 method A, cycle 1.

Cycle No.	Exposure period	Irradiance		Black standard tempera-ture in °C	Chamber tempera-ture in °C	Relative humidity in %
		Broadband (300 nm to 400 nm) in W/m²	Narrowband (340 nm) in W/(m² 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	2870 MPa	2510 MPa
Ultimate tensile strength	70 MPa	50 MPa
Elongation at break	10%	2%

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

Coloration

After being exposed up to 1000 hours, only slight additional yellowing compared to the reference sample could be detected.

Effect of UV exposure on color of the specimens

Post-Processing

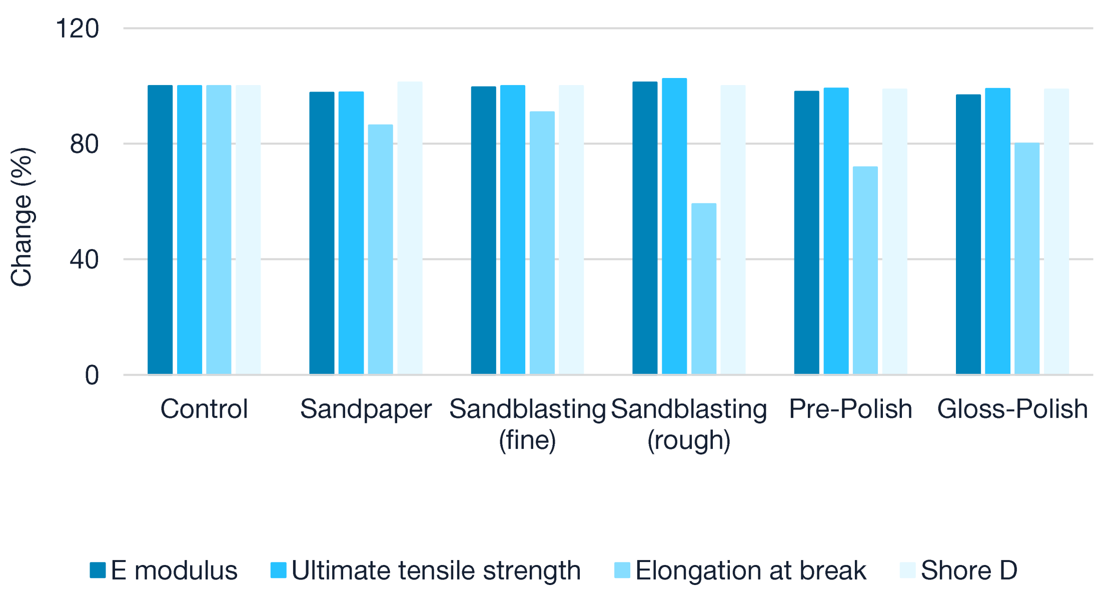
Some applications may require adequate post-processing to smoothen the surface from support structures as well as to enhance the visual appearance. The post-processing can be achieved through manual or automatic grinding, smoothing, polishing, sandblasting or else. A special test was conducted to observe the change in mechanical properties and appearance.

Test Method and Specimens

ASTM D638 type IV tensile bars and Shore D samples were prepared manually with five different post-process methods after full UV post-curing.

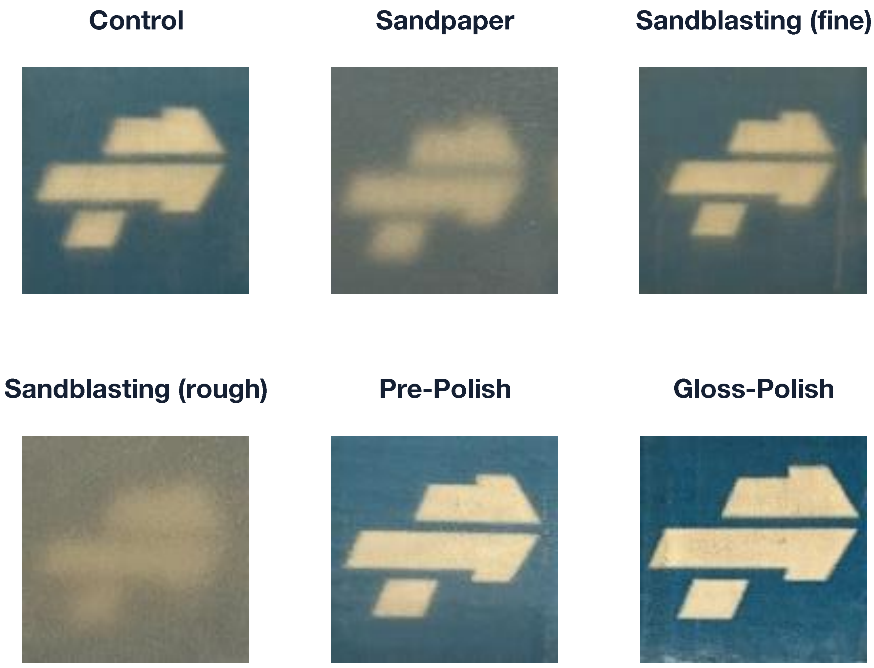
Sample	Details
Sandpaper	Sandpaper with Granulation 320
Sandblasted (fine)	Blasting sand 50 µm (400-200 mesh)
Sandblasted (rough)	Blasting sand 125 µm (115 mesh)
Pre-Polish	Insert brush (SCOTCH BRITE) with Pumice powder
Gloss-Polish	Nettle buff with polishing paste

Mechanical Testing



Change in mechanical properties after post-processing

Surface appearance



Change of Surface appearance with Logo as background

Change of Surface appearance with dark background

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Sterilization

Sterilization is an essential requirement in many applications especially when used in the medical field. Testing not only ensures the material quality but also determines how effectively the chosen sterilization process is eliminating potential microorganisms.

Test Method and Specimens

Four different sterilization techniques were tested according to the conditions listed below, and their effect on mechanical properties and part color was investigated.

E-Beam Sterilization

The samples were exposed to 36.04 – 39.26 kGy (calculated dose).

Ethylene Oxide (EtO) Sterilization

EtO sterilization parameters	Settings
Preconditioning temperature	48°C
Preconditioning humidity	60%
Preconditioning time	8 hours
Chamber temperature	45°C
Vacuum	75 mbar A
EO dwell time	3 hours
EO concentration (calculated)	610 mg/l
Postconditioning time	48 hours
Postconditioning temperature	45°C

Testing conditions Ethylene Oxide

Gamma Sterilization

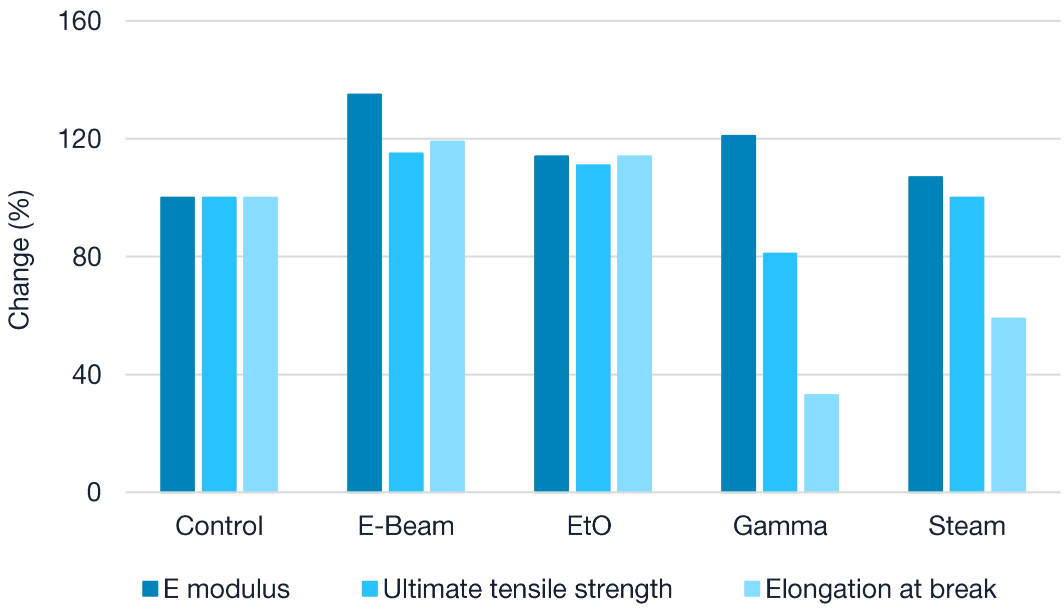
The samples were exposed to 37.1 – 37.5 kGy gamma radiation (measured via dosimeter).

Steam Sterilization

Steam sterilization parameters	Settings
Vacuum pulses	4
Temperature	134°C
Pressure	210 kPa
Holding time	4 minutes
Drying time	20 minutes

Testing conditions steam sterilization

Mechanical Testing



Change in mechanical properties after sterilization

Coloration

Depending on the sterilization process used, different changes in color could be observed as shown below.

Color discs before and after sterilization

Biocompatibility

Product: Ultracur3D® RG 35

Revision: 29th of March 2021

3D printed test items of the above stated product have fulfilled the requirements of tests as stated below:

Cytotoxicity Testing- Neutral Red:

(EN ISO 10993-5 (2009))

Human Skin Irritation Test:

(EN ISO 10993-10 (2013))[6)]

In Vivo Sensitization Testing- Local Lymph Node Assay:

(ISO 10993-10 (2013); OECD Guideline No. 429)

In Vitro Skin Irritation Testing:

(OECD Guideline No. 439)

Systemic Toxicity - In Vitro Endotoxins and Pyrogens Detection:

(EN ISO 10993-11 (2018))

6) Patch test on 10 volunteers.

The biocompatibility tests were recorded on test specimen of the referenced product to show compatibility of the material in general. The biocompatibility tests listed are not part of any continuous production protocol. The test assessments reflect only the test specimen and have to be retested on the final product. It remains the responsibility of the de-vice manufacturers and /or end-users to deter-mine the suitability of all printed parts for their respective application.