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Ultracur3D[®] ST 45

Tough | Fast | Clear

Extended TDS

Complete Technical Documentation
and Testing Summary

Version 3.2

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Are you looking for an updated TDS version? [Check out the latest online version here.](#)

Technical Data Sheet

Multi-purpose resin with optimum toughness and processing speed.

The data contained in this publication is based on our current knowledge and experience. In view of the many factors that may affect processing and application of our product, this data does not relieve processors from carrying out their own investigations and tests; neither does this data imply any guarantee of certain properties, nor the suitability of the product for a specific purpose.

Any descriptions, drawings, photographs, data, proportions, weights etc. given herein may change without prior information and do not constitute the agreed contractual quality of the product. It is the responsibility of the recipient of our products to ensure that any proprietary rights and existing laws and legislation are observed.

The safety data given in this publication is for informational purposes only and does not constitute a legally binding MSDS. The relevant MSDS can be obtained upon request from your supplier or you may contact Forward AM Technologies GmbH directly at sales@forward-am.com.

General Properties	Method	Typical Values
Appearance	-	Clear
Viscosity, 25°C	Cone/Plate Rheometer ¹⁾	320 mPas
Viscosity, 30°C	Cone/Plate Rheometer ¹⁾	210 mPas
Density (Printed Part)	ASTM D792	1.2 g/cm ³
Density (Liquid Resin)	ASTM D4052-18a	1.12 g/cm ³

Tensile Properties ²⁾	Method	Typical Values
E Modulus	ASTM D638	2300 MPa
Ultimate Tensile Strength	ASTM D638	60 MPa
Elongation at Break	ASTM D638	25%

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	20 J/m
Notched Izod (Machined), 23°C	ASTM D256	30 J/m
Unnotched Izod, 23°C	ASTM D256	509 J/m
Notched Charpy (Machined), 23°C	ISO 179-1	1.3 kJ/m ²

Thermal Properties	Method	Typical Values
HDT at 0.45 MPa	ASTM D648	73°C
HDT at 1.82 MPa	ASTM D648	61°C
Glass transition temperature (DMA, tan(d))	ASTM D4065	91°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

Automotive	Norm	Typical Values
Volatile Organic Compounds Automotive (VOC)	VDA 278	246 ppm
Fogging Automotive (FOG)	VDA 278	59 ppm
Fogging Automotive (FOG)	DIN 75201B	1.03 mg

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⁾

Other	Method	Typical Values
Hardness Shore D	ASTM D2240	80
Water Absorption, Short-Term (24 hours)	ASTM D570	>5%

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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 5 mm/min
- 3) Patch test on 30 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 x 10 mm, ASTM D256 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).

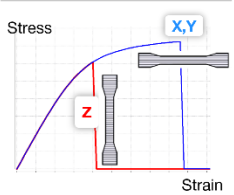
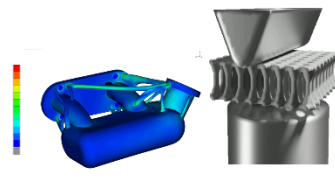
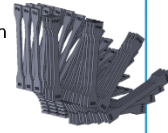
Printing Performance

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.

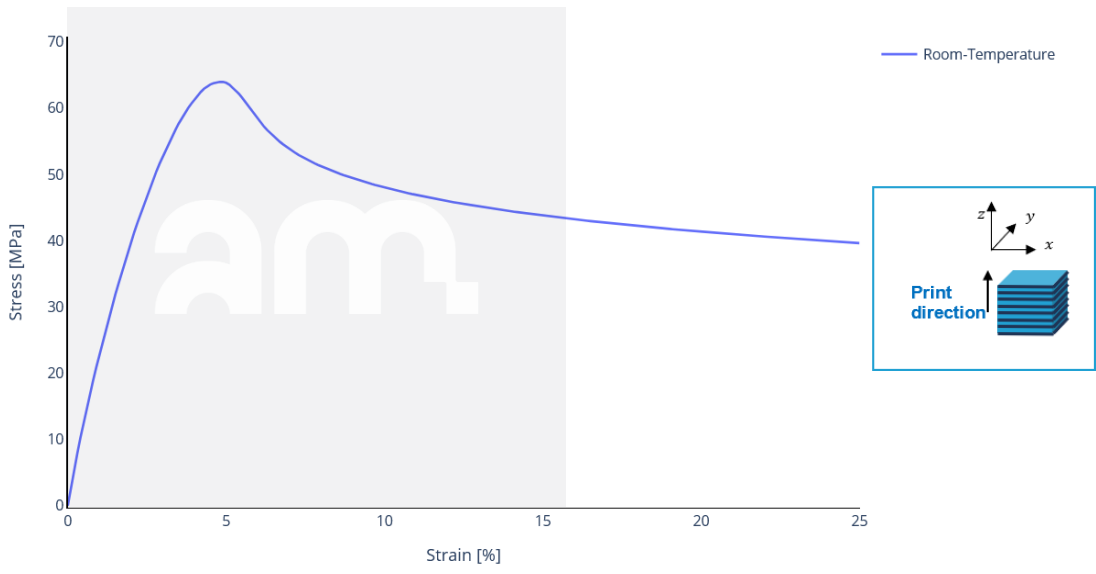
We can support you with 3D simulation in different ways, ranging from simply supplying you with raw test data, to doing the full simulation for you. These are the 3 options we offer:

Raw Material Data	3D Simulation	Material Model as a Service
<p>Starter: Get the curves behind our TDS data to start basic simulation work.</p> 	<p>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.</p> 	<p>Enterprise: Use our in-house developed material models for 3D-Printing incl. anisotropy of the process and FEA support of our experienced virtual engineers.</p> <ul style="list-style-type: none"> ■ Anisotropic ■ Nonlinear ■ Strain-rate sensitive ■ Tensile-compression asymmetry ■ Failure modelling ■ Temperature dependent 

For Ultracur3D® ST 45, 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® ST 45		●		●	

- 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® ST 45 under quasi static load, loaded in x direction, 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.

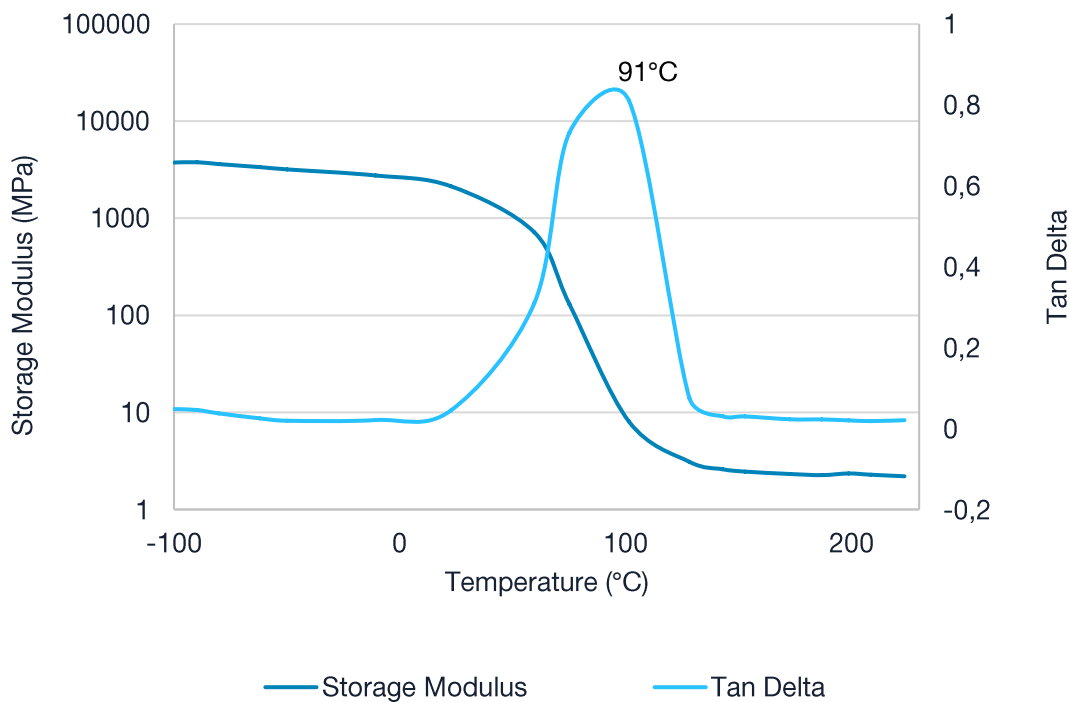
Additional material data available on request	Quasi static Raw data (.csv/ASCII)	<p>Request raw data for internal use via sales@forward-am.com or your key account</p> <p>See full material overview under: Material data overview</p> <p>For more information visit : Ultrasim® 3D Simulation (FEA) (forward-am.com)</p>
	Low temperature performance	
	High temperature performance	
	Higher strain rate performance	
	Additional load cases (x,y,z,xy)	

Dynamic Mechanical Analysis (DMA)

In this DMA measurement, a cyclic strain is applied to the sample, and the response of the sample is recorded as a function of temperature. This can give a good impression of the changes in material behavior, both at low and high temperatures. The measured Storage modulus is a good indication of the stiffness of the material. The maximum in Tan Delta gives the glass transition temperature.

	Setting
Measurement	Strain-controlled
Temperature sweep	1°C / min
Strain	0.019% (linear viscoelastic regime)
Type of loading	Dual cantilever
Frequency	1 Hz

Testing conditions DMA



DMA curve

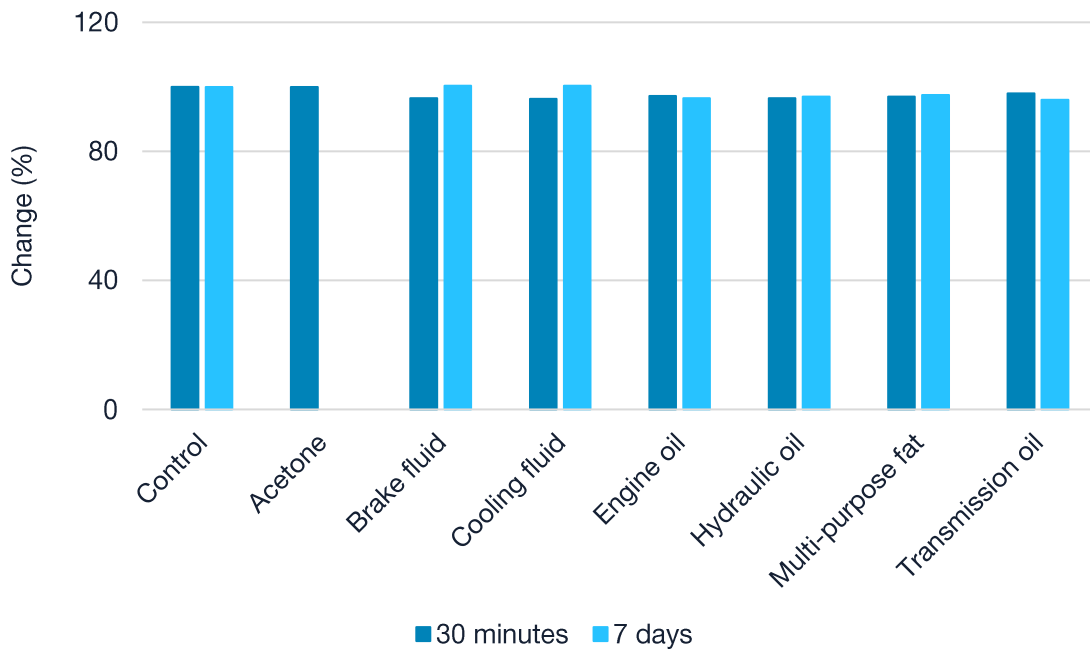
Industrial Chemical Resistance

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.

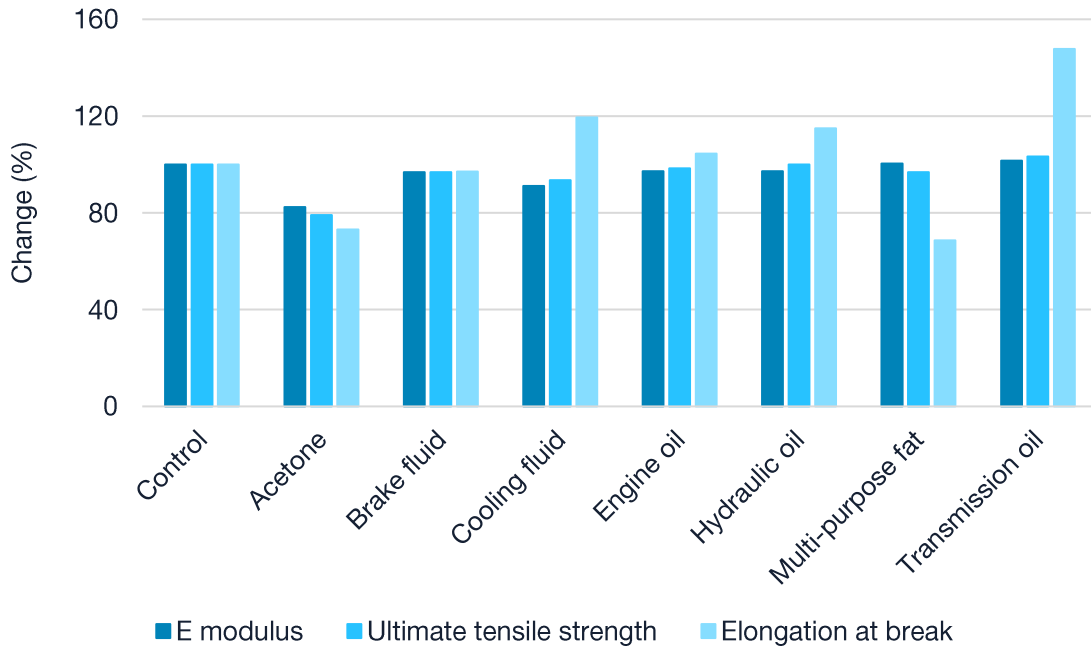
Weight Measurement



Change in weight after immersion time

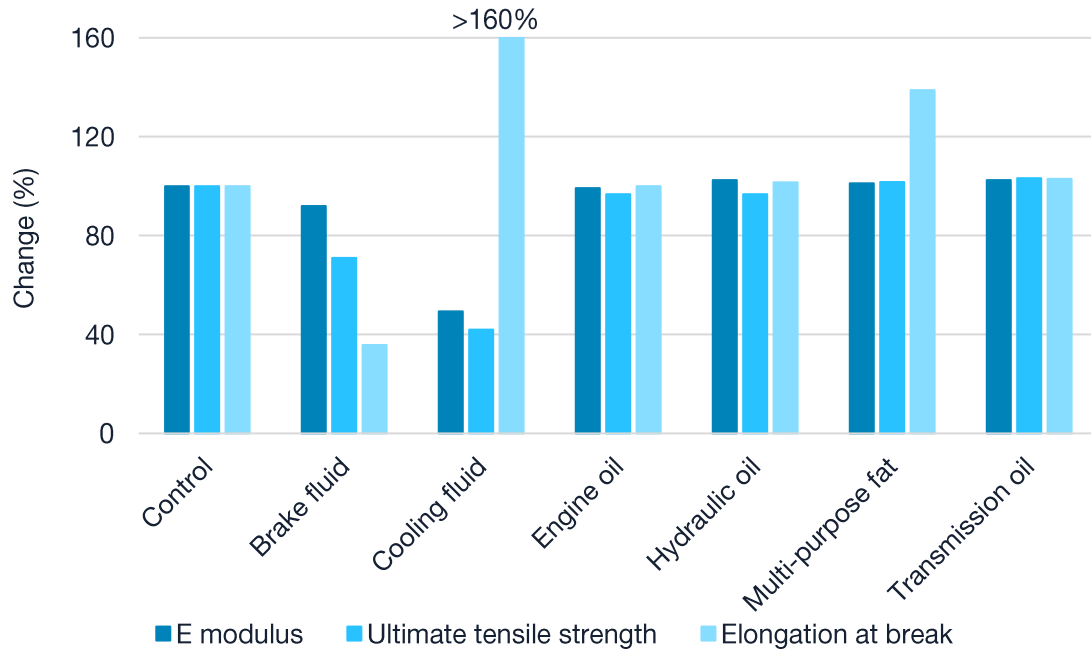
Mechanical Testing

30 minutes



Change in mechanical properties after 30 minutes immersion

7 days



Change in mechanical properties after 7 days immersion

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.

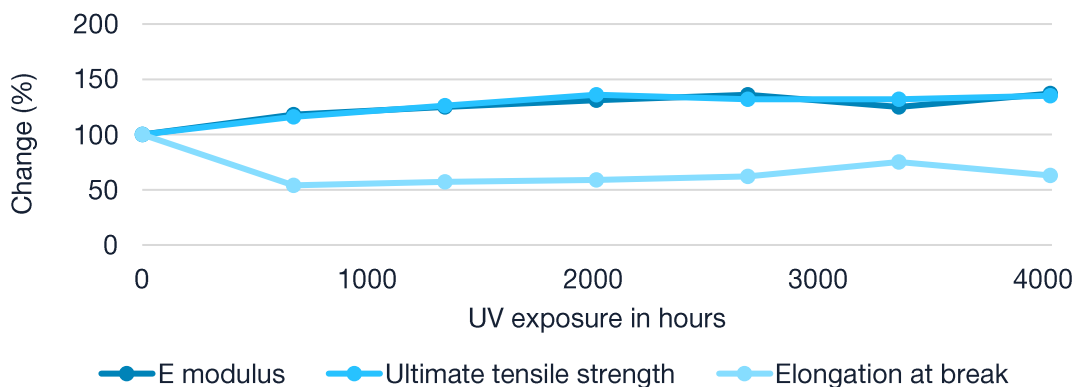
Test Method and Specimens

The ageing tests were performed with ISO 527-2 Type 5A tensile bars and color cones as per ISO 4892-2:2013 method B, cycle 1.

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	Continuously dry	50 ± 2	1.10 ± 0.02	65 ± 3	38 ± 3	50 ± 10

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

Mechanical Testing



Change in mechanical properties after accelerated weathering

Coloration

After being exposed up to 4000 hours, visible yellowing can be seen.



Effect of UV exposure on color of the specimens

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.

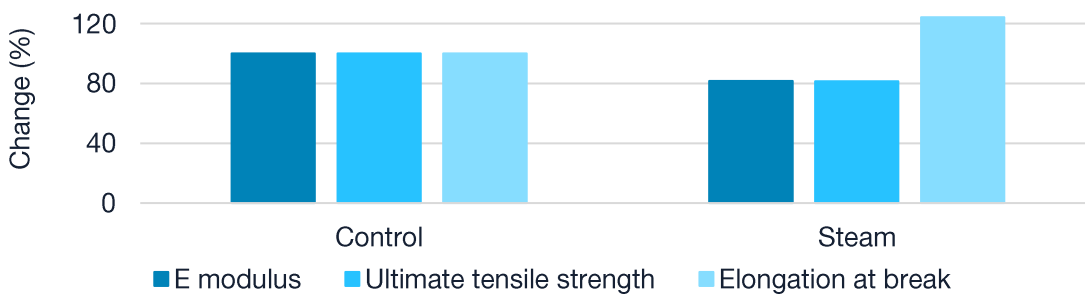
Test Method and Specimens

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



Color samples before and after sterilization

Biocompatibility

Product: Ultracur3D® ST 45

Revision: 03rd of December 2020

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 Vitro Skin Irritation Testing:

(OECD Guideline No. 439)

In Vivo Sensitization Testing- Local Lymph Node Assay:

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

⁶⁾ Patch test on 30 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 determine the suitability of all printed parts for their respective application.

For notice:

We give no warranties, expressed or implied, concerning the suitability of mentioned product for use in any medical device and pharmaceutical applications.

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