

## Material Data Sheet: Z-ABS

Mechanical Properties	Test Method	English	Metric
Young's Modulus	DIN EN ISO 527-2 (ASTM D638)	261 067 psi	1,80 GPa
Tensile Strength	DIN EN ISO 527-2 (ASTM D638)	5511 psi	38 MPa
Tensile Elongation	DIN EN ISO 527-2 (ASTM D638)	17 %	17 %
Charpy Impact, notched	PN-EN ISO 179-1: 2004/A1:2006 (ASTM 6110-1)	3,8 ft-lb/in <sup>2</sup>	8 kJ/m <sup>2</sup>
Rockwell R Hardness	PN-EN ISO 2039-1 (ASTM D785)		109
Maximum Load	PN-EN ISO 2039-1 (ASTM D785)		49 N
Efficient melting point for 3D printing*		482 - 500 F	250 - 260 °C
Glass Transition Temperature		257 F	125 °C
Vicat Softening Temperature		234 F	112 °C
Thermal Expansion		Minimal	
Odor		Nearly odorless	
Solubility		Insoluble in water	
Hazards		Product does not present any hazard while operating	

The information presented are typical values intended for reference and comparison purposes only. They should not be used for design specifications or quality control purposes. End-use material performance can be impacted(+/-) by, but not limited to part design, end-use conditions, test conditions, etc. Actual values will vary with build conditions. Tested parts were built on Zortrax M200 @ 0.2mm slice. Product specifications are subject to change without notice.

The performance characteristics of these materials may vary according to application, operating conditions, or end-use. Each user is responsible for determining that the Zortrax material is safe, lawful and technically suitable for the intended application, as well as for identifying the proper disposal (or recycling) method consistent with applicable environmental laws and regulations. Zortrax makes no warranties of any kind, express or implied including but not limited to the warranties of merchantability, fitness for a particular use.

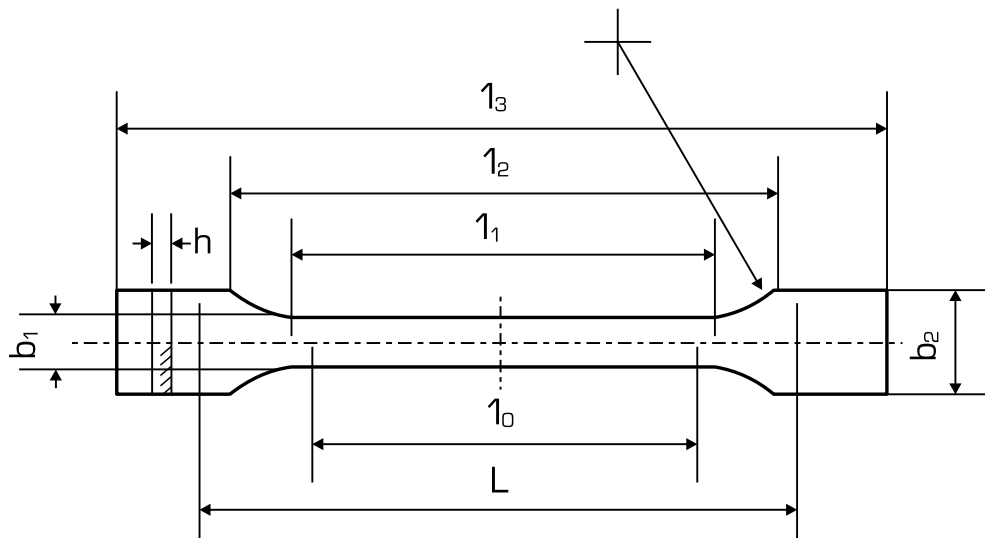
\*Due amorphous nature, material does not display a true melting point.

## Test Report

Plastic samples supplied by the principal were tested to determine their toughness in a static tensile test, the Charpy impact test and the Brinell hardness test.

### 1. Endurance Testing

Test was performed in accordance with DIN EN ISO 527-2 standard (ASTM D638). Dumbbell shaped specimens that were used to perform these tests are shown in picture 1. The INSTRON model 4481 toughness testing machine (made in UK) was used to perform the tests. Tests were carried out in room temperature. Samples were elongated with the speed of 50 mm/ min. Test results are summarized in the table 1., detailed overview of the results can be found in an annex.



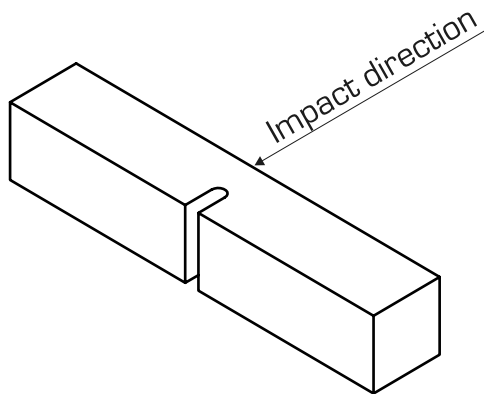
Picture 1. Dumbbell shaped specimen used for the Tensile Tes

No	Young's Modulus [MPa]	Tensile Strength [MPa]	Yield Strength [MPa]	Breaking Strength [MPa]	Elongation at Break [%]
SAMPLE	564,69 ± 12	15,28 ± 0,43	7,83 ± 0,69	14,11 ± 2,11	17,21 ± 3,45

Table 1. Test results marked in a Static Tensile Test

## 2. Charpy Impact Test

Test was performed in accordance with PN-EN ISO 179-1:2004/A1:2006 standard (ASTM 6110-1) ('Plastic materials: the Charpy Impact Test. The standard test for measuring impact energy – part 1 Non-Instrumental Impact Test'). In the picture 2. there is a sample of notched beam and marked impact direction of an impact hammer. Instron PW-5 impact hammer was used during this test.



Picture 2. Notched beam used for the Charpy Impact Test

The score was calculated as an average of 10 calculated impacts, where also fractured samples were counted in as approved (parts of which were still connected to each other with a thin layer of material after an impact). The impact score was estimated from the following formula:

$$a_k = \frac{A_k}{bt_k} 10^3, \text{ kJ/m}^2$$

Where:  $a_k$  – stands for the energy used to break the sample, kJ;  $b, t$  – thickness and width of a sample, mm;  $t_k$  – sample thickness under the notch

Charpy Impact Test results are presented in table 2.

Sample	Calculated impact score of notched samples in the Charpy Impact Test [kJ/m <sup>2</sup> ]
SAMPLE	7,98 ± 1,03

Table 2. Calculated impact score of notched samples

### 3. Ball Indentation Hardness Test

Test was performed in accordance with PN-EN ISO 2039-1 standard (ASTM D785) 'Plastic materials – determination of hardness – Part 1: Ball Indentation Hardness Test' on KB Pruftechnik durometer.

The final score is a result of calculating the average of 10 measurements. Test results are summarized in table 3.

Sample	HB Hardness was determined at a load of 49 N
SAMPLE	20,45 ± 1,15

Table 3. Samples hardness

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Entered in the Register of Entrepreneurs of the National Court Register kept by the District Court in Olsztyn, VIII Commercial Division of the National Court Register, under KRS number 0000564079, with a share capital of PLN 6 962 500 paid in full.