

Connecting**Chemistry**

**STRONG CONSTRUCTION  
MATERIALS AS  
METAL SUBSTITUTES**



## **POLYMERS DACH**

Glass Fiber reinforced Polyamides  
produced in the feed-up Process

**NYLAFORCE<sup>®</sup>**

**NYLAFORCE<sup>®</sup>**  
**dynamic**

[www.brenntag.de](http://www.brenntag.de)



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## Metal Substitution by highly filled Compounds

The NYLAFORCE® and NYLAFORCE® dynamic product groups are stabilized polyamides with a high glass fiber reinforcement content. Outstanding physical and mechanical properties make these materials ideal for technically demanding applications.

An innovative production technology, the feed-up process, ensures that the glass fibers are incorporated into the polymer matrix in a particularly gentle manner. The mechanical properties achieved in this way are unique for highly reinforced polyamides.

The tensile modulus and hence the dimensional stability is clearly above that of conventionally manufactured compounds. Tensile strengths of up to 300 MPa with a still very high degree of elasticity as well as enormous mechanical strength and stiffness, coupled with outstanding elongation are material properties that highly reinforced polyamides have come nowhere near to attaining to date. The NYLAFORCE® dyn-2 A 60 grade even reaches a tensile strength of 320 MPa with an elongation at break of 2.7 %.

As a consequence of its manufacturing process, NYLAFORCE® only absorbs moisture slowly. This ensures a high dimensional and property stability under changing environmental conditions. In combination with excellent processing properties and surface finishes, NYLAFORCE® materials are ideally suited for the substitution of metals in a wide variety of industries and applications.

## NYLAFORCE® and NYLAFORCE® dynamic Features

- High glass fiber reinforced construction materials based on PA 6 and PA 66
- Predestined for the substitution of metals
- For technical applications with the highest demands on strength and stiffness
- Outstanding physical and mechanical properties
- No PA 6 / PA 66 on the market with comparable mechanical values
- High tensile modulus and thus high dimensional stability
- High tensile strength of up to 320 MPa with a still very high degree of elasticity
- Outstanding dimensional stability and low warpage
- NYLAFORCE® dynamic especially for applications subjected to high dynamic load
- Depending on the tool geometry, significant cycle time reduction possible
- Better processing properties than partially aromatic polyamides
- Also suitable for extrusion
- Universal application profile



# Physical and mechanical Properties

STANDARD GRADES NYLAFORCE®			A 50	dyn A 50	B 50	dyn B 50	A 60	dyn A 60
Glass fiber reinforcement	–	%	50	50	50	50	60	60
Density	ISO 1183	g/cm <sup>3</sup>	1.57	1.57	1.57	1.57	1.70	1.70
Tensile strength dry 23 °C	ISO 527	MPa	260	275	250	270	270	295
Tensile strength conditioned 23 °C	ISO 527   ISO 1110	MPa	180	190	170	175	200	215
Tensile strength dry 80 °C	ISO 527	MPa	155	–	140	–	150	200
Tensile strength dry 120 °C	ISO 527	MPa	135	–	105	–	130	160
Elongation at break dry 23 °C	ISO 527	%	2.9	2.9	3.2	3.3	2.5	2.6
Elongation at break conditioned 23 °C	ISO 527   ISO 1110	%	4.5	4.5	5.5	5.5	3.5	3.5
Elongation at break dry 80 °C	ISO 527	%	3.8	–	7.4	–	3.1	4.0
Elongation at break dry 120 °C	ISO 527	%	6.2	–	7.6	–	5.2	4.3
Tensile modulus dry 23 °C	ISO 527	MPa	18 000	18 000	17 500	18 000	21 500	23 000
Tensile modulus conditioned 23 °C	ISO 527   ISO 1110	MPa	12 000	12 500	12 000	12 500	16 000	16 500
Tensile modulus dry 80 °C	ISO 527	MPa	12 300	–	7 600	–	15 000	14 500
Tensile modulus dry 120 °C	ISO 527	MPa	7 900	–	7 400	–	8 900	10 000
Charpy impact strength unnotched dry 23 °C	ISO 179/1eU	kJ/m <sup>2</sup>	96	n. b.	100	n. b.	95	100
Charpy impact strength unnotched conditioned 23 °C	ISO 179/1eU   ISO 1110	kJ/m <sup>2</sup>	96	n. b.	n. b.	n. b.	95	103
Charpy impact strength unnotched -30 °C	ISO 179/1eU	kJ/m <sup>2</sup>	90	n. b.	n. b.	n. b.	90	98
Charpy impact strength notched dry 23 °C	ISO 179/1eA	kJ/m <sup>2</sup>	16	16	19	18	17	17
Charpy impact strength notched conditioned 23 °C	ISO 179/1eA   ISO 1110	kJ/m <sup>2</sup>	20	20	30	26	20	19
Charpy impact strength notched -30 °C	ISO 179/1eA	kJ/m <sup>2</sup>	14	15	16	17	16	16
Melting temperature	ISO 3146 (10K/min)	°C	260	260	221	221	260	260
Heat deflection temperature HDT/A	ISO 75	°C	250	250	>200	>200	250	250
Surface resistivity	DIN IEC 60093	Ohm	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>
Volume resistivity	DIN IEC 60093	Ohm*m	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>
Flammability (3 mm)	UL 94	–	HB	HB	HB	HB	HB	HB
Humidity absorption	similar to ISO 62	%	1.4	1.4	1.5	1.5	1.1	1.1
Water absorption	similar to ISO 62	%	3.8	3.8	4.8	4.8	3.1	3.1
Moulding shrinkage	ISO 294 <sup>1)</sup>	%	0.1 - 0.5	0.1 - 0.5	0.1 - 0.5	0.1 - 0.5	0.1 - 0.5	0.1 - 0.5

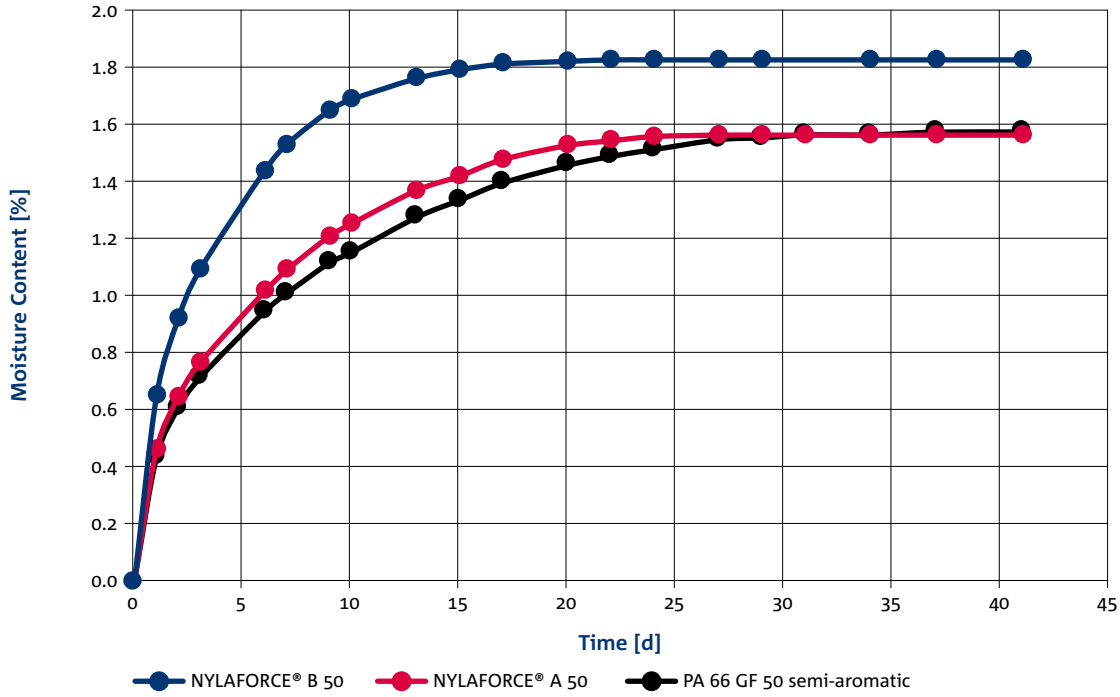
<sup>1)</sup> Internal test method in accordance with ISO 294 (test specimen 60 mm x 60 mm x 2 mm)

<sup>2)</sup> Source: [www.campusplastics.com](http://www.campusplastics.com)

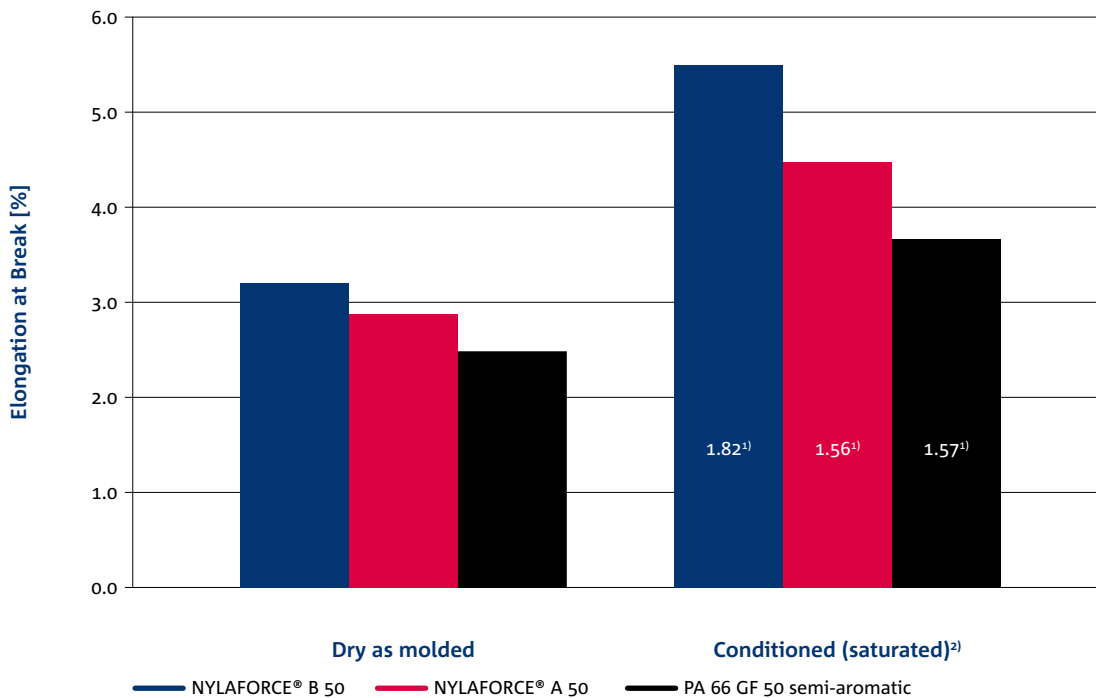
dyn-2 A 60	B 60	dyn B 60	B 70	SPECIAL GRADE A 50 SCHWARZ- 12643	SPECIAL GRADE B 50 Z SCHWARZ	SPECIAL GRADE dyn B 50 Z NATUR	STANDARD PA 6.6 GF 50 <sup>2)</sup>	STANDARD PA 66 GF 50 SEMI-AROMATIC <sup>3)</sup>
60	60	60	70	50	50	50	50	50
1.74	1.70	1.70	1.85	1.56	1.56	1.56	1.56	1.56
320	265	285	255	240	220	265	240	250
240	185	195	180	–	150	185	180	220
–	145	175	140	–	–	–	–	–
–	110	140	100	–	–	–	–	–
2.7	2.9	3	2.5	2.5	2.6	3.1	2.5	2.5
3.5	4.5	4.5	3	–	5	4.6	3.5	2.5
–	6.4	5	4.1	–	–	–	–	–
–	5.4	5.5	3.1	–	–	–	–	–
24 000	21 000	22 000	25 000	17 500	16 500	17 500	16 800	18 000
19 500	14 000	14 500	18 000	–	11 500	12 500	12 500	17 000
–	9 800	12 100	12 100	–	–	–	–	–
–	9 600	9 100	11 600	–	–	–	–	–
100	95	n. b.	87	85	85	n. b.	95	90
95	n. b.	n. b.	90	–	86	–	100	90
–	n. b.	n. b.	–	–	–	n. b.	–	–
18	19	19	16	12	14	18	18	15
19	29	25	24	–	26	–	25	15
–	18	18	–	–	–	17	–	–
260	221	221	221	260	221	221	–	–
–	>200	>200	>200	250	>200	>200	–	–
>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	–	–
>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	>10 <sup>12</sup>	–	–
HB	HB	HB	HB	HB	HB	HB	–	–
1.1	1.2	1.2	–	1.4	1.5	1.5	–	–
3.1	3.8	3.8	–	3.8	4.8	4.8	–	–
0.2 - 0.5	0.1 - 0.4	0.1 - 0.4	0.1 - 0.3	0.1 - 0.5	0.1 - 0.5	0.1 - 0.5	–	–

# Diagrams of selected Polyamides

## Conditioning of selected Polyamides (EN ISO 1110)



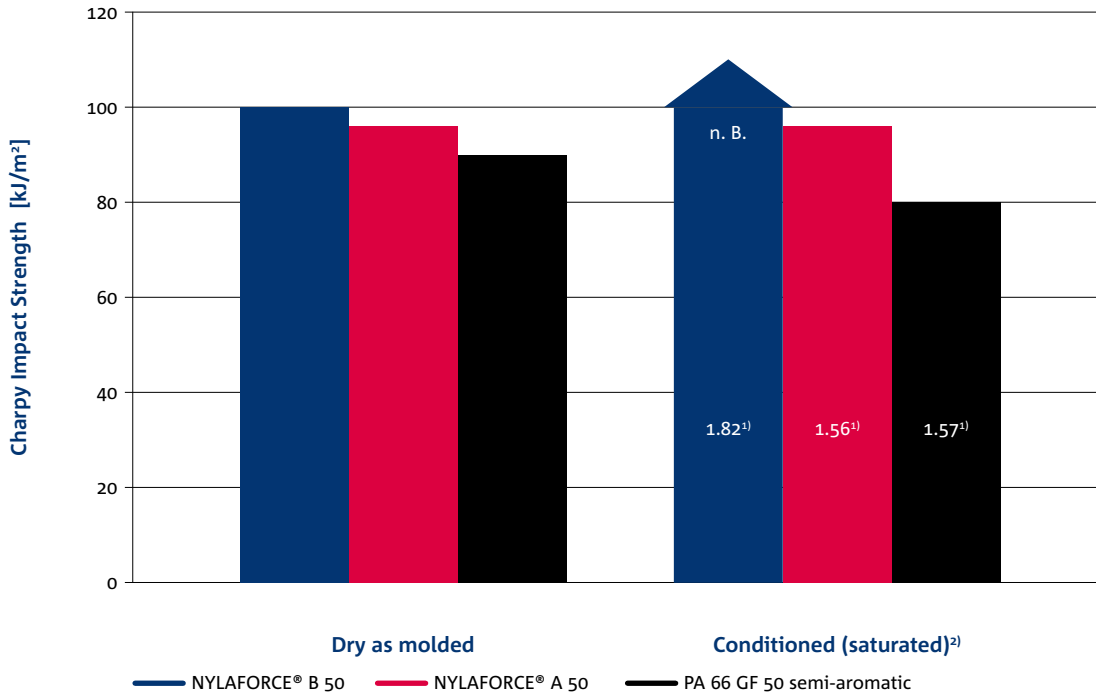
## Elongation at Break of selected Polyamides (ISO 527) at 23 °C



1) Moisture Content  
2) Sample Storage according to EN ISO 1110

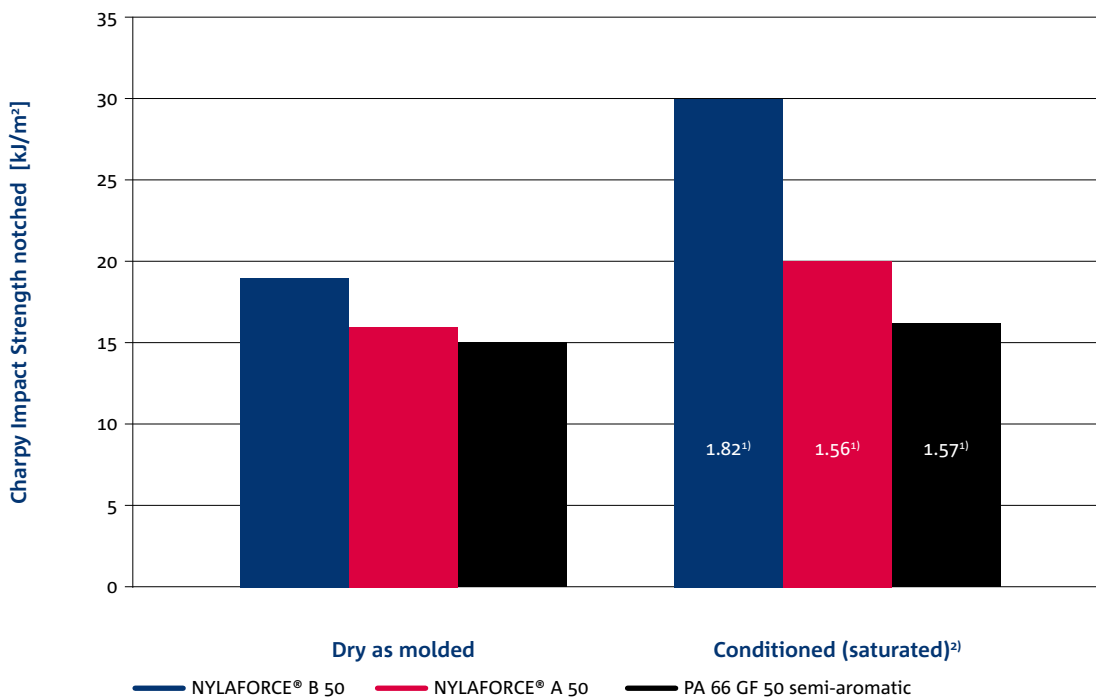


### Charpy Impact Strength of selected Polyamides (ISO 179/1eU) at 23 °C



1) Moisture Content  
2) Sample Storage according to EN ISO 1110

### Charpy Impact Strength notched of selected Polyamides (ISO 179/1eA) at 23 °C



1) Moisture Content  
2) Sample Storage according to EN ISO 1110



# NYLAFORCE® Grades

## NYLAFORCE® A

NYLAFORCE® A grades based on PA 66 are noted for their extremely high strength at high temperatures. Heat stabilized grades are thus ideal for high-strength parts subject to temperature loads, such as components in car engine compartments. At high temperatures, NYLAFORCE® A experiences a considerably less pronounced drop in strength than semi-aromatic polyamides with the same glass fiber reinforcement, for example.

### Special Grades

NYLAFORCE® A 50 SCHWARZ-12643 is a grade with a high hydrolysis resistance. A special form of stabilization also gives the material effective resistance to hydrolytic corrosion. The mechanical properties are scarcely impaired by this stabilization.

## NYLAFORCE® B

NYLAFORCE® B grades based on PA 6 display excellent behavior under dynamic stress. Their high absorption potential for kinetic energy, coupled with exceedingly high strength values at the same time, make these engineering materials into genuine alternatives to metal. Further key properties are the excellent surface quality of the injection molded parts and the straightforward processing.

### Special Grades

NYLAFORCE® B 50 Z is a special grade that has been optimized in terms of impact resistance. The exceptional behavior of this material only becomes clear when it is in service, with complex stress states acting on it.

## NYLAFORCE® dynamic - A Power Pack for dynamic Applications

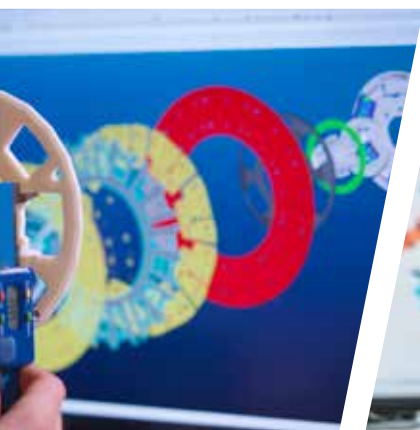
NYLAFORCE® dynamic is the second generation of feed-up polyamides. This high-performance materials have been developed especially for applications subject to high dynamic loads. Its enormous mechanical strength, coupled with outstanding elongation, makes NYLAFORCE® dynamic the ideal alternative to metals, such as aluminium, and zinc and brass alloys.

NYLAFORCE® dyn-2 A 60 reaches a tensile strength of 320 MPa with an elongation at break of 2.7 %. The NYLAFORCE® dyn B 50 grade even passes the impact test without fracturing while offering a tensile strength of no less than 270 MPa and an elongation at break of more than 3 %. These are figures that polyamides with 50 % glass fiber reinforcement have come nowhere near to attaining to date.

## NYLAFORCE® and NYLAFORCE® dynamic Grades

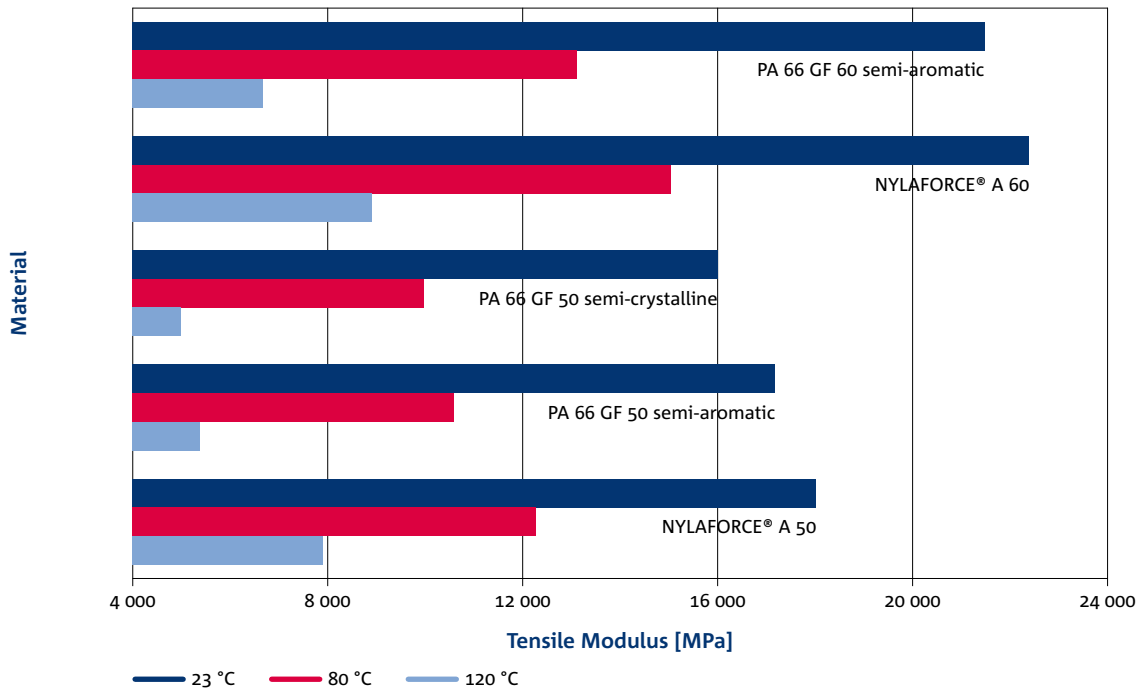
- NYLAFORCE® A 50
- NYLAFORCE® A 60
- NYLAFORCE® B 50
- NYLAFORCE® B 50 Z
- NYLAFORCE® B 60
- NYLAFORCE® B 70
- NYLAFORCE® dyn A 50
- NYLAFORCE® dyn A 60
- NYLAFORCE® dyn-2 A 60
- NYLAFORCE® dyn B 50
- NYLAFORCE® dyn B 50 Z
- NYLAFORCE® dyn A 60

Special grades are available on request.

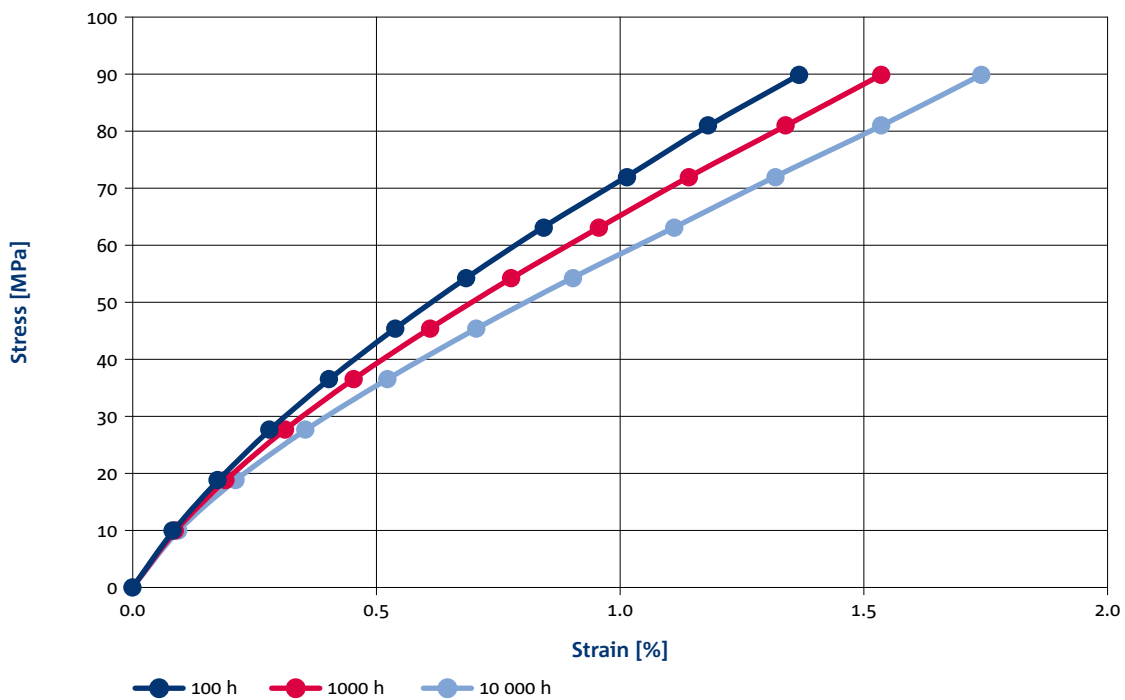


# Diagrams NYLAFORCE® A

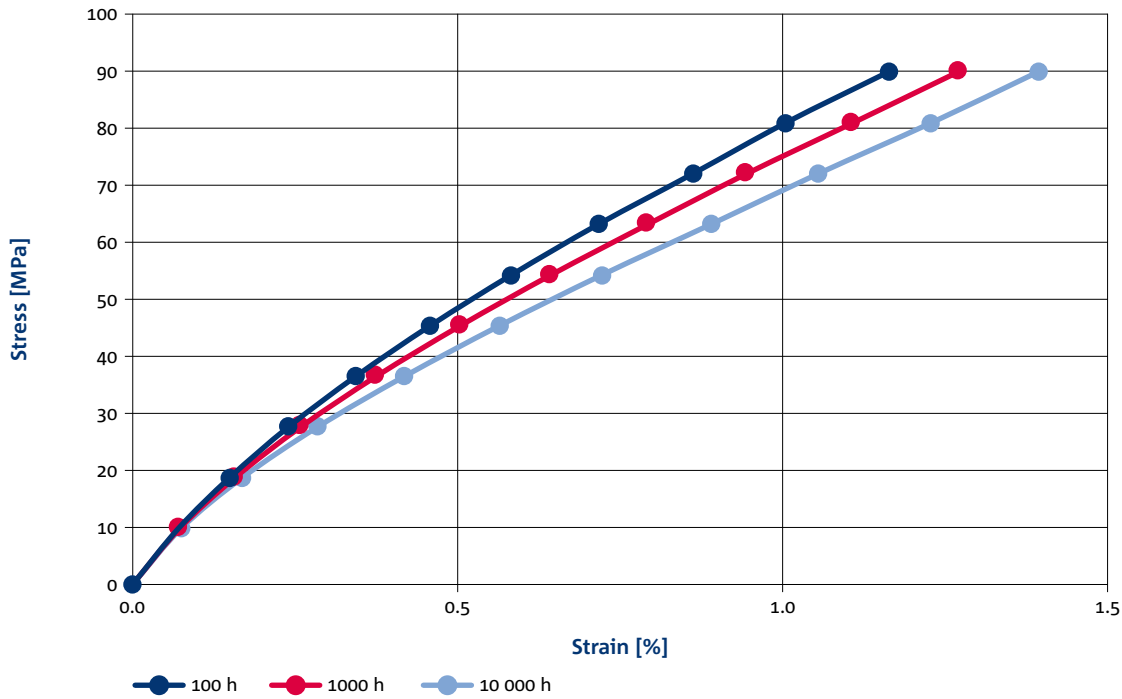
## Tensile Modulus of selected Polyamides (dry)



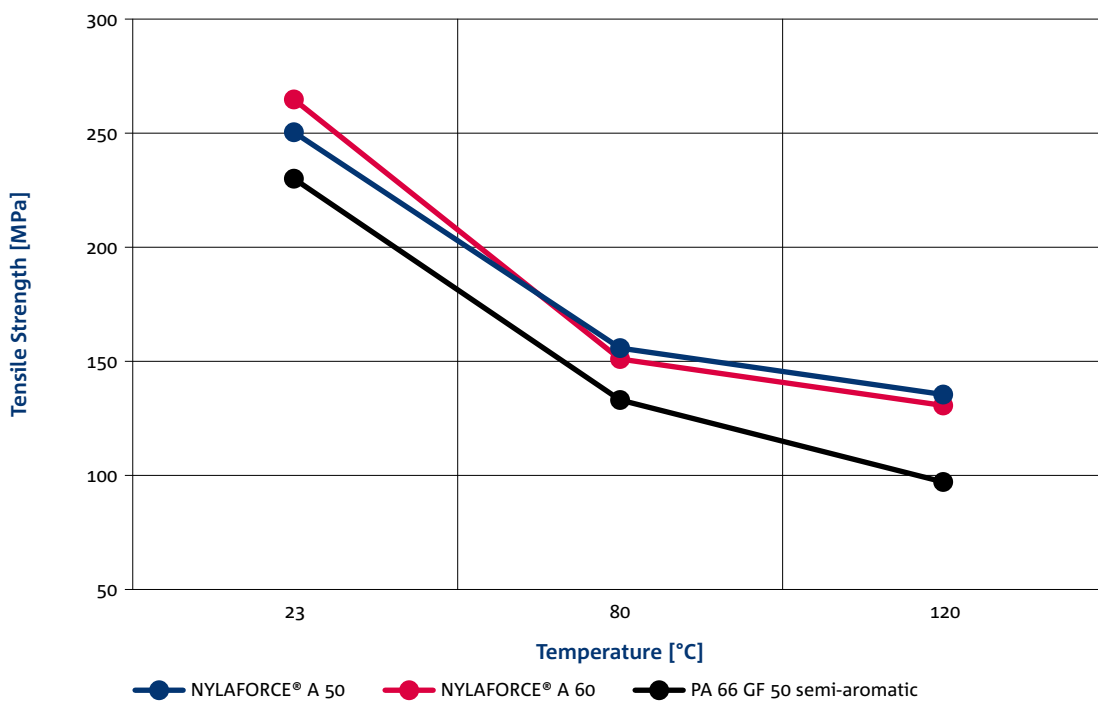
## Stress-Strain Curves (isochronic) NYLAFORCE® A 50 (dry 23 °C)



### Stress-Strain Curves (isochronic) NYLAFORCE® A 60 (dry 23 °C)

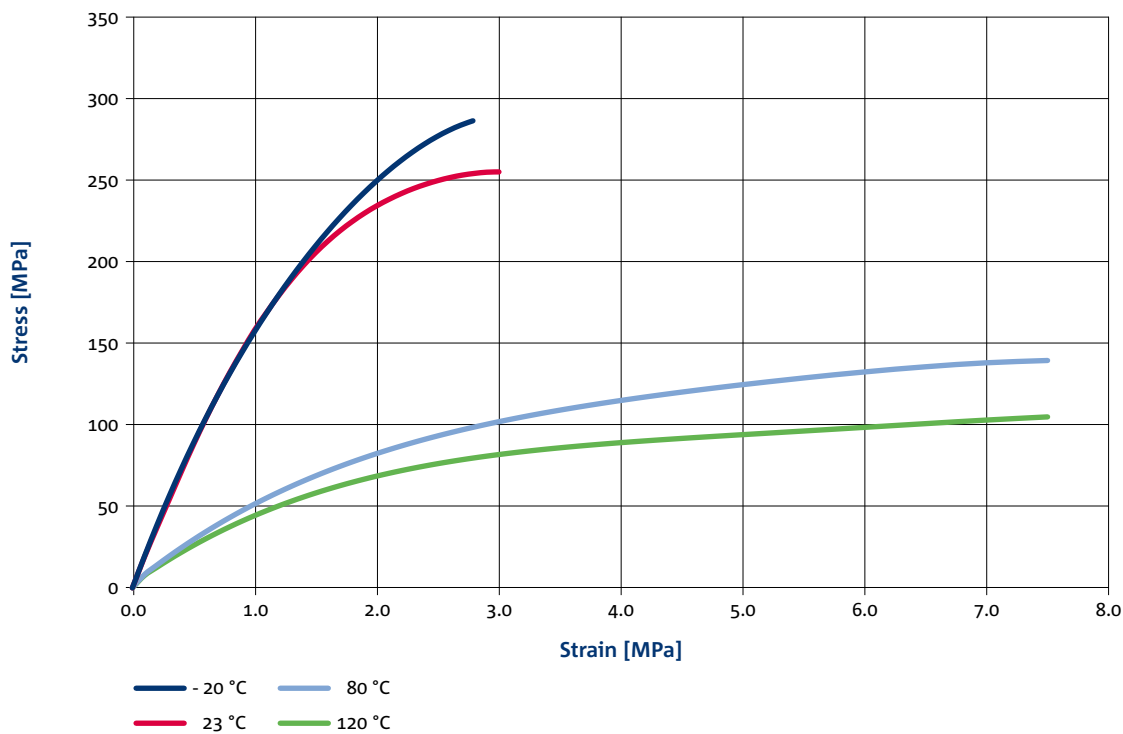


### Tensile Strength of selected Polyamides as a Function of Temperature (dry)

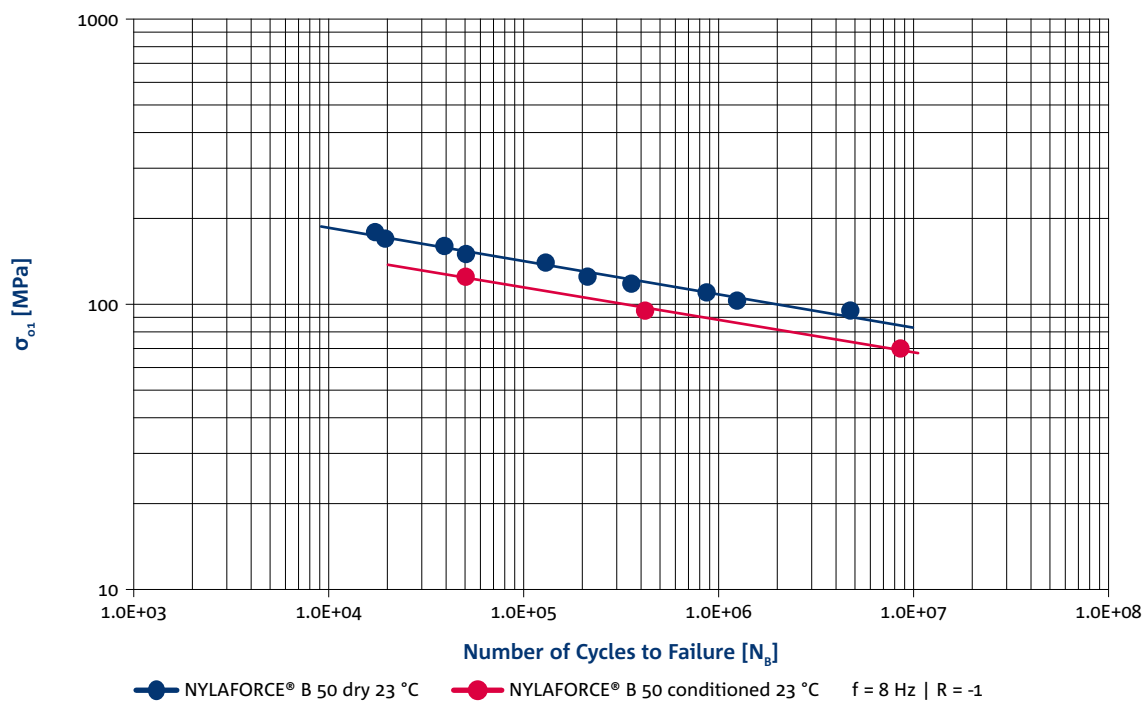


# Diagrams NYLAFORCE® B

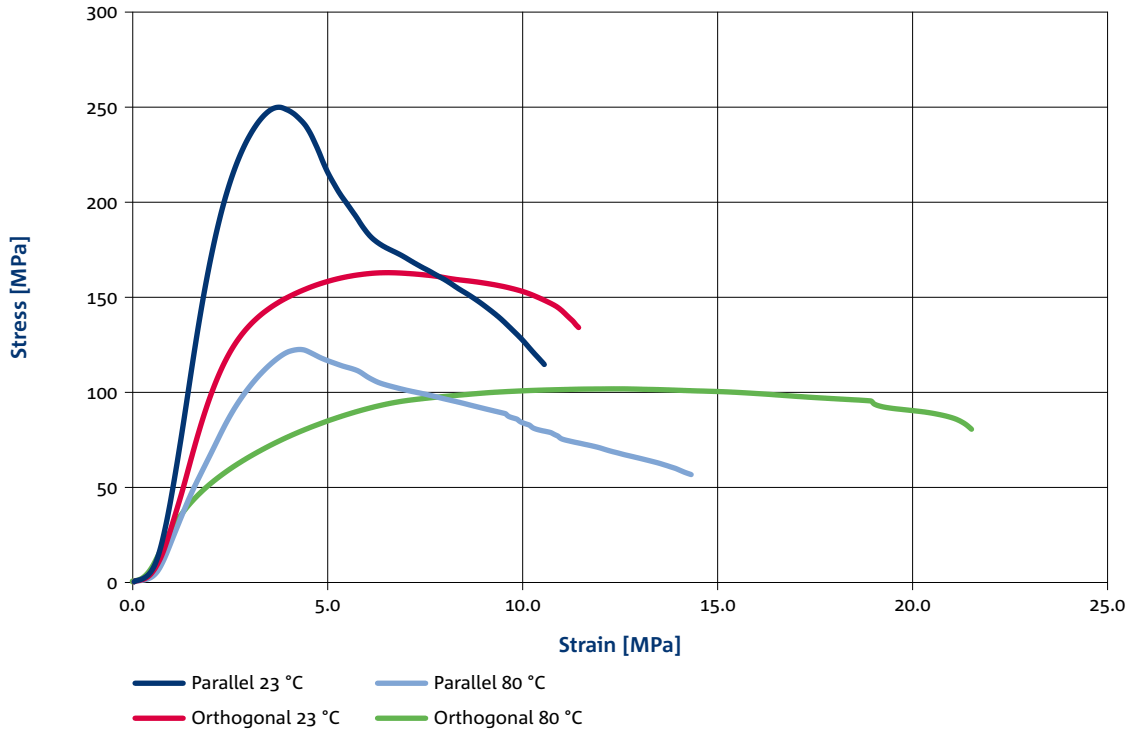
## Tensile Test NYLAFORCE® B 50 (dry)



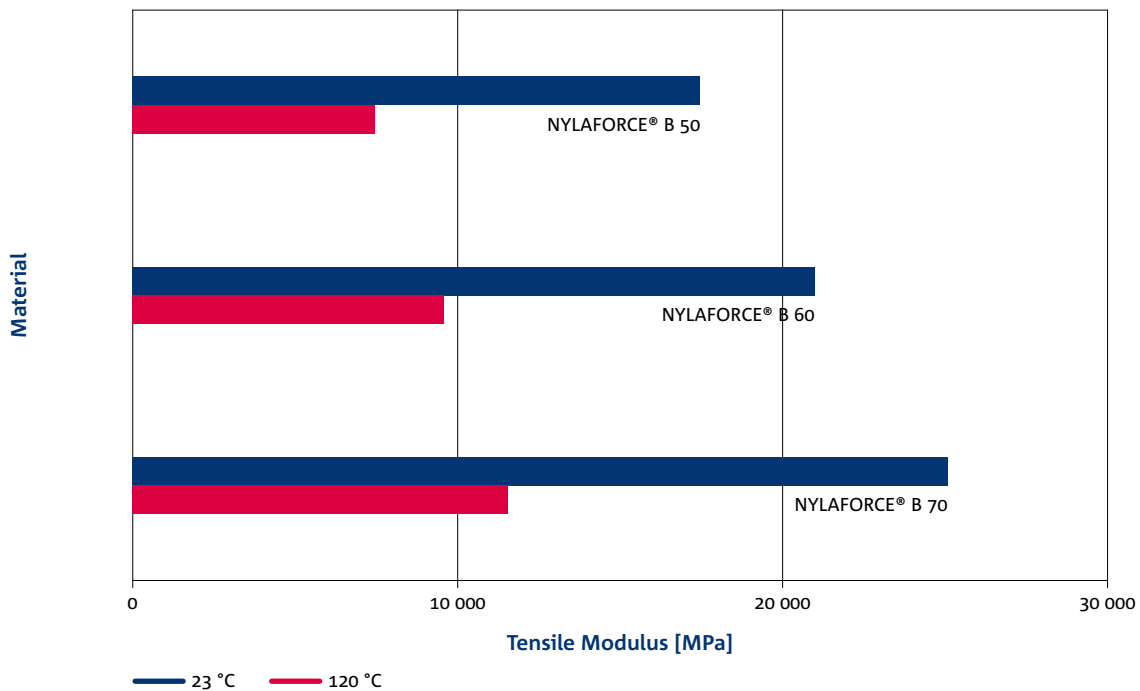
## Flexural Fatigue Test NYLAFORCE® B 50



**Load Test (DIN EN ISO 604) NYLAFORCE® B 50 Z (dry)**

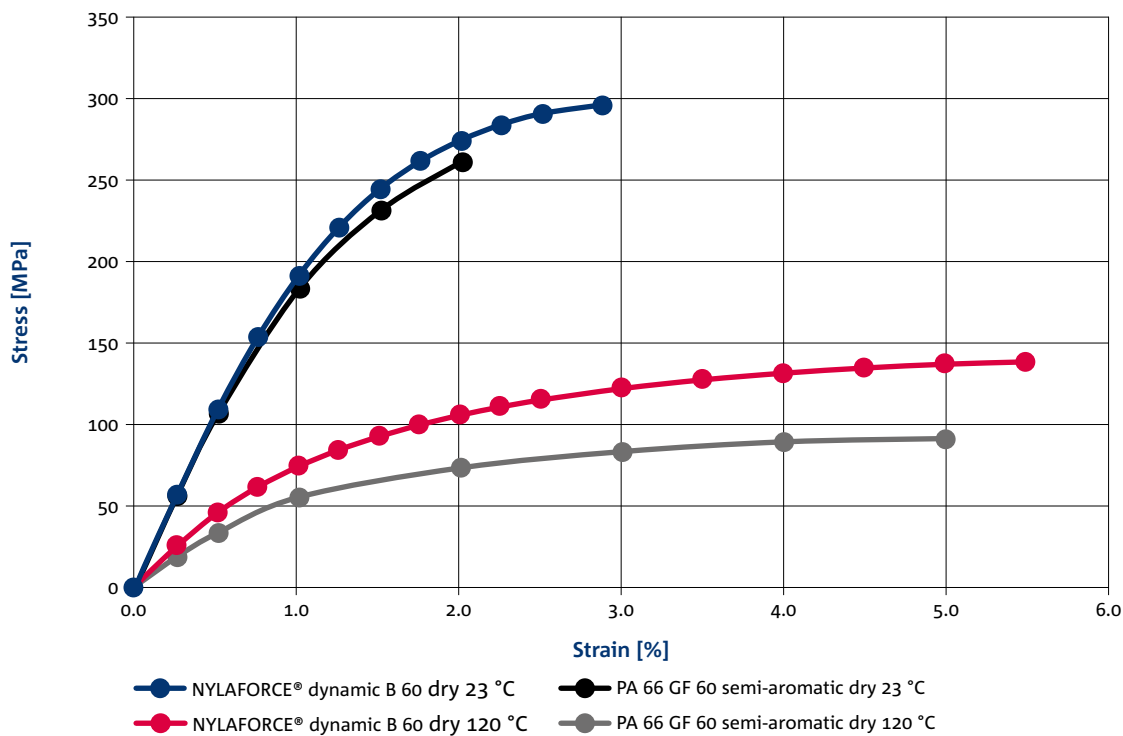


**Tensile Modulus of selected NYLAFORCE® B Grades (dry)**

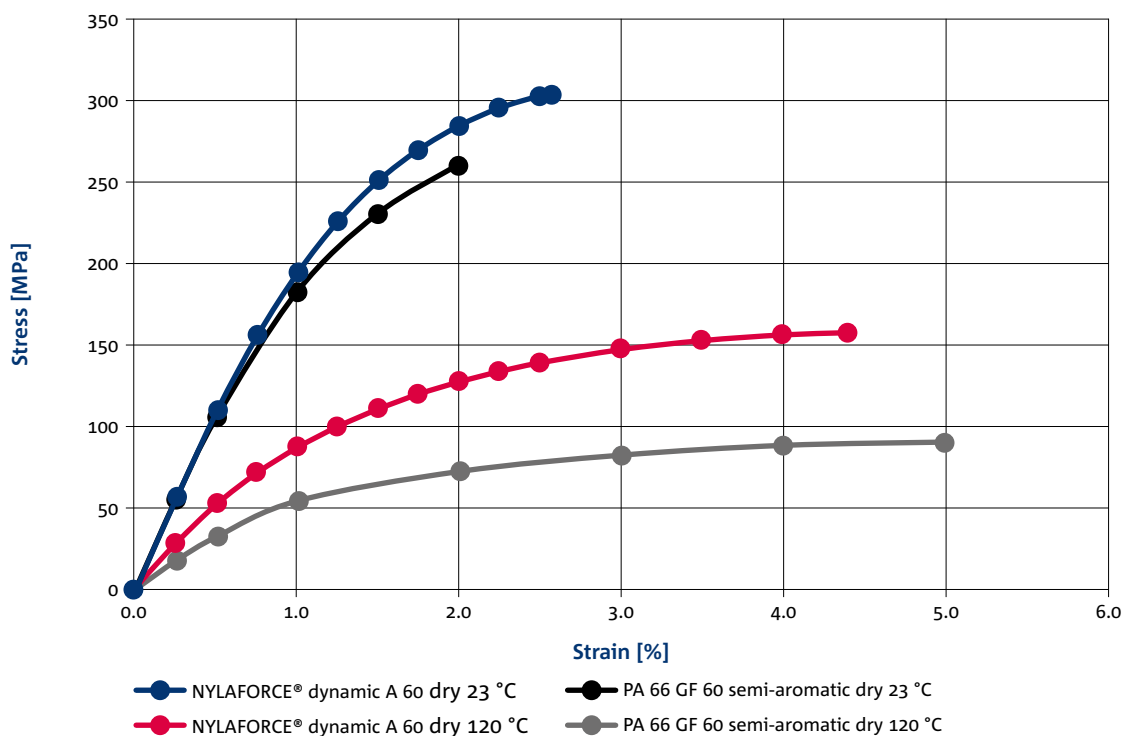


# Diagrams NYLAFORCE® dynamic

## Stress-Strain Curves NYLAFORCE® dynamic B 60 at different Temperatures

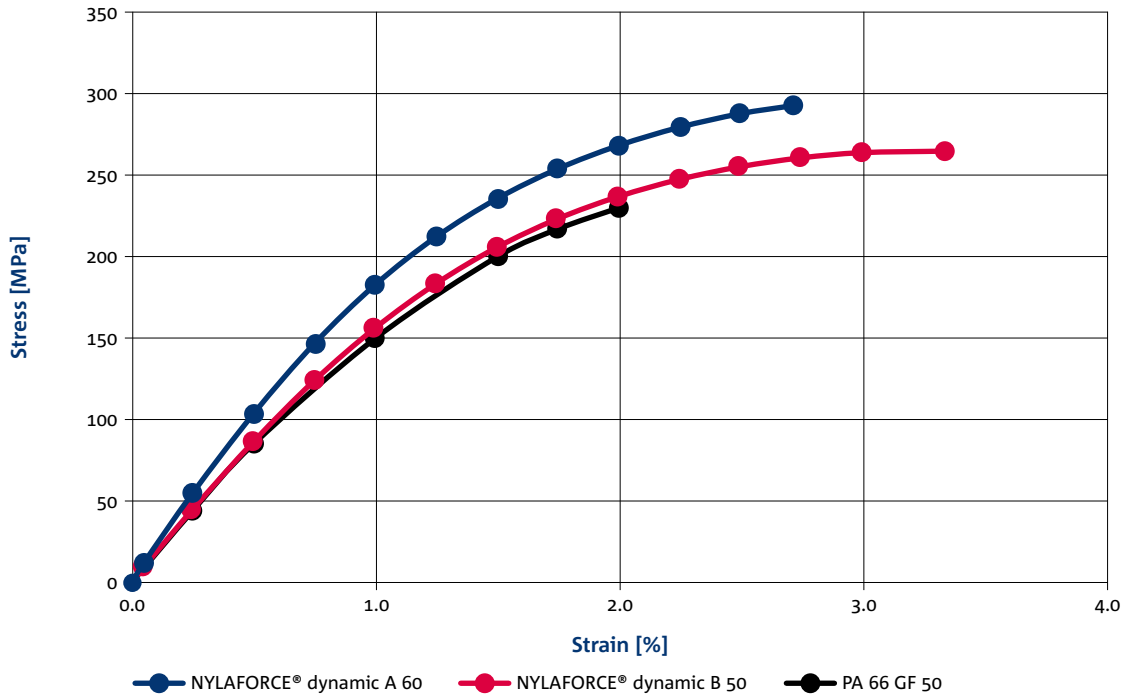


## Stress-Strain Curves NYLAFORCE® dynamic A 60 at different Temperatures

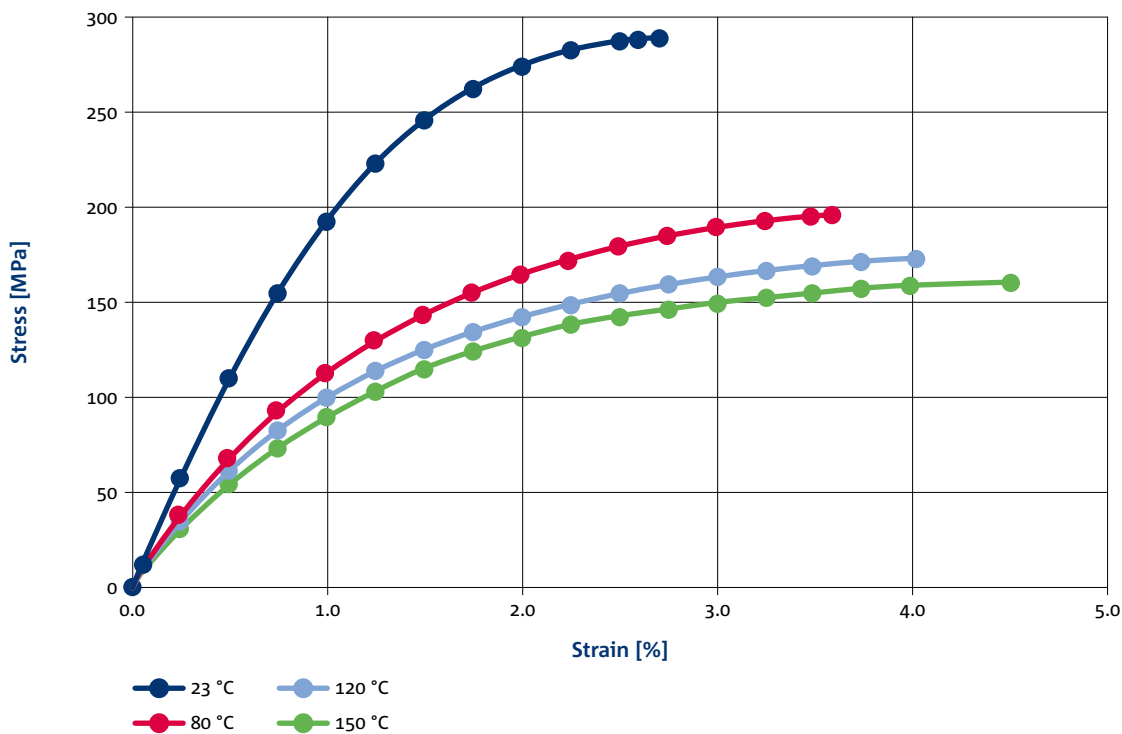


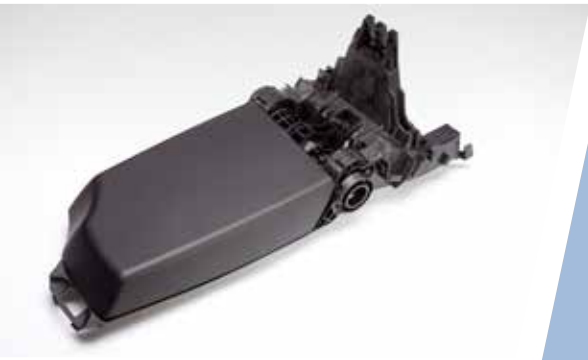
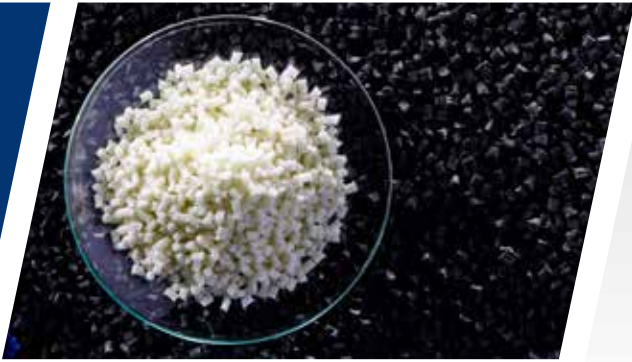


Comparison of NYLAFORCE® dynamic and Standard PA 66 GF 50 (dry 23 °C)



Tensile Test NYLAFORCE® dynamic B 60 (dry)





## Processing Advice

### General Information

NYLAFORCE® and NYLAFORCE® dynamic resins can be molded with usual types of molding machines. In principle the same processing conditions as for standard glass fibre reinforced nylon fit for the materials. Due to the high processing temperature and the abrasion of reinforced nylon, for barrel, screw and hot runner systems wear resistant steel must be specified. Heated, open nozzles are recommended for use in molding. For best molding and good part quality the actual shot size should be between 10 % and 70 % of the machine rated capacity and the screw design should be appropriate. A back-flow valve is necessary for molding.

For extrusion of NYLAFORCE® we recommend a three-section screw with a total length of 20-28D and a constant lead of 1D. The depth of flight ratio should be between 3:1 and 4:1. The flight depth of the screw depends on the screw diameter D as well as the melt viscosity. In case of a low melt viscosity the flight depth at the metering section should be minimized. To minimize the leakage flow, the radial screw clearance should be between 0.1-0.2 mm.

### Material Storage and Drying

NYLAFORCE® and NYLAFORCE® dynamic resins are supplied dry (less than 0.2 % moisture by weight) and are ready to mold directly from the moisture-proof shipping containers. We recommend dry storage areas. The required final water content for best molding and part quality is less than 0.1 %, therefore we recommend pre-drying in a hopper dryer working with dehumidified air (dewpoint below - 20 °C) or an oxygen-free environment (vacuum oven) at 80 to 90 °C for 4 to 8 hours. After drying hygroscopic materials like nylon have to be protected against atmospheric moisture.

## Recommended Machine Parameters and Tool Temperature

INJECTION MOLDING PARAMETERS	Range	Recommendation
Solid Mass Temperature NYLAFORCE® A / NYLAFORCE® dynamic A	280 to 310 °C	290 °C
Solid Mass Temperature NYLAFORCE® B / NYLAFORCE® dynamic B	250 to 320 °C	290 °C
Dosing Speed	10 to 20 m/min.	15 m/min.
Back Pressure	20 to 80 bar	40 bar
Filling Pressure	800 to 1500 bar	1200 bar
Injection Speed	high	high
Mold Temperature	80 to 140 °C	140 °C
EXTRUSION PARAMETERS	Range	Recommendation
Solid Mass Temperature NYLAFORCE® A / NYLAFORCE® dynamic A	270 to 300 °C	–
Solid Mass Temperature NYLAFORCE® B / NYLAFORCE® dynamic B	240 to 290 °C	–
Screw Speed	20 to 60 U/min.	–
Melt Pressure	50 MPa	–
Feeder Section	8 to 9 D	–
Homogenizing Section	4 to 6 D	–
Metering Section	8 to 13 D	–

The specified values are for orientation only. The values actually required depend in particular on the geometry and the desired quality of the molded part.

# Brenntag Polymers in brief

- Innovative development partner for your projects
- Decades of compounding experience
- Certified to ISO 9001:2015 and ISO 14001:2015
- More than 700 products from our own development work
- Own production processes (feed-up process)
- State-of-the-art compounding facilities
- Cooperation with other, well-known global market leaders
- Flexible demand adjustment, fast reaction times
- Networked in regional and global markets
- Cross-industry solutions

## Our Core Competencies

- Compound Development
- Individual Material Solutions
- Metal Substitution
- Thermally conductive Compounds
- Compounds for the Food Industry
- Detectable Compounds
- Tribologically optimized Compounds
- Drinking Water Compounds



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