

# The superhero for engineers

Ultramid® Advanced N for challenging applications



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# Ultramid® Advanced N Contents

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# Ultramid® Advanced N – the high-performance, long-chain polyphthalamide (PPA) by BASF

BASF's engineering plastics of the Ultramid® family have a very successful history in metal replacement. They have allowed lightweight and high-performance parts to be used in many different applications, for example in the automotive or E&E industry.

In recent years, the challenges for plastic parts in these fields have increased drastically by trends such as further miniaturization, higher efficiency targets and functional integration. In particular, good mechanical properties at high temperatures and resistance to humid environments or chemicals call for new high-performance plastic materials which are able to succeed also under these demanding conditions.

In order to meet these requirements, BASF is now offering Ultramid® Advanced N – a new compound portfolio based on long alkyl chain polyphthalamides. Due to their partially aromatic chemical structure they offer excellent mechanics at elevated temperatures. In addition, their hydrophobic nature allows them to withstand humidity and contact with challenging media and at the same time to maintain their strength. The low water uptake results in a dimensional stability of the plastic parts in humid environments which is among the highest of all polyamides (fig. 1).

With these outstanding properties, Ultramid® Advanced N is the ideal problem-solving material for many demanding applications – the superhero for engineers facing new challenges!



**Stable mechanics  
at elevated  
temperatures**



**Outstanding  
chemical  
resistance**



**Perfect  
lead-free  
soldering**



**High  
dimensional  
stability**

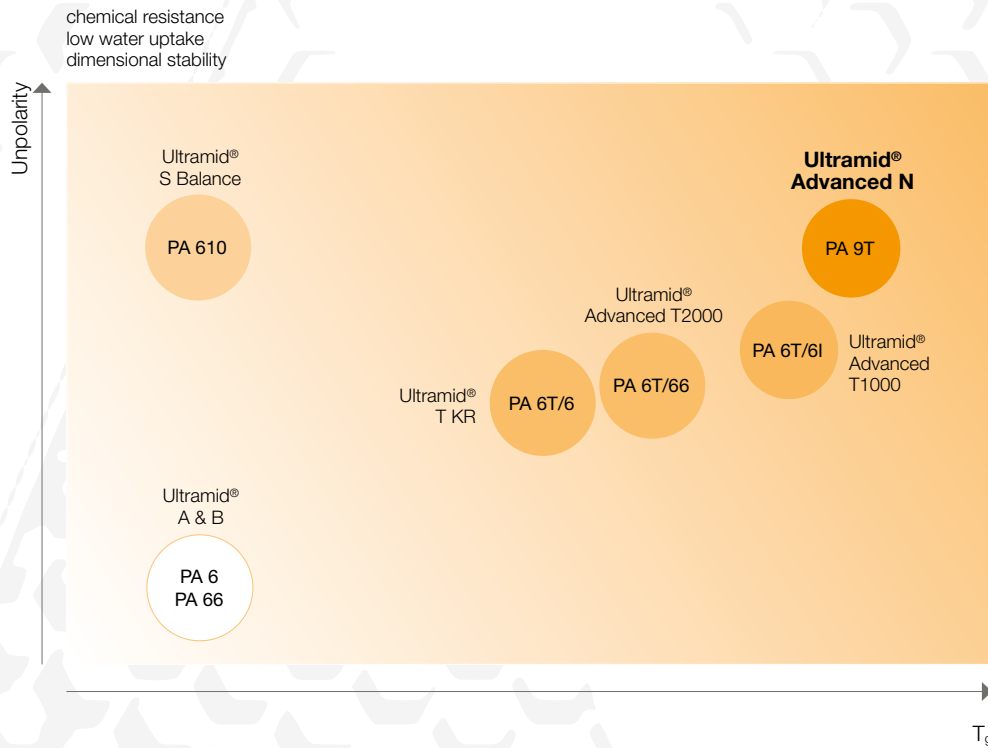


Fig. 1: Performance of different Ultramid® grades at elevated temperatures and under humid/wet conditions or in contact with challenging media

# Ultramid® Advanced N – the PPA by BASF for many challenging parts in all industries

## Ultramid® Advanced N provides

- excellent mechanics of up to 125°C and in wet or conditioned state (fig. 2)
- very low water uptake resulting in high dimensional stability and small influence on properties (fig. 3)
- resistance to many challenging media such as hot oil, coolants, aggressive fuels, acids, calcium or zinc chloride solutions
- excellent wear behavior and abrasion resistance
- simple processing with a broad parameter window and good flowability
- several post-processing options such as welding, laser marking, reflow soldering.

For a broad application range, BASF developed several grades of Ultramid® Advanced N ranging from unreinforced to varying degrees of glass fibers, carbon fibers or mineral fillers. Depending on the requirements of individual applications, different heat stabilizers and also flame-retardant grades are available.



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## With these properties, Ultramid® Advanced N can be applied in

- the transportation industry, especially where constant mechanics both in wet and dry state over a temperature range from -40 to over 85°C and resistance to challenging media are required
- the E&E industry, especially in demanding SMT (surface mount technology) applications where a very low moisture absorption and a high melting point are needed and can be combined with flame retardants
- applications across diverse industries where resistance against heat, humidity, media or abrasion/wear are crucial

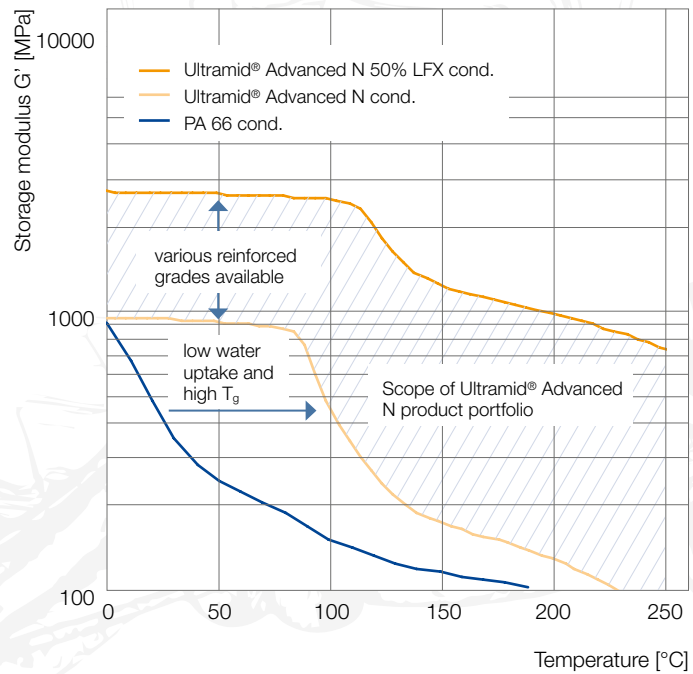


Fig. 2: Mechanics at elevated temperatures and in conditioned state: comparison of Ultramid® Advanced N to PA66

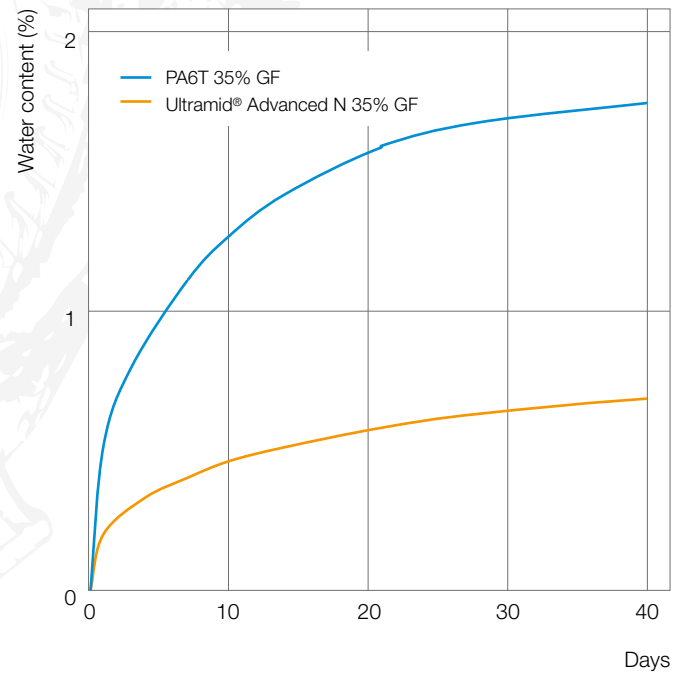


Fig. 3: Moisture uptake test at 70°C and 62% relative humidity: comparison of Ultramid® Advanced N to PA6T (both 35% GF)

## Ultramid® Advanced N – Broad portfolio for specific requirements

BASF is launching Ultramid® Advanced N as a portfolio consisting of different grades to meet customers' specific requirements. The BASF R&D team is dedicated to continuously developing this portfolio with further customized compounds to extend and improve the products' fit and performance.

### The initial portfolio consists of the following compounds:

- unreinforced: a very tough material with high wear and abrasion resistance
- various glass-fiber reinforced grades comprising several combinations of heat stabilization and colors as well as with high flowability or extra toughness
- compounds of highest stiffness for outstanding mechanical performance, reinforced either with long glass fibers or carbon fibers
- several other special grades: e.g. a UL 94-V0 flame-retardant grade, a mineral-reinforced compound of lowest warpage and high reflectivity

All grades are especially suitable for processing by injection molding. There are also grades that can be well processed by extrusion.



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	Grade	Heat stabilization	Color	Description
<b>Unreinforced</b>	Ultramid® Advanced N	medium (H type)	LS black, uncolored	unreinforced, for applications with high wear and abrasion resistance
<b>Glass-fiber reinforced</b>	Ultramid® Advanced N 30% GF	medium (H type)	LS black, uncolored	30% GF reinforced, heat stabilized, high flowability for E&E applications, JEDEC class 1
	Ultramid® Advanced N 30% GF	high (W type)	LS black	30% GF reinforced, high heat stabilization, high flowability for E&E applications, JEDEC class 1
	Ultramid® Advanced N 35% GF	medium (H type)	LS black, uncolored	35% GF reinforced, heat stabilized, high toughness for automotive applications
	Ultramid® Advanced N 35% GF	high (W type)	LS black	35% GF reinforced, high heat stabilization, high toughness for automotive applications
<b>Special grades</b>	Ultramid® Advanced N 30% GF flame retardant	medium	LS black, uncolored	30% GF reinforced, heat stabilized, flame retardant without halogens fulfilling UL 94-V0 rating, high flowability for E&E applications, JEDEC class 1
	Ultramid® Advanced N 45% GF flame retardant	medium	LS black	45% GF reinforced, heat stabilized, flame retardant without halogens fulfilling UL 94-V0 rating, high flowability for E&E applications, JEDEC class 1
	Ultramid® Advanced N 50% LGF	medium (H type)	black	50% long-glass fibers reinforced, heat stabilized, for extra stiffness and highest toughness in automotive applications
	Ultramid® Advanced N high modulus	medium (H type)	black	carbon-fiber reinforced for highest modulus and stiffness, for automotive applications
	Ultramid® Advanced N high reflectivity	medium (H type)	white	high flowability, excellent reflectivity and retention of reflectivity for LED applications
	Ultramid® Advanced N high dimensional stability	medium	black	heat-stabilized, high flowability, high toughness for LED bracket applications
	Ultramid® Advanced N 30% GF laser transparent	medium (H type)	LT black	good weldability with excellent weld line strength and high laser transparency
	Ultramid® Advanced N high viscosity	medium (H type)	black, uncolored	with high viscosity, especially suited for extrusion

# Ultramid® Advanced N for the automotive and transportation industry

Ultramid® grades are widely applied in the transportation and automotive industry due to their high mechanical performance and their contribution to lightweight requirements. As a part of the Ultramid® brand family, Ultramid® Advanced N also features excellent mechanical properties. It is one of the toughest PPAs on the market.

On top of its performance at standard conditions, Ultramid® Advanced N extends the use of Ultramid® plastics to areas where extreme resistance to humidity, chemicals, also in combination with elevated temperatures, are required. Ultramid® Advanced N is resistant against challenging media such as

- coolants, e.g. Glysantin®/water up to 135°C for > 3,000h (fig. 4)
- calcium or zinc chloride solutions
- various acids such as acetic acid or mixtures of hydrochloric, nitric and sulfuric acids
- aggressive fuels, e.g. with high ethanol or methanol content
- engine and gear oils

## **Application example from the automotive industry: thermostat housing**

Ultramid® Advanced N provides excellent mechanics at elevated temperatures and long-term media resistance, for example against a 1:1 mixture of Glysantin® and water at temperatures of up to 135°C for more than 3,000h. The high flowability compared to other PPA materials enables the design of sophisticated parts like thermostat housings: These parts require high hydrolysis resistance as well as high strength.





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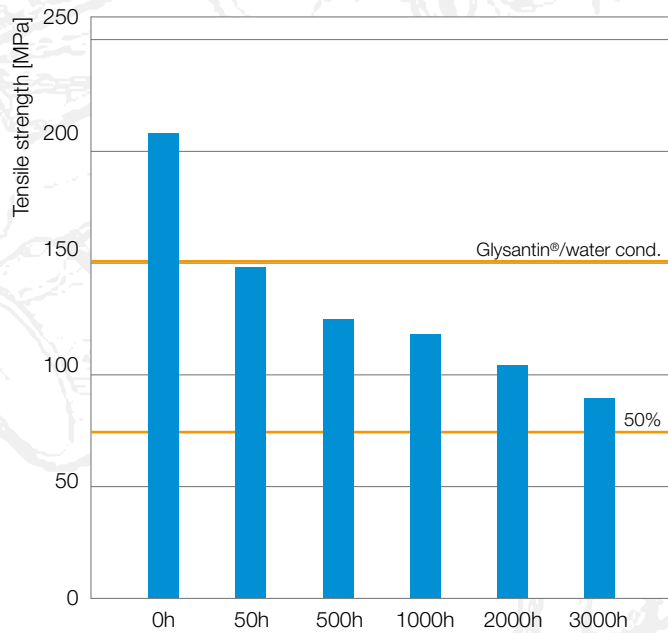


Fig. 4: Ultramid® Advanced N 35% GF retains 50% of its initial tensile strength after storage in Glystantin®/water at 135°C for 3,000h

# Ultramid® Advanced N for the E&E industry

The high mechanical performance, very low water absorption, good insulation properties and the availability of flame retardant grades make Ultramid® Advanced N very interesting for applications in the electrical and electronics industry.

**Ultramid® Advanced N provides special benefits and is superior to other HTPAs and PPAs in performance:**

- no blistering in surface mount technology (SMT) applications due to low water uptake and high temperature resistance, e.g. JEDEC/IPC J-STD-020, Class 1 (fig. 6)
- easy injection molding: high flowability, good melt stability, maximally reduced mold deposits with FR grade
- excellent tracking properties with CTI values of 600V (class 0) for the 30% GF grades both with and without flame retardants (fig. 5)
- FR system without halogens with UL 94-V0 listing for thicknesses down to 0.4mm, and 5VA for >1.5mm
- lowest migration effects of flame retardants due to high resistance against heat and humidity (figs. 6 and 7)
- very high surface quality, perfectly suited for laser marking

**Application example from the E&E industry:  
LED electronic packaging**

Ultramid® Advanced N provides excellent initial reflectance and outstanding reflectance retention even after thermal and light aging. These are the key requirements for a LED resin using SMT. Together with the benefits of low moisture absorption, excellent mechanical properties and good silicone adhesion, Ultramid® Advanced N is an ideal choice for LED reflector resins in LED packaging application.

<b>Advanced N40 G6</b>				
Polyamide 9T (PA9T), flame retardant, "Ultramid®", furnished as pellets				
Color	Min Thk (mm)	Flame Class	HWI	HAI
BK	0.40	V-0	3	0
	0.75	V-0	0	0
	1.5	V-0, 5VA	0	0
	3.0	V-0, 5VA	0	0
Comparative Tracking Index (CTI): 0				
Dielectric Strength (kV/mm): 35				
High-Voltage Arc Tracking Rate (HVTR): -				

Fig. 5: UL 94 yellow card for Ultramid® Advanced N40 G6 FR (30% glass-fiber reinforced, flame retardant without halogens)



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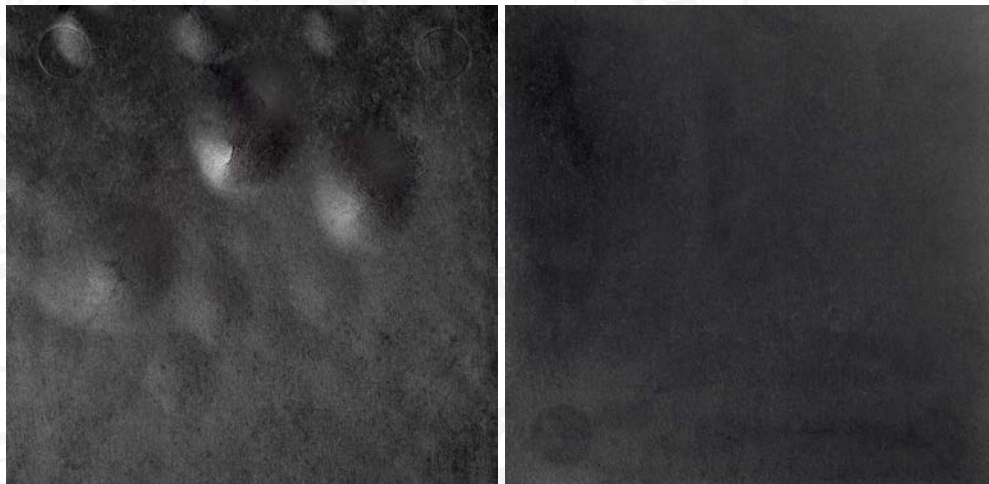


Fig. 6: Surface after heat treatment as in reflow soldering  
left: standard PPA with blisters  
right: Ultramid® Advanced N 30% GF FR



Fig. 7: Wet/dry alternating storage test showing resistance against humidity  
left: standard PPA/FR with visible surface defects due to migration of flame retardant  
right: smooth surface due to lowest migration of flame retardant with Ultramid® Advanced N 30% GF FR

## Ultramid® Advanced N for other industries

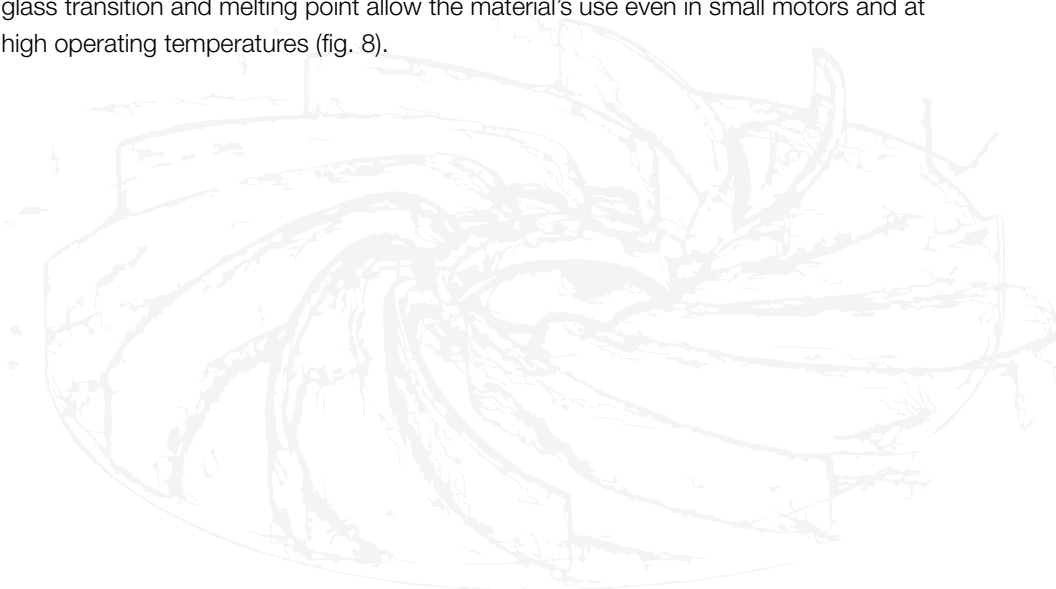
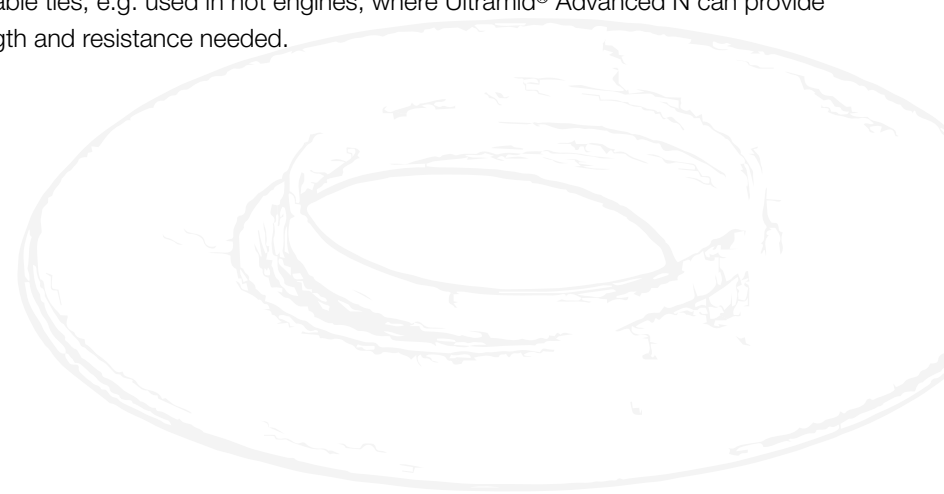
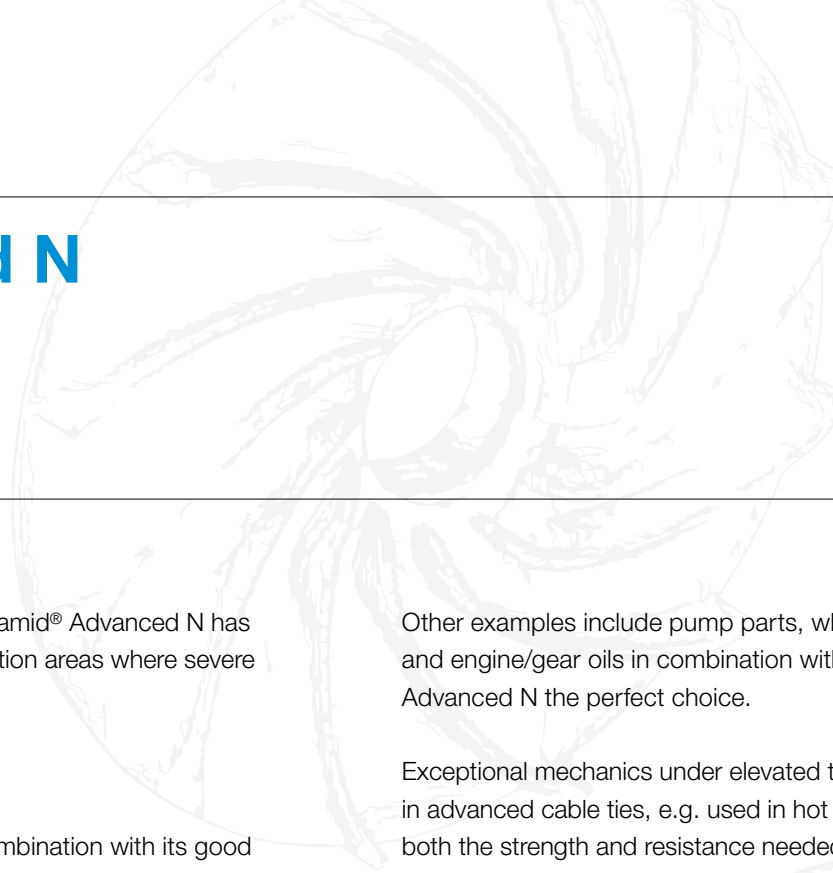
Apart from electronic and transportation applications, Ultramid® Advanced N has tremendous potential as a problem solver in other application areas where severe challenges have to be overcome.

### **Example: Gear wheel**

The excellent resistance against abrasion and wear in combination with its good mechanical properties and high dimensional stability make Ultramid® Advanced N an outstanding material for gear wheels. On top of its tribological properties, its high glass transition and melting point allow the material's use even in small motors and at high operating temperatures (fig. 8).

Other examples include pump parts, where the high resistance against both hydrolysis and engine/gear oils in combination with its high dimensional stability make Ultramid® Advanced N the perfect choice.

Exceptional mechanics under elevated temperatures and in humid conditions are exploited in advanced cable ties, e.g. used in hot engines, where Ultramid® Advanced N can provide both the strength and resistance needed.





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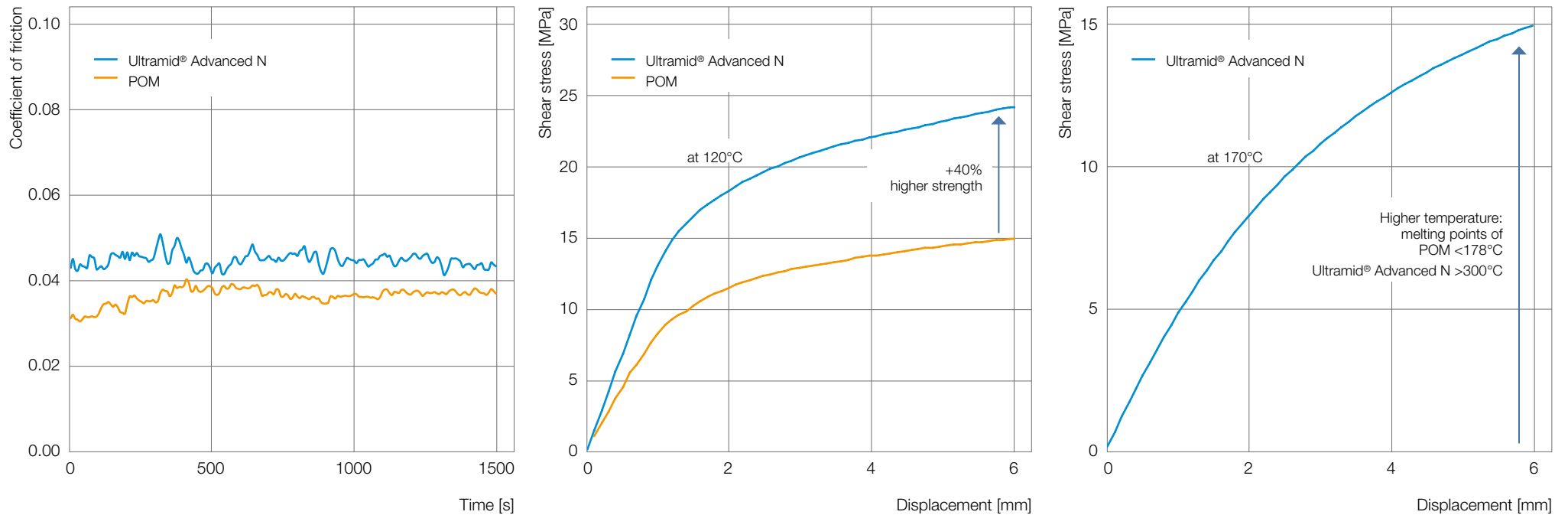


Fig. 8: Experiment showing the constant coefficient of friction (COF) for unfilled Ultramid® Advanced N in lubricated friction (at 80°C, left): The COF values are on a similar level as the POM reference. Parts made of Ultramid® Advanced N are up to 120°C over 40% stronger than POM (shear stress, ASTM D7078, middle). Unlike POM, they can be used with temperatures higher than 170°C (right).

# Ultramid® Advanced N: easy processing

Ultramid® Advanced N can be processed with standard injection molding machines. The material has a broad processing window with a melt temperature range between 310°C and 340°C, and a mold temperature range between 100°C and 160°C. Ultramid® Advanced N is not sensitive against changing processing conditions like dosing speed or injection speed. It can be processed with hot runner systems and needle valve nozzles.

The spectrum of flowabilities covered by the various Ultramid® Advanced N grades are shown in fig. 9. The different materials were processed at 330°C melt and 140°C mold temperature with constant injection speed and injection pressure. The indicated values are a measure of flowability and show the maximum flow path until solidification for a flow spiral mold of 2mm thickness.

A detailed processing instruction is available to enable optimum injection molding conditions.

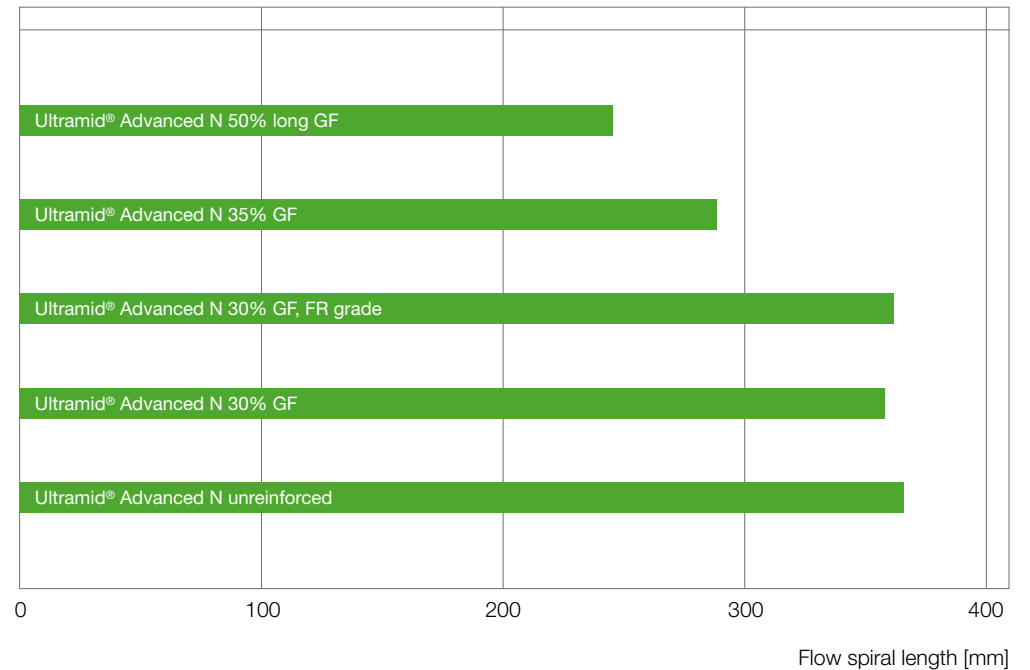


Fig. 9: Maximum flow paths of different Ultramid® Advanced N grades until solidification for a flow spiral mold of 2mm thickness



# Ultramid® Advanced N: straightforward post-processing

Plastic parts made of Ultramid® Advanced N can be further processed using many different methods:

- They can be welded to complex structural elements using vibration or laser welding.
- Most grades are laser-markable. Combined with a smooth surface, the markings feature high contrast (fig. 10).
- For E&E applications, reflow soldering can be applied to manufacture and integrate electronic parts. Due to its low water uptake, Ultramid® Advanced N shows a blister-free surface even when heated to temperatures of up to 260°C.

Further details on processing are available for individual grades.

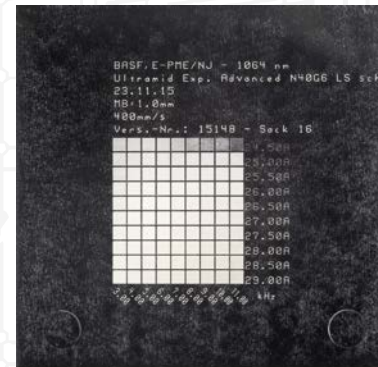


Fig. 10: With Ultramid® Advanced N, parts can be excellently laser-marked.



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# Ultramid® Advanced N: precise part design with Ultrasmim®

BASF's simulation tool Ultrasmim® is used in the design of parts from all industries. Examples are found in automotive and mechanical engineering, in construction, in power tools and household appliances, and in parts for the sports and leisure sectors.

Using Ultrasmim®, the physical behavior of the part can be predicted on the basis of manufacturing parameters, fiber anisotropy and load direction or speed. The mathematical part optimization can furthermore provide the best possible design under the given conditions. With customized models, BASF has developed the calculation tool in such a way that parts made of Ultramid® Advanced N can also be simulated.

Ultrasmim® is therefore a unique tool for optimizing customer parts at a very early stage so that they are able to handle loads. With the precise predictions costs and time associated with prototypes or extensive mold corrections can be avoided.

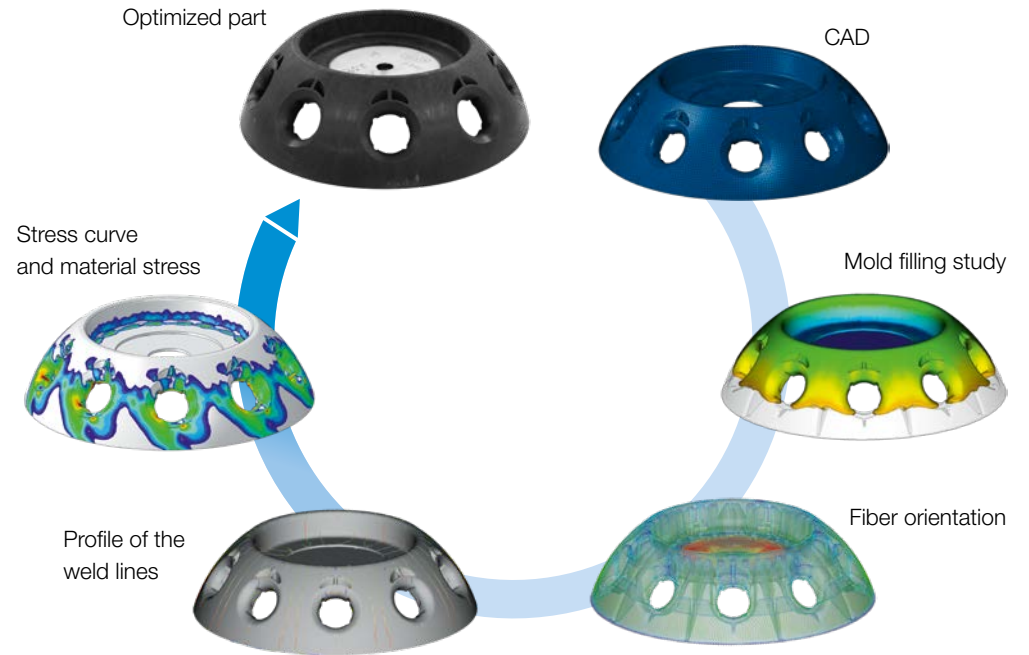


Fig. 11: Process of designing parts with the BASF simulation tool Ultrasmim®

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