Stanyl®

General Information on Properties

a DSM Product

Astonishing Stanyl®

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The World's Most Versatile High Temperature Thermoplastic

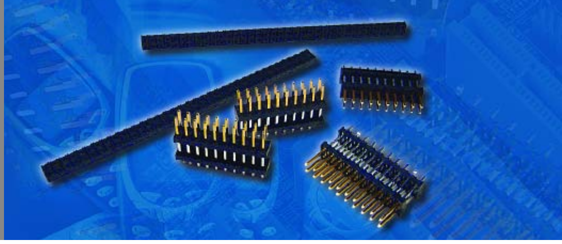
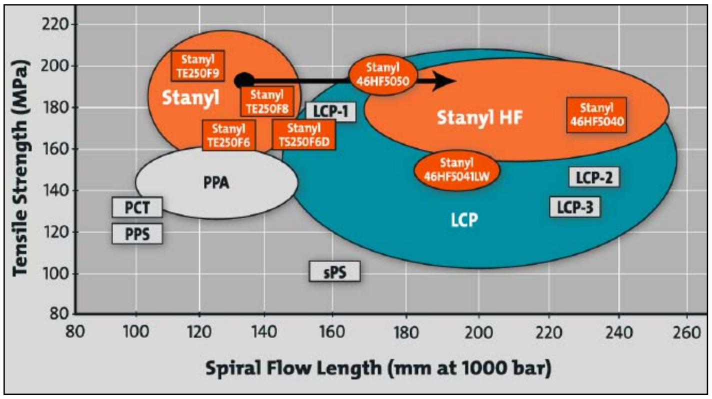


Figure 1 Spiral flow versus tensile strength.



Stanyl® is a high performance polyamide that provides unmatched performance and value across an amazingly broad range of applications. Its versatility derives from its unique set of properties, the core of which are:

- **Highest mechanical property retention at high temperatures**
- **Excellent resistance to wear and friction**
- **Outstanding flow for easy processing and exceptional design freedom**

Stanyl has a unique property profile that provides the best solution for many applications that need outstanding performance. Stanyl grades are based on polyamide 46, a highly crystalline material with a melting temperature of 295°C (560°F). Its toughness and high mechanical strength combine with exceptional flow to give the widest design freedom possible in engineering plastics.

Product Scope. Stanyl is offered in a wide variety of grades including unreinforced and grades containing glass fiber, mineral, lubricants, and/or flame retardants. A list of the most important grades can be found in Table 1.

Stanyl High Flow™

Stanyl High Flow combines the high strength and toughness levels of the standard Stanyl PA46 with excellent flow characteristics virtually the same as Liquid Crystal Polymers (LCP), a material often used for Information and Communication Technology (ICT) equipment (see Figure 1).

The Stanyl High Flow V-0 grades can replace LCP, resulting in a cost savings up to 50%. Stanyl 46HF5040 is a standard High Flow 40% glass fiber reinforced, flame retardant grade. 46HF5050 is developed for improved dimensional stability combined with excellent mechanical performance while 46HF5041LW was designed for improved dimensional stability with minimum warpage.

Stanyl High Flow 46HF5040 has an Underwriters Laboratories (UL) 94 V-0 rating at 0.35 mm for all colors and a UL approval for 50-100% regrind use. Stanyl High Flow 46HF5050 and 46HF5041LW have an Underwriters Laboratories (UL) 94 V-0 rating at 0.4 mm for natural and black; UL yellow card file numbers for Stanyl PA46 are E47960, E43392 (US) and E172082 (Japan). Stanyl inherently offers high toughness, even in dry-as-molded conditions. The weld-line strength of the new High Flow flame retardant grades is three times higher than that of LCP. This enables connector manufacturers to post-insert pins directly after injection molding without the risk of cracking, thereby reducing reject levels.

Stanyl High Flow grades for high pin density connector applications include:

- **46HF5040 - extremely high flow**
- **46HF5050 - extremely high flow, low warpage tendency, improved dimensional stability**
- **46HF5041LW - extremely high flow, very low warpage tendency, improved dimensional stability**

Stanyl High Flow grades for automotive and metal replacement include:

- **TW241F12 - specifically targeted for metal replacement applications**
- **46HF4130 - specifically targeted for thin wall automotive connector and other encapsulation applications**

Table 1 Stanyl product portfolio.

Grades	Non-reinforced	GF-reinforced	(%)
Non-flame-retardant HB or V-2	TW341	TW200F3/TW241F3	15
	TW441	TW200F6/TW241F6	30
	TW363	TW200F8/TW241F8	40
		TW241F10	50
		TW241F12	60
Flame-retardant (V-0)	TE351	TE250F6/TS250F6D	30
		TE250F8/TS250F8	40
		TE250F9	45
Wear & Friction	TE373	TW271F6/TW275F6	30
	TW371		
High Flow		46HF4130	30
		46HF5041LW (V0)	40
		46HF5040 (V0)	40
		46HF5050 (V0)	50

Characteristics of Stanyl

Figure 2 Oil stability, aging at 150°C – testing at 150°, absolute values.

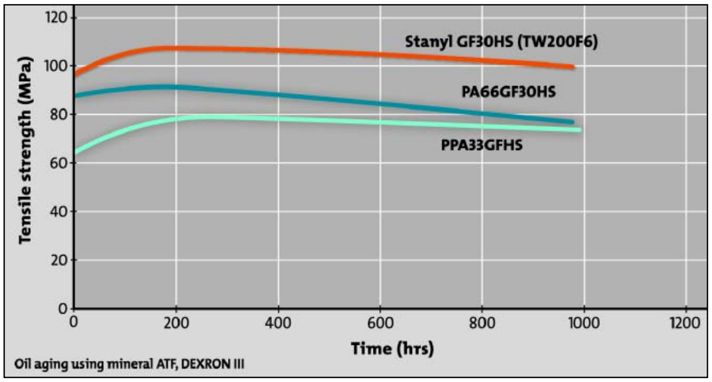
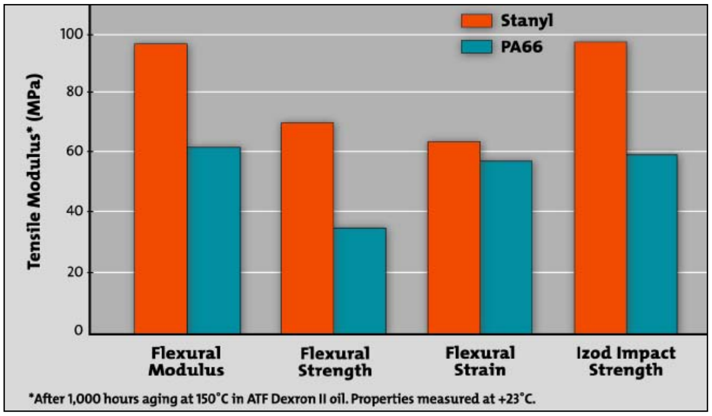


Figure 3 Retention of mechanical properties (30% glass fiber reinforced polyamides) after immersion in hot oil.



Chemical Resistance

Polyamides are well known for their resistance to a wide range of chemicals. Stanyl is no exception. At higher temperatures its resistance to oils and greases is excellent (see Figures 2-4).

Stanyl also has an outstanding resistance to fuels (see Figure 5), with low permeation levels (see Figure 6) even for alcohol containing fuels. Stanyl is therefore an ideal material for applications under the hood in the automotive industry and for other industrial applications such as gears and bearings.

As with all other polyamides, Stanyl is attacked by strong mineral acids and absorbs polar solvents. For more information concerning the resistance of Stanyl to various chemicals and solvents reference the chemical resistance chart at www.stanyl.com or contact your local DSM sales office.

Chemical Resistance

Figure 4 Influence of immersion in oil on flexural strength of 30% glass fiber reinforced polyamides.

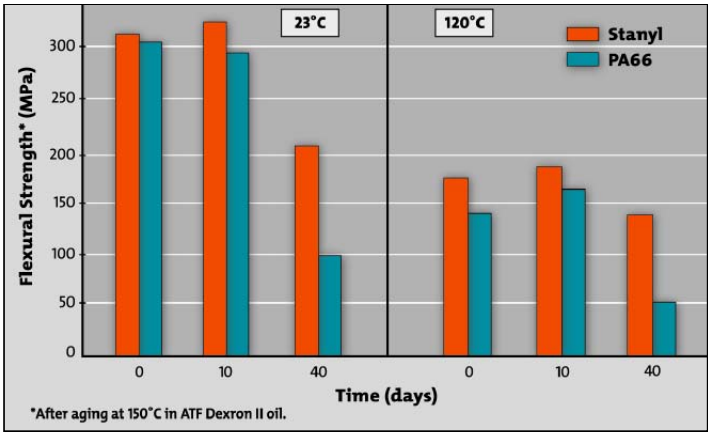


Figure 5 Fuel resistance 85% Methanol, 15% unleaded fuel.

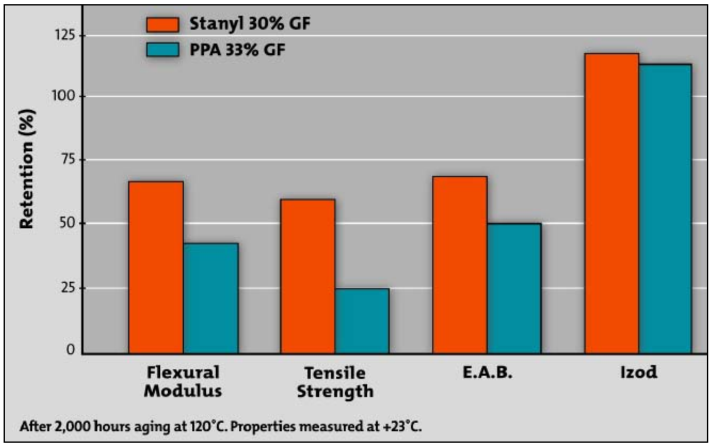


Figure 6 Fuel permeation M25 at 60°C.

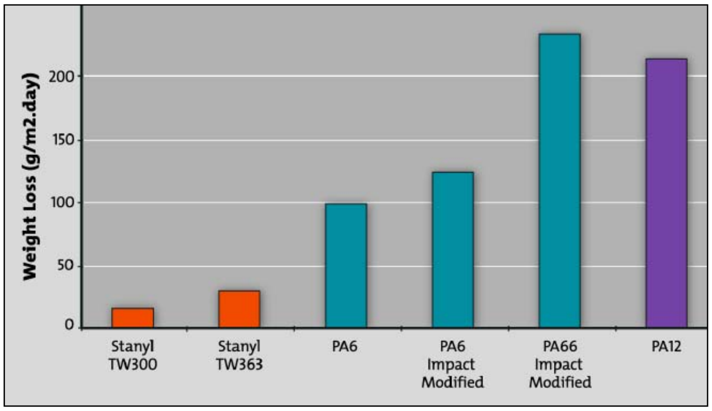


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Figure 7 Flexural modulus versus temperature.

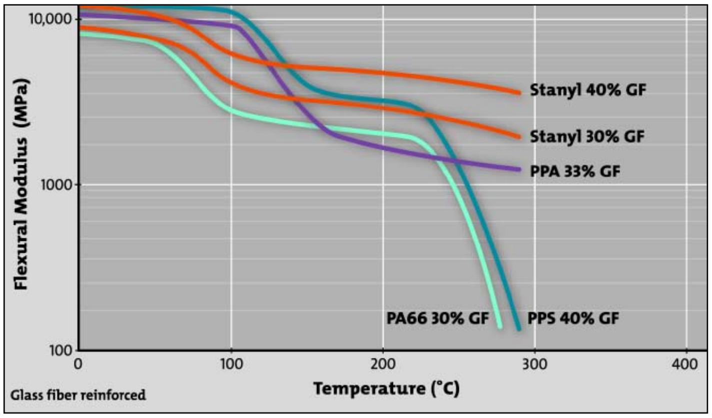


Figure 8 HDT of Stanyl versus LCPs.

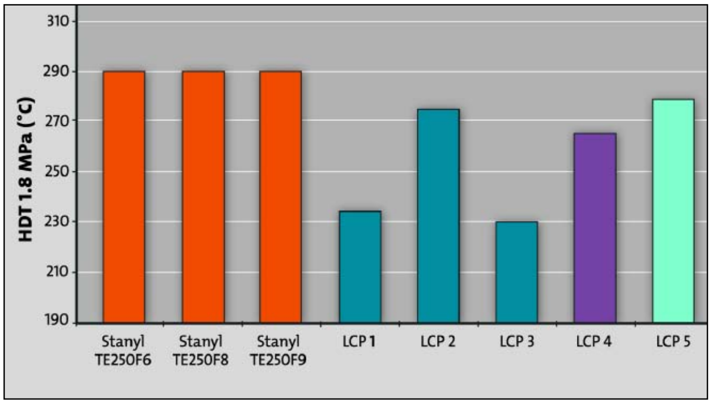
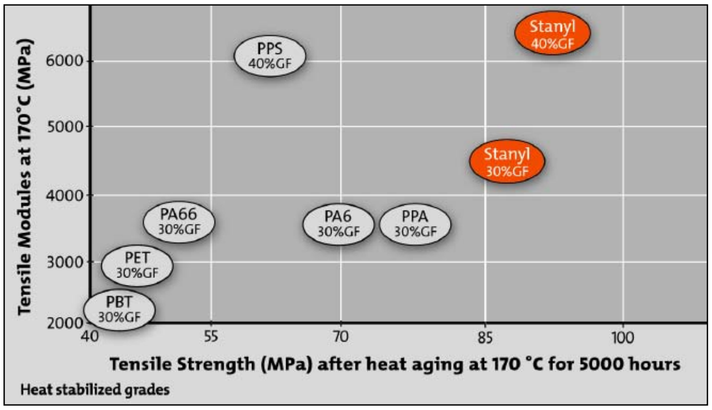


Figure 9 Positioning of thermoplastics according to ARO principle.



Thermal Properties

Stanyl has a temperature resistance similar to high heat materials like PPS, polysulfones, PEI and LCP's and above the well-known engineering plastics such as polyamide 6 or 66 and polyesters. Stanyl stands out from these other materials through its mechanical performance over the full temperature range. This is a critical factor in today's high-tech world where performance over a wide temperature range can often be of critical importance.

When designing with thermoplastics, the properties of a material for a given set of environmental conditions need to meet the critical design level required of the component. Most properties decrease as temperature increases and heat aging also occurs. Consequently performance at high temperature, either continuous and/or short term, needs to be considered when high temperature conditions apply.

Short-term heat performance. An indication for the short term temperature performance of a material is its stiffness and strength level at elevated temperatures, for instance between 100°C and 290°C. This stiffness/strength level at elevated temperatures should be considered as the critical level to design for, since room temperature levels for stiffness/strength are in general much higher, even after moisture absorption.

The melting point in combination with the Heat Distortion Temperature (HDT) gives another good impression of the peak temperature resistance under a certain load. The HDT is defined as the temperature at which a test bar is deformed to a given extent at a given load applied; this is related to a certain level of stiffness at the elevated temperature. Due to its excellent retention of stiffness at higher temperatures, Stanyl's HDT-rating of 190°C (375°F) for unreinforced and 290°C (555°F) for reinforced grades is higher than that of other engineering plastics or high performance materials.

Long-term heat performance. For designers it is crucial to know the performance level of the end product and therefore of the material at the end of its lifetime, which often means after exposure for thousands of hours to heat in an oxygen environment. This performance, the heat or air aging resistance, can be expressed in various ways. Different parameters like strength, stiffness, impact resistance, elongation at break can be selected to monitor the performance after heat aging over time and measured either at room temperature or at the elevated temperatures.

The results of these measurements can again be displayed in various ways; in a relative way via retention levels or via relative characteristics like Continuous Use Temperature and Relative Temperature Index, or in an absolute way, using the Absolute Real Operating (ARO) Value concept which shows the absolute value of the property measured, for instance at 150°C (300°F) after aging for several thousands of hours at 150°C.

The Continuous Use Temperature (CUT) is frequently used in the automotive industry as a selection criterion. It is defined as the temperature at which a given mechanical property, usually tensile strength or impact resistance, decreases by 50% within a certain period of time, usually 500, 1000, 5000, 10000 or 20000 hours. Stiffness and tensile elongation cannot be used to measure CUT since stiffness only increases after heat aging and tensile elongation shows a too sharp, non-discriminating drop for all materials. The CUT of 30% glass fiber reinforced Stanyl at 5000 hours is 175°C; the drop in tensile strength is 50% after 5000 hours of aging at 175°C. The different CUTs for different aging times are summarized in the Table 2.

The Relative Temperature Index as given by UL is commonly used in the E&E industry. It can be considered to a certain extent as a CUT for very long half-life times ranging between 60,000 and 100,000 hours. The RTI of heat stabilized Stanyl 30% GF is 140°C (280°F).

The Absolute Real Operating Value after heat aging gives designers more realistic comparisons between the various materials. It overcomes the major drawbacks of the CUT and RTI concepts in that only the retention of properties is considered and these properties are only measured at room temperature after heat aging. Certain materials that start at a very low level but retain this level to a high degree, as for instance PPS (Figure 10), are rated better in CUT terms than other materials which start at a higher level but show more of a reduction. Such materials can still outperform the former materials in absolute values after the heat aging exposure.

In addition, the CUT is based on measurements of properties at room temperature, while the more critical design levels are to be expected in the elevated temperature range.

The ARO concept, demonstrated in Table 2 and Figure 11, shows the superiority of Stanyl in comparison with PA66, PPA and PPS after heat aging at 150°C (300°F).

Table 2 Heat aging resistance as expressed by the CUT and ARO-concept and stiffness at elevated temperatures for Stanyl and competitive polyamides (30-33% GF reinforced).

Property	PA66	Stanyl	PPA
CUT 5000 hrs (°C)	130-170*	177	185
ARO 5000 hrs Strength at high Temp (MPa) after Aging at high Temp			
150°C	70	110	90
170°C	50	90	80
E-modules (MPa)			
150°C	4000	5000	4000
170°C	3500	4500	3500

*Depending on the exact heat stabilizer package and content used.

Figure 10 Tensile strength at 23°C after heat aging at 150°C for Stanyl and competitive thermoplastics.

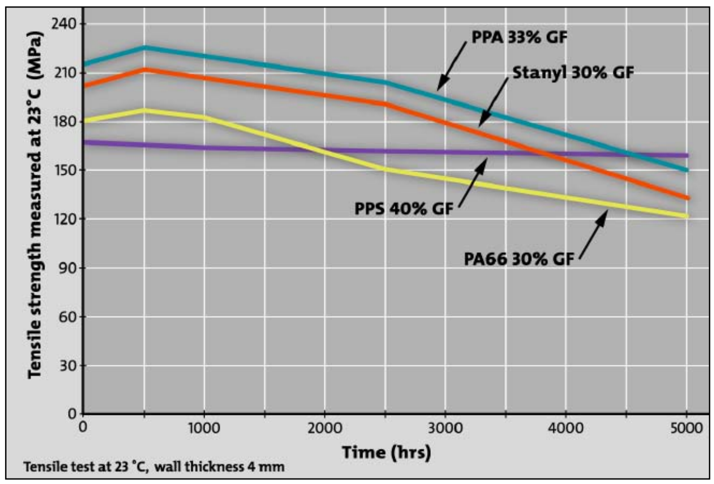


Figure 11 Absolute level of tensile strength at real operating temperature (150°C) after heating at 150°C for Stanyl and competitive thermoplastics.

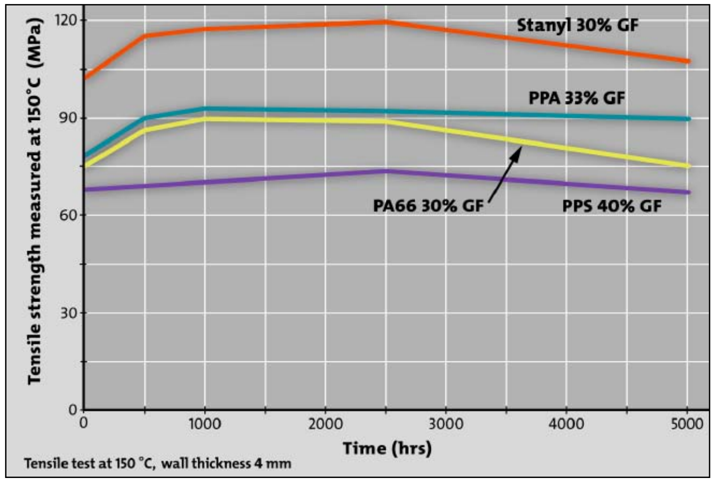


Figure 12 Flexural modulus versus temperature.

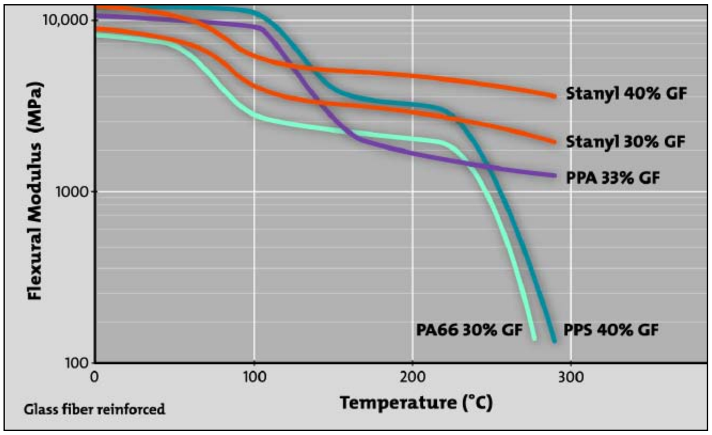
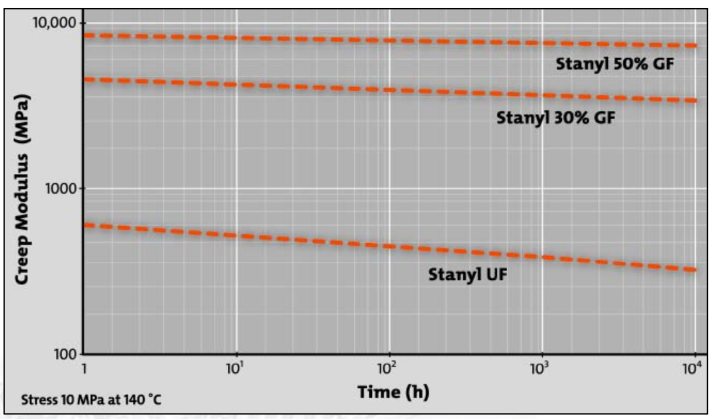
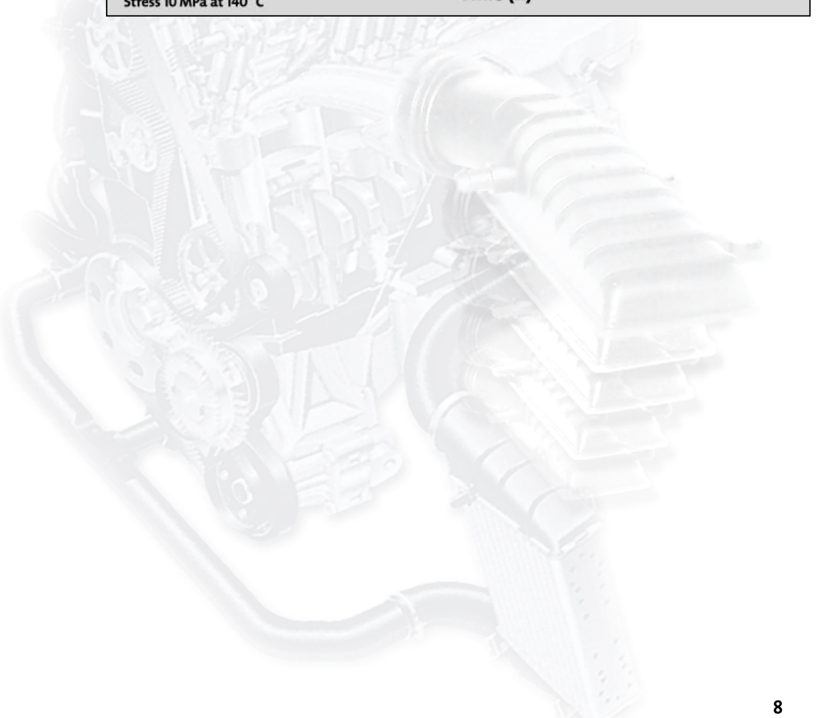


Figure 13 Effect of glass fiber reinforcement on the creep modulus of Stanyl at 140°C (285°F).





Mechanical Properties

The mechanical properties of Stanyl depend on temperature, moisture content, and aging time. The composition of the compound, particularly the type and amount of reinforcement and additives, has a large influence on the absolute level of these properties.

Stiffness. Due to its high crystallinity, Stanyl retains a high level of stiffness up to temperatures very close to its melting point. This provides wider safety margins for critical applications than standard engineering plastics (e.g. PA6, PA66, and polyesters). Other high heat resins (e.g. PPA and PPS) have a very high modulus at room temperature but show a significant drop in stiffness at elevated temperatures [above 100°C (210°F)] In practice, Stanyl has a higher stiffness at temperatures >100°C (210°F).

The stiffness advantage offered by Stanyl at elevated temperatures can be exploited by designing components with reduced wall sections, some 10 to 15% thinner than those necessary compared to PPA or PPS with the same level of glass fiber reinforcement. The weight savings achieved with Stanyl are important for automotive and aviation applications where weight is a vital issue. By adding reinforcements, stiffness levels can be increased further.

Creep resistance. For optimum performance and maximum lifetime, engineering plastics, which are subjected to long-term loading, must have a high creep resistance (i.e. low plastic deformation under load). Stanyl's high crystallinity results in an excellent retention of stiffness at elevated temperatures [above 100°C (210°F)] and hence in a creep resistance which is superior to that of engineering plastics and other heat-resistant materials.

Creep behavior is one of the factors that limit the maximum application temperature of a material. When Stanyl and PA66 or PPA are compared at the same temperature exposure, several alternatives exist:

- **Decrease the wall thickness by using Stanyl (with an equivalent level of reinforcement)**
  - Reduces material usage and cost
- **Use a Stanyl grade with a lower level of reinforcement than is possible with PA66 (for equal wall thickness)**
  - Giving greater design freedom due to a higher elongation at break
  - Facilitating the use of snap-fits
  - Lowering material consumption per part due to a lower density

Only Stanyl offers a real performance improvement over PA66 (see Figure 14).

Toughness and fatigue. Toughness, or ductility, is usually measured by impact resistance (related to high speed) and (tensile) elongation (low speed). While tensile and flexural strength decrease with increasing temperature, toughness increases. Therefore, toughness is usually most critical at lower temperatures. For automotive applications indeed the low temperature impact at -30 or -40°C is critical. For many E&E applications, toughness at room temperature or elevated temperatures is important in processes such as pin insertion, winding operation and soldering. Due to its fine crystalline structure, Stanyl exhibits unmatched toughness/ductility in comparison with many other engineering plastics/heat resistant resins. Notched Izod or Charpy impact values remain at a high level even at temperatures below 0°C (32°F). These are detailed further in the Product Database found at www.dsmep.com.

Figure 14 Creep behavior of glass fiber reinforced Stanyl versus competitive glass fiber reinforced materials at 160°C and load 20 MPa.

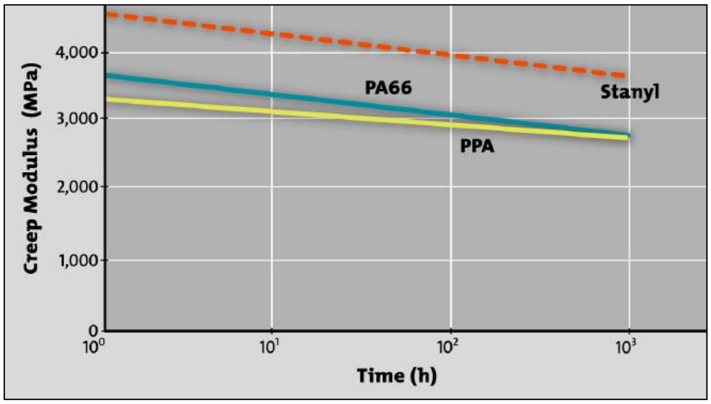


Figure 15 Creep modulus of unreinforced polyamides at 120°C load 10 MPa.

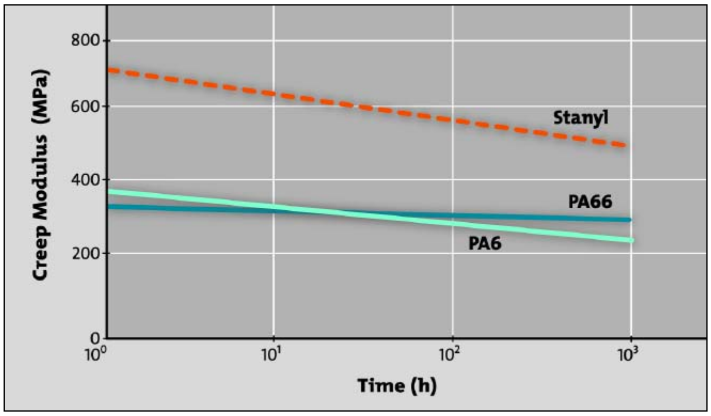


Figure 16 Impact (23°C DAM) and temperature resistance of unreinforced thermoplastics.

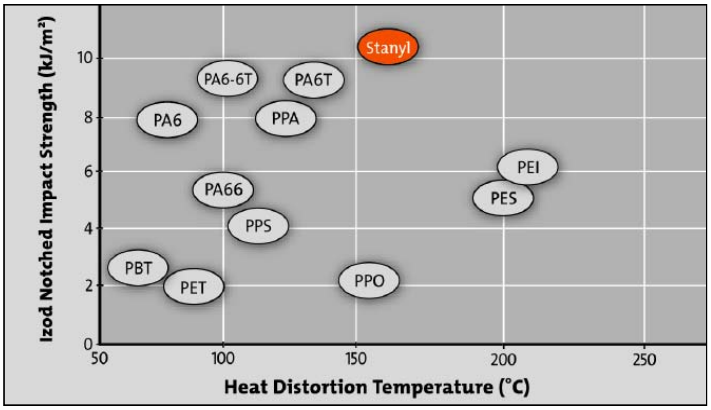


Figure 17 Impact resistance of glass fiber reinforced thermoplastics.

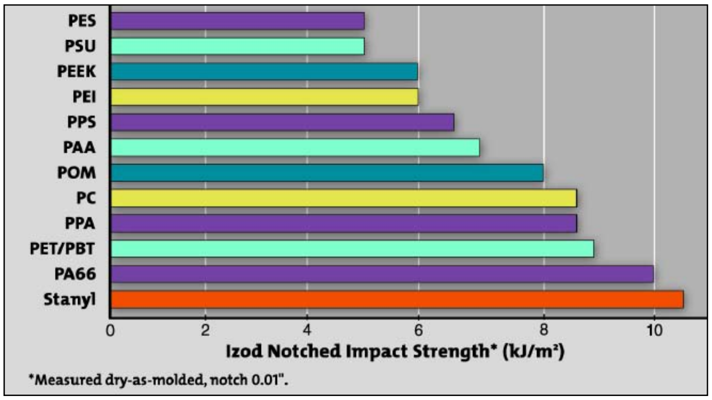


Figure 18 Tensile and temperature behavior of 30% glass fiber reinforced thermoplastics.

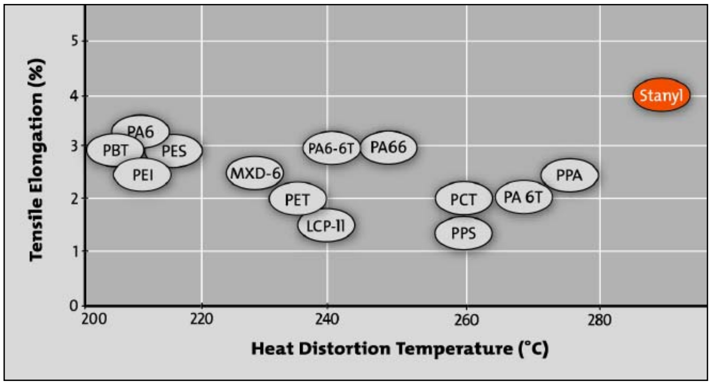
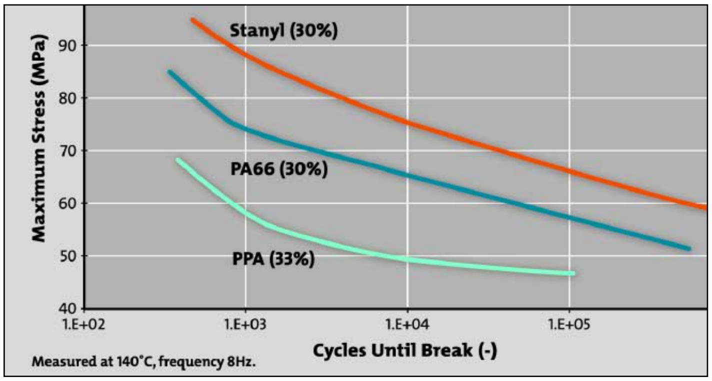


Figure 19 Fatigue behavior of glass fiber reinforced Stanyl versus polyamide 66 and PPA.

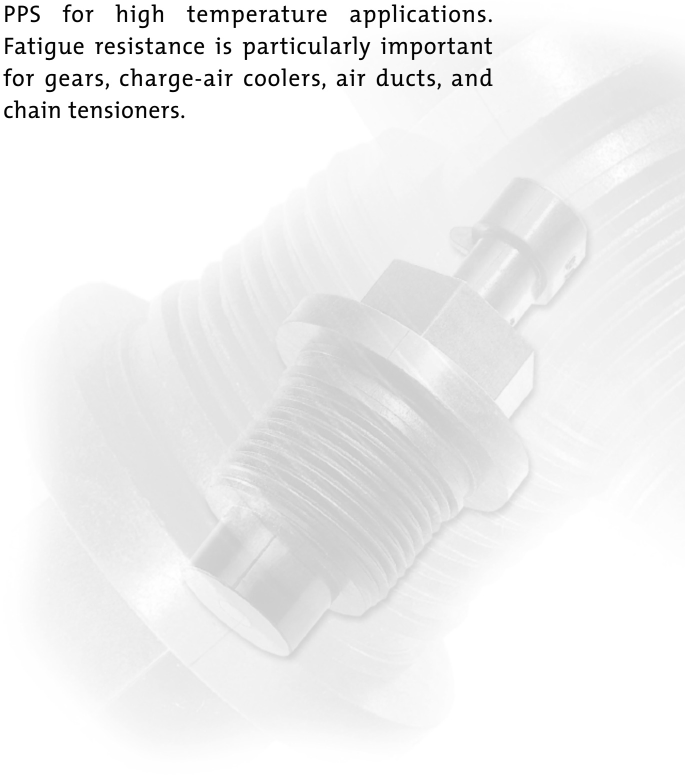


The effect of different amounts of glass fiber reinforcement is different for both toughness parameters. With increasing reinforcement percentages, the elongation at break decreases while the Izod or Charpy impact resistance increases.

The Izod or Charpy impact resistance of glass fiber reinforced Stanyl is also unmatched. This makes Stanyl the material of choice for demanding applications and facilitates further assembly steps, for instance using inserts and snap-fits. The very high elongation at break of Stanyl offers the best solution for thin-walled parts, film hinges, and insert molding (eg in gears and pulleys).

The high crystallinity and fine crystalline structure of Stanyl lead to a fatigue resistance superior to that of most other engineering and heat-resistant resins.

Stanyl offers a significant improvement in fatigue resistance compared to PA66, PPA and PPS for high temperature applications. Fatigue resistance is particularly important for gears, charge-air coolers, air ducts, and chain tensioners.



Electrical Properties

When using Stanyl in E&E applications one of the main functions is electrical insulation. The insulating power of a thermoplastic can be expressed in several ways:

- **The material conducts current homogeneously, through the bulk or via the surface.**
  (Related properties: volume resistivity and dielectric strength.)

- **The material breaks down and conducting paths are formed through the bulk.**
  (Related properties: breakdown voltage and dielectric strength.)

- **The surface is degraded gradually by the electric field, arcing and/or contamination, and conducting paths are formed in the surface.**
  (Related properties: arc resistance, high voltage tracking rate and comparative tracking index.)

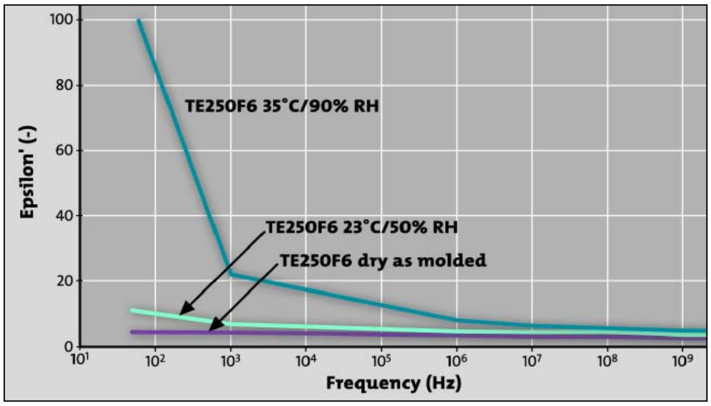
- **Also heat formation, caused by above phenomena (or by other electrical sources) may ignite the material.**
  (Related properties: hot wire ignition and high-ampere arc ignition.)

- **The combination of metal, insulating material, moisture and contaminants may cause special chemical and physical degradation processes.**
  (Related properties: electrolytic corrosion.)

- **Effects of alternating current are polarization (loss of current and electronic signal noise), related to the dielectric constant and dissipation of energy (temperature rise), related to dissipation factor or loss index.**

The exact levels of the electrical properties mentioned above depend on the specific grade, temperature, and moisture content. In general these properties are sufficiently retained at elevated temperatures to fulfill critical application requirements. More detailed information is available under Product Data at www.dsmep.com or at www.ul.com

Figure 20 **Low and stable dielectric constant of Stanyl at high frequencies.**



In addition, Stanyl offers low and stable values for dielectric constants at high frequencies which is key in designing today's IT connectors. Moisture uptake may increase the dielectric constant, however this effect is only seen at low frequencies and not at the high frequencies typically encountered in current or future IT equipment (see Figure 20). DSM has developed a Stanyl portfolio combining excellent performance for E&E applications with outstanding long-term performance, including several High Flow grades (see Table 1 on Page 3).

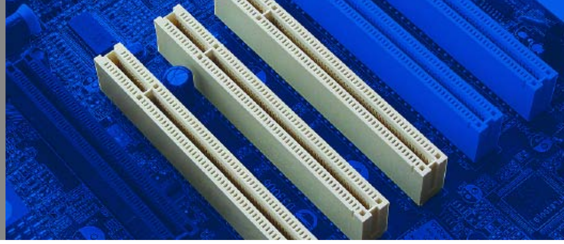


Table 3 UL 1446 insulation system recognition for Stanyl.

UL 1446 classes	Stanyl Grades
B 130°C (265°F)	TE250F6, TE250F8, TE250F9, TW250F6, 46HF5040
C 155°C (310°F)	TE200F6, TE250F6, TE250F8, TE250F9, TW200F6, TW250F6, TW300, TW341, 46HF5040
H 180°C (355°F)	TE200F6, TE250F6, TE250F8, TE250F9, TW200F6, TW250F6, 46HF5040

Table 4 Glow wire flammability index for Stanyl grades.

Generic Type	Grade	Color	Thickness mm	GWIT °C	GWFI °C
Stanyl Unreinforced	TE300	NC	0.75	775	775
		NC	1.5	700	825
		NC	3	700	960
	TE341	NC	0.75	725	750
		NC	1.5	700	675
		NC	3	700	650
Stanyl Glass reinforced	TE200F6	NC	0.75	700	675
		NC	1.5	700	650
		NC	3	725	925
	TW200F6	NC	0.75	700	650
		NC	1.5	675	700
		NC	3	725	960
	46HF4130	NC	0.75	700	675
		NC	1.5	700	650
		NC	3	725	960
Stanyl Glass reinforced, Flame retardant	TE250F3	NC	0.75	800	960
		NC	1.5	775	960
		NC	3	825	960
	TE250F6	NC	0.75	825	960
		NC	1.5	800	960
		NC	3	850	960
	TE250F8	NC	0.75	800	960
		NC	1.5	800	960
		NC	3	925	960
	TE250F9	NC	0.75	825	960
		NC	1.5	800	960
		NC	3	925	960
	TW250F6	NC	0.75	800	960
		NC	1.5	775	960
		NC,BK	3	925	960
	46HF5040	NC	0.75	850	960
		NC	1.5	800	960
		NC	3	925	960
	46HF5050	NC	0.75	825	960
		NC	1.5	800	960
		NC	3	925	960
	46HF5041LW	NC	0.75	825	960
		NC	1.5	800	960
		NC	3	925	960

Flame Retardancy

UL classifications. A number of flame-retardant grades have been developed, rated V-0 according to the Underwriters Laboratories UL 94 classification [even at 0.35 mm (0.01 in)]. These include High Flow flame retardant grades. For many of these grades 50-100% regrind V-0 ratings have been obtained which gives advantages through lower waste generation and lower material costs. Unmodified, unreinforced Stanyl grades are rated V-2 and the glass fiber reinforced grades without flame retardant are rated HB. Other classifications according to a number of UL standards have been obtained for different Stanyl grades.

In Table 3, the most important ratings according to UL 1446 have been summarized. The class H [180°C (355°F)] rating according to UL 1446 for the glass fiber reinforced grades of Stanyl is noteworthy. A complete overview of all UL listings is available at your local DSM sales office or at www.ul.com.

Flammability. Flammability of materials can also be expressed in terms of glow wire ignition temperature and glow wire flammability index. This is to simulate the short-term effect of thermal stresses caused by e.g. heat sources (heating elements) or overloaded resistors. Testing of end products is required in safety standards for all kinds of electrotechnical equipment.

Glow wire ignition temperature and glow wire flammability index can be used for pre-selection of materials for such applications. Both glow wire ignition temperature and flammability index depend on the thickness of the samples and the specific grade. For an overview for Stanyl grades see Table 4 (measured according to IEC 60695-2-12 GWIT and IEC 60695-2-13 GWFI). More detailed information is also available in the product database at www.dsmep.com.

Effects of Moisture

As with any other polyamide, Stanyl absorbs moisture reversibly due to the presence of the amide groups in the molecular chain. Moisture absorption is dependent on the temperature, the relative humidity of the environment, and the wall thickness of the specific part. In general moisture absorption results in a decrease of the glass transition temperature (see Figure 21), which may lead to an increase in toughness and reduction in stiffness and strength at room temperature.

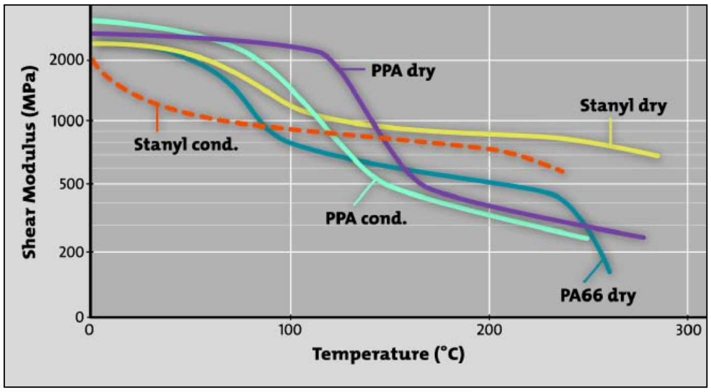
This drop in stiffness for Stanyl is small compared to the drop for other polyamides due to Stanyl's high level of crystallinity. The performance above the glass transition temperature [75°C(165˚F)] is not affected by moisture uptake. As Stanyl is typically used at higher operating temperatures, the effect of moisture will not be noticed.

Competitive materials such as semi-aromatic polyamides have a higher Tg, often in the operating temperature range. A shift in Tg due to moisture uptake will in this case lead to a change in properties at the critical operating temperatures.

In addition, due to this higher Tg, higher mold temperatures are required, resulting in the need for oil or electrically heated molds, with higher safety risks, higher mold and maintenance costs, and more difficult processing.

For prolonged exposure above 100°C (210˚F), Stanyl dries out, especially rapidly at higher temperatures, and properties will approach those given by the "dry" curve. This leads to a consistent property profile over a wide temperature range, especially once the effects of annealing are taken into account.

Figure 21 Shear modulus of glass fiber reinforced thermoplastics.



Astonishing Stanyl®

Figure 22 Water absorption at 23°C/50%RH followed by desorption at 180°C of Stanyl (3.2 mm thickness sample).

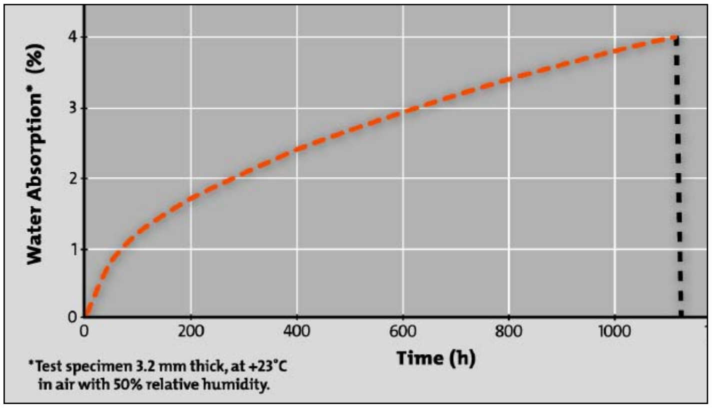


Table 5 Typical CLTE values for Stanyl grades.

Grade Type	Direction	Value	Unit
Reinforced	Parallel	0.2	E-4/°C
	Normal	0.8	E-4/°C
Unfilled	Parallel	0.8	E-4/°C
	Normal	1.0	E-4/°C

Table 6 Dimensional change as a function of moisture uptake of non-flame retardant grades.

Dimensional Change (%) in Flow/Per. to Flow	Stanyl	Stanyl 30% GF	PA66 30% GF	PPA 30% GF	Stanyl 50% GF
50%RH - oriented part	0.7/0.7	0.15/0.6-0.9	0.1/0.4	0.1/0.3-0.4	0.1/0.5-0.8
50%RH - non oriented part	0.8/0.8	0.3/0.6-0.9	0.15/0.4	0.15/0.3-0.4	0.3/0.3-0.6
90%RH - oriented part	1.8/1.9	0.35/1.4	0.2/1.0	0.2/0.5	0.2/1.2
90%RH - non oriented part	2.2/2.2	0.5/1.5	0.4/0.9	0.2/0.3	0.8/0.8

Table 7 Dimensional change as a function of moisture uptake of flame retardant grades.

Dimensional Change (%) in Flow/Per. to Flow	PPA 30% GF V0	Stanyl 30% GF V0	Stanyl 40% GF V0	Stanyl 45% GF V0
50%RH - oriented part	0.1-0.15/0.3	0.1-0.2/0.5	0.1-0.15/0.4	0.05-0.1/0.4
50%RH - non oriented part		0.2-0.3/0.5	0.15-0.25/0.5	0.15-0.25/0.5
90%RH - oriented part	0.15-0.2/0.5	0.2-0.3/1.1	0.15-0.2/1.0	0.15-0.2/0.9
90%RH - non oriented part		0.4-0.6/1.1	0.4-0.5/1.0	0.4-0.5/0.9

Note: oriented part: thickness 2mm / non oriented part: thickness 3-4 mm

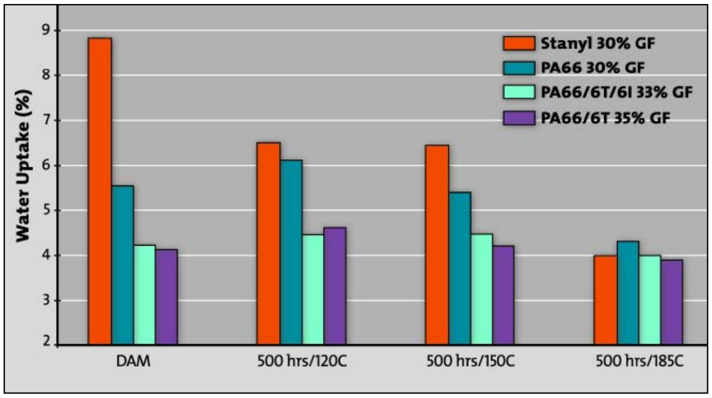
Moisture uptake leads to dimensional changes. However, because highly filled compounds are used, in many applications this dimensional change is limited. Due to glass fiber orientation, dimensional changes mainly take place in the direction perpendicular to the flow direction (thickness of the part, see Tables 6 and 7). This is the direction that in terms of dimensions is often the least critical. The effect of moisture on dimensions is small compared to the dimensional change due to temperature changes (Coefficient of Linear Thermal Expansion, see Table 5). Stanyl exhibits excellent performance in many applications where dimensions are very critical, including many small connectors, gears, or SMT components. For E/E applications where dimensional stability is very critical, special flame retardant, reinforced grades have been developed: 46HF5050 and 46HF5041LW.

Moisture absorption usually takes place at room temperatures. This is a rather slow process taking a long time before equilibrium is reached. When using the application at operating temperatures, which for Stanyl parts is often above 100°C (210°F), drying is extremely fast. Therefore, full saturation is not seen in typical applications (see Figure 22) and effects of moisture uptake are very limited.

Annealing significantly reduces moisture uptake. Moisture absorption is significantly reduced upon annealing of Stanyl. Annealing results in densification of the amorphous part of Stanyl upon exposure at high temperatures (>100°C). This phenomenon is unique for Stanyl and is irreversible. Annealing takes place during operation at elevated temperatures in for instance automotive applications. Annealing may result in a moisture uptake reduction by a factor three. Annealing can also be used as a separate step to improve the dimensional stability of Stanyl parts (preferably using a nitrogen atmosphere). Moisture uptake reduction depends on the annealing time and temperature. DSM has developed a model to quantify this. Please contact your local sales engineer for further information.

Properties such as stiffness, strength, fatigue, creep and abrasion resistance are generally improved upon annealing while toughness might be slightly reduced, although still at a level that outperforms competitive materials. This leads to a strongly improved property profile for applications such as gears.

Figure 23 Reduction of water uptake of Stanyl GF and competitive materials at several annealing conditions.



Effects of Moisture

Blistering. Moisture uptake at extreme humidities may lead to blistering during soldering at very high peak temperatures close to a material's HDT. This is a phenomenon not unique to Stanyl. It is also observed for other polyamides and even for LCPs. Blistering can be prevented by protection from moisture, and optimized processing.

Molded part after molding

– Keep parts under dry circumstances as much as possible.

– Record the actual molding date to control the time to re-flow process.

Detailed information on blistering in connectors can be found at www.dsmep.com.

Moisture control during processing. During melt processing, a high moisture content may lead to the occurrence of silvery streaks or splash marks on the surface of the final parts. In extreme cases it may lead to degradation of the base polymer resulting in a drop in viscosity. To prevent this Stanyl granules are supplied dry in airtight, moisture proof bags. Should your Stanyl material come into contact with ambient air for extended periods, moisture will be absorbed and it should be dried prior to processing.

Drying

– Dryer should be a dehumidifying dryer or vacuum dryer (not hot air oven).

– Material before molding should contain below 0.1% moisture.

– Regrind material also should be dried before molding.

– Regrind material size should be uniform as much as possible.

– Content of regrind material should be controlled.

Molding

– Temperature at the nozzle should be controlled precisely.

– Frequently check the wear of sealing ring at the front.

– Tool temperature should be set between 80 to 120°C (175 - 250°F).

– Barrel temperature setting should be set 310°C +/-10°C (could be different for High Flow grades. Contact your local sales representative for more information).

– Keep residence time in screw as short as possible.

– Keep screw RPM as low as possible.

– Backpressure should be set around 5 kg/cm^2.

– Injection speed should be set as fast as possible.

– Select suitable holding pressure and time.

– Suckback should be set as low as possible.

– At the start purge should be done sufficiently.

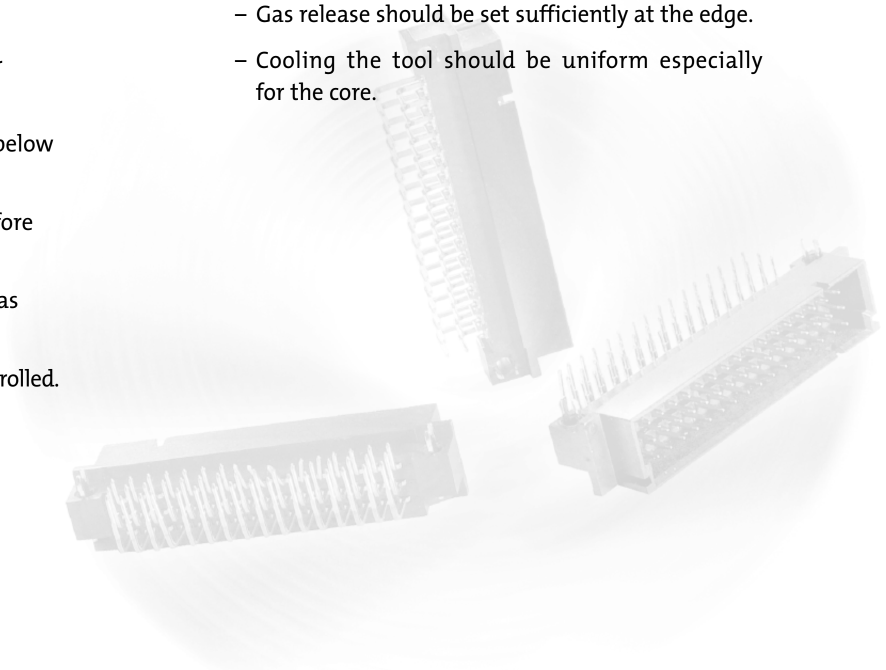
Tool design

– Sprue/runner/gate should not be too small.

– Top of the submarine gate should be "R" design.

– Gas release should be set sufficiently at the edge.

– Cooling the tool should be uniform especially for the core.



Wear & Friction

Stanyl has an excellent abrasion resistance (or wear resistance) and outperforms most other engineering/high performance plastics under most conditions but especially at higher temperatures and/or high torque/loads. Although the coefficients of friction of standard grades of these materials are quite similar, Stanyl outperforms its competitors. The main reason is its higher PV rating, which permits higher pressures or velocities to be used.

Where other materials fail when using demanding application conditions (high temperature, high loads, high velocities, harsh chemical environment, vibrations) due to melting (POM, PA6), brittle behavior (PPS, PPAs), low stiffness at high temperatures (POM, PPS, PA6, PA66, PPAs) or high abrasiveness (PPS), Stanyl will deliver smooth and reliable performance (see Figures 24-29).

Modified Stanyl grades with even better wear properties are available in unreinforced as well as glass fiber reinforced form. Its smooth and tough surface, combined with its stiffness at elevated temperatures, high melting point, high fatigue and vibration resistance, high resistance against crack propagation and resistance against oil and greases, make Stanyl an ideal material for sliding parts like valve lifter guides, chain tensioners (see Figure 27), gears, bushings, and thrust washers.

Figure 24 Comparison between Stanyl, PA66, & POM with respect to Taber Abrasion Test (ASTM D1044).

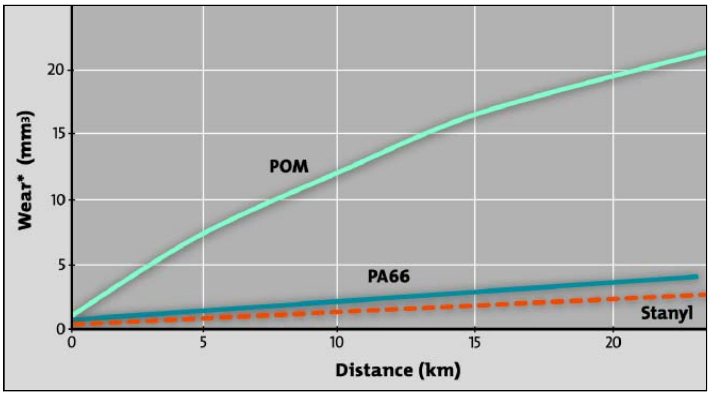


Figure 25 Stanyl performs better than POM at high PV combinations.

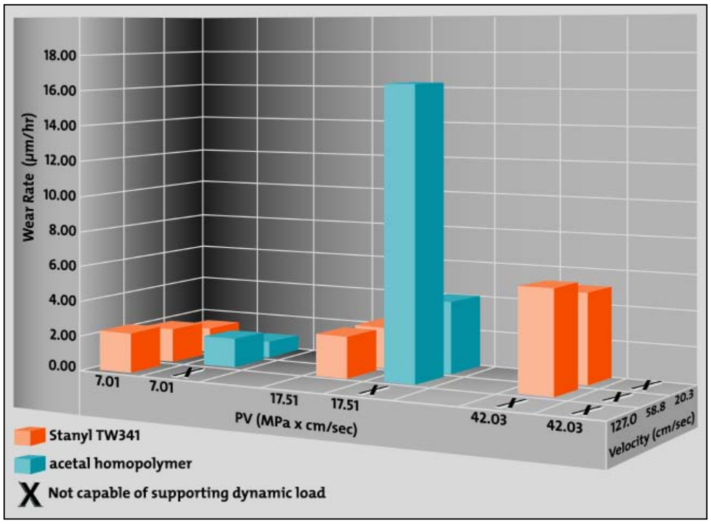


Figure 26 Stanyl performs better than PPA at high PV combinations.

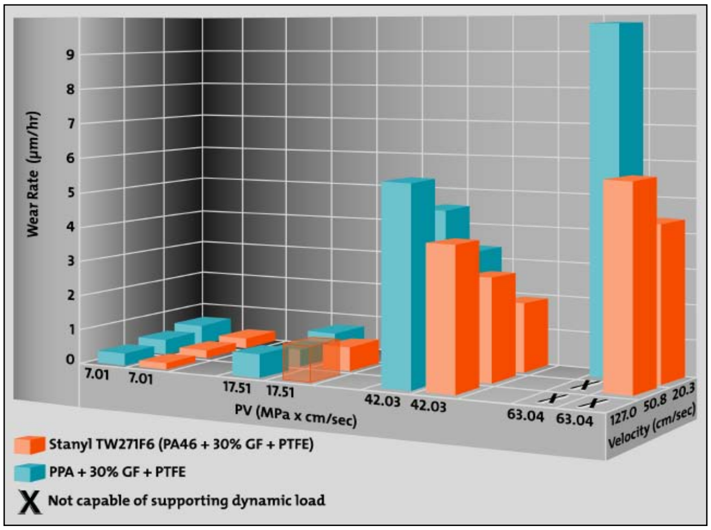


Figure 27 Chain tensioner wear testing: Stanyl UF outperforms PA66 UF.

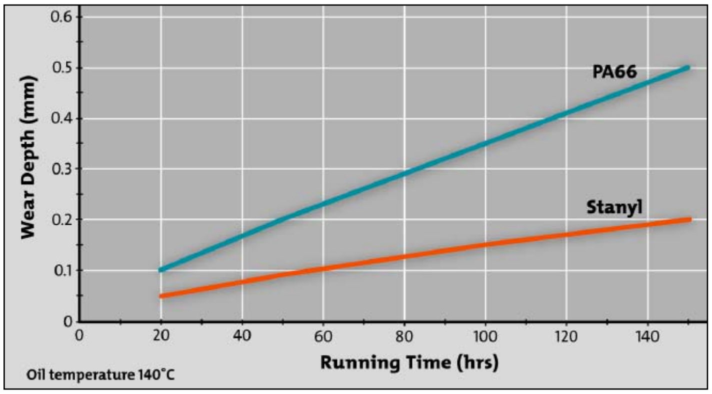


Figure 28 Stanyl performs better than PPS at high PV combinations.

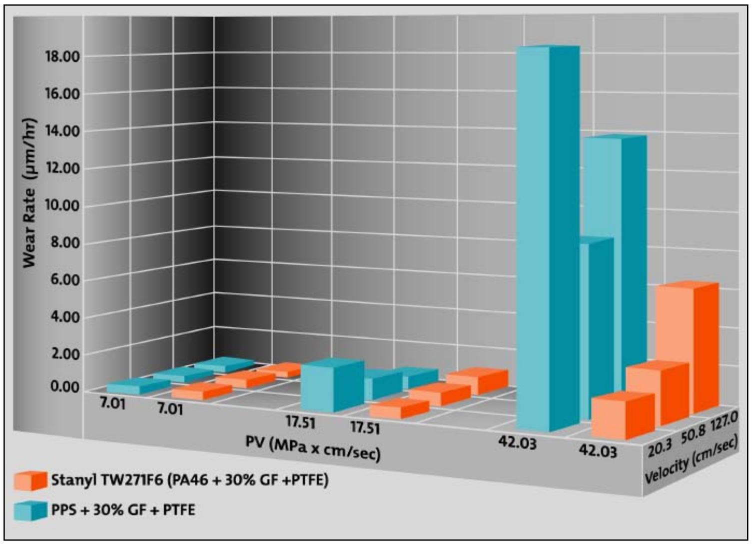
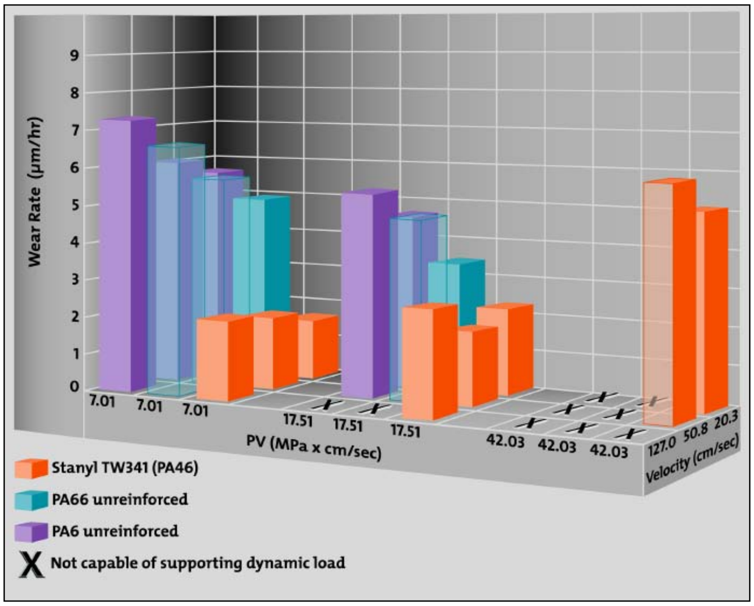


Figure 29 Stanyl performs better than PA6 and PA66 at both low and high PV combinations.



Designing with Stanyl

Design

Due to its unique combination of properties, Stanyl can compete across a wide range of the engineering plastics market. Some applications which might be designed in polyamide 6 or 66 may actually be more economical to produce in Stanyl if Stanyl's faster crystallization rates can be used to advantage by reducing cycle times enough to more than offset the higher cost of Stanyl. In addition, Stanyl is often used in applications originally thought to be reserved for high temperature amorphous resins such as PES, due to the high continuous use temperature ratings of these resins. In fact, Stanyl's higher deflection temperatures under load and higher shear modulus at elevated temperatures make it the better choice. Stanyl's high flow characteristics have allowed it to work in application areas once reserved only for LCPs.

When designing for electrical / electronic applications Stanyl provides thinner wall sections, long flow paths, multi-cavity tools, lower scrap rates (complete fill of cavities, lower breakages on demolding), lower rejects on pin insertion, and higher pin retention for more durable components.

For more information on designing with Stanyl visit www.dsmep.com.

Processing with Stanyl

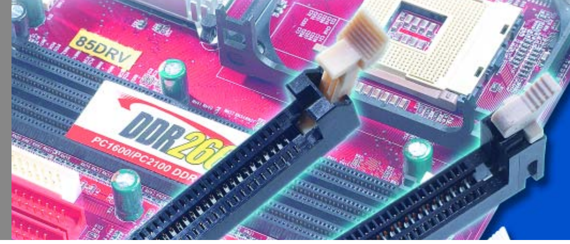
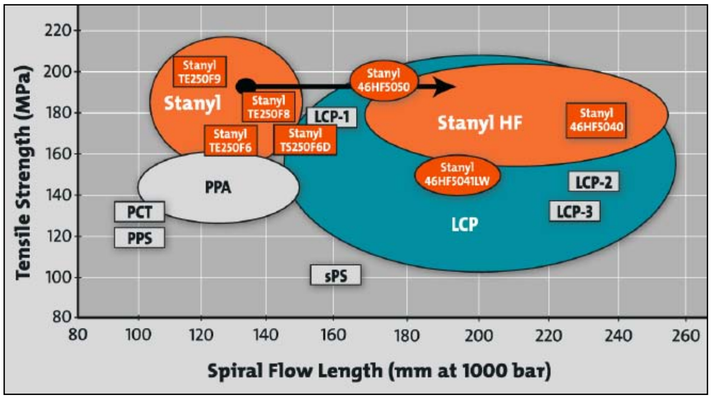


Figure 30 Spiral flow versus tensile strength.

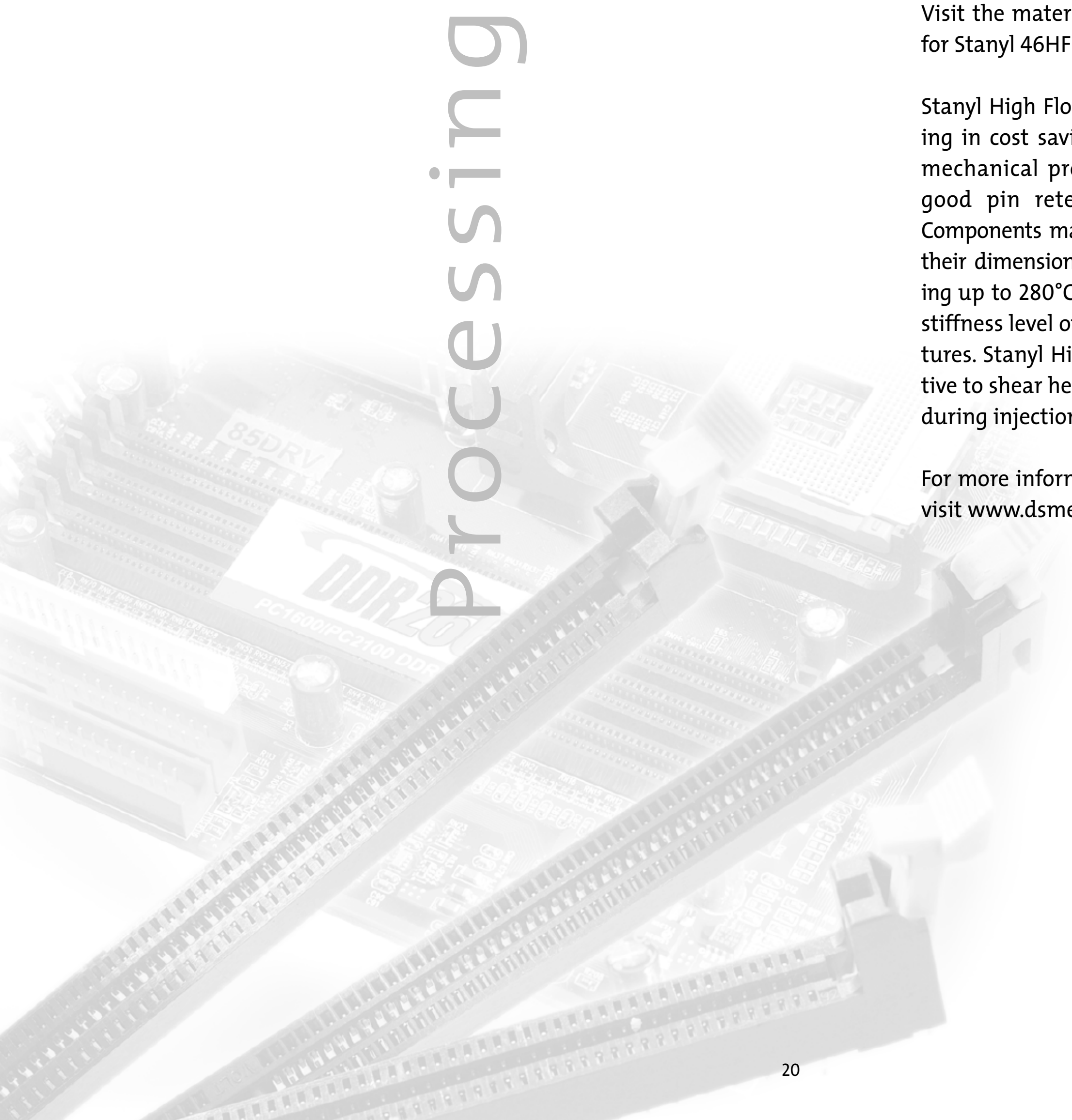


Stanyl combines excellent flow properties during injection molding with a high level of mechanical properties (strength, toughness and stiffness), short cycle times (high productivity) and high temperature resistance (high heat distortion temperature, high melting point). Therefore Stanyl can be used in thin walled application (like connectors).

Processing with Stanyl High Flow. Flow is even further improved for Stanyl High Flow grades, matching flow of the best flowing LCPs while maintaining high level of mechanical properties, a unique combination! Three commercial flame retardant High Flow grades (UL-94 V-0 ratings) are available for E&E applications (including improved dimensional stability grades) as well as two non flame retardant materials. Visit the material database at www.dsmep.com for Stanyl 46HF designated grades.

Stanyl High Flow grades can replace LCP, resulting in cost savings of up to 50% due to better mechanical properties (eg weldline strength) good pin retention and low rejects levels. Components made of Stanyl High Flow maintain their dimensional integrity during reflow soldering up to 280°C (535°F) due to the extreme high stiffness level of the materials at these temperatures. Stanyl High Flow materials are less sensitive to shear heating and need different settings during injection molding.

For more information on processing with Stanyl visit www.dsmep.com.



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