HIGH-TECH POLYAMIDES
UNDER THE HOOD

Improved performance in the engine compartment

Our Durethan® polyamide compounds (PA 6 and PA 66) are proving successful in an increasing number of under-the-hood applications. They are mainly used for cooling and oil system components, airflow management, covers and housings. They often replace metals such as steel and aluminum or thermosetting plastics. We are responding to the latest trends in engine and drive technology by developing new materials. These meet the growing demands placed on components and are optimized for all kinds of processing and machining – such as water injection technology and laser welding. Our material innovations include

- a PA 66 that can withstand continuous service temperatures of up to 230 °C and is suitable for applications such as turbocharged engine components thanks to the new XTS2 temperature stabilization system
- a PA 6 and a PA 66 grade that enable a larger process window and enhanced surfaces when blow molding items such as air ducts
- weldable PA grades that cater to the trend toward higher engine compartment temperatures, higher bursting pressures and components with complex geometries

Our HiAnt® competence package is a valuable tool that combines our material, design, simulation, process and test know-how. It enables us to support our customers and their partners throughout the development of innovative engine compartment components – from the concept phase all the way through to the start of series production.

- Cooling water distributor made of Durethan® DPAKV50HRH2.0

Cooling system – outstanding long-term stability against coolants

The cooling system is principally the domain of the hydrolysis-stabilized Durethan® HR (hydrolysis-resistant) PA 66 grades. They resist aging in the presence of water glycol coolants at operating temperatures of up to 130 °C. Typical applications include coolant pipes, distributors and expansion reservoirs. One example of this line is Durethan® DPAKV50HRH2.0. Its excellent stiffness at high temperatures makes it ideal for oil modules with water glycol cooling. Our Durethan® HR line also includes

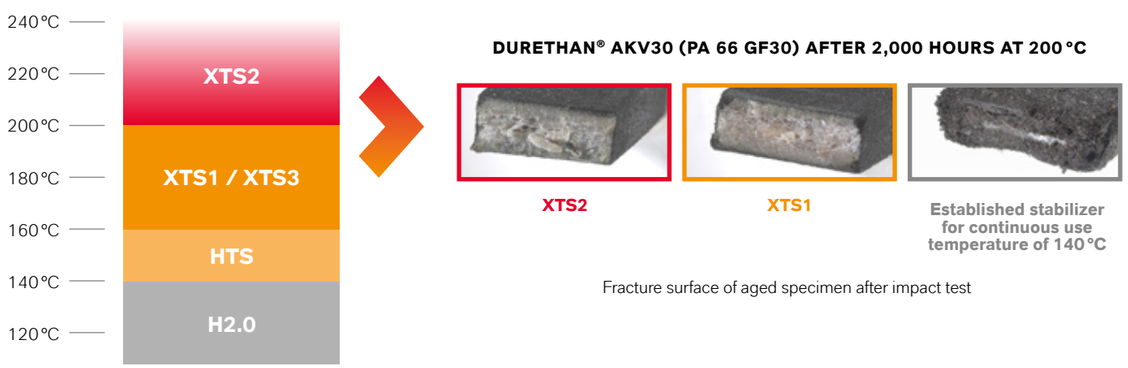
- materials for special processes such as water/gas injection technology (WIT/GIT), including grades that produce very smooth interior pipe surfaces
- highly reinforced injection molding grades for components of the cooling system that also perform load-bearing functions or have to withstand high internal pressures
- very easy-flowing material variants for delicate and thin-walled parts

Temperature-stabilized polyamides for continuous temperatures of up to 230 °C

Plastic under-the-hood components are exposed to a wide range of thermal stresses. We have therefore developed precisely coordinated additive systems for thermostabilization that enable our polyamides to withstand continuous service temperatures ranging from 120 °C to far in excess of 200 °C (see figure). The XTS2 (Xtreme Temperature Stabilization) system is a new development and a real highlight. The Durethan® XTS2 product line boasts outstanding stability at continuous service temperatures of up to 230 °C and is designed for hightech engine compartment applications that are subject to unusually high temperatures – such as air intake manifolds with integrated charge air coolers or media hoses for transporting air in the vicinity of the turbocharger. It offers an alternative to costly heat-stabilized specialty thermoplastics such as fully and semi-aromatic polyamides and polyphenylene sulfide.

The established XTS1 and XTS3 systems enable continuous use of our PA 6 and PA 66 grades at around 200 °C. Like H3.0 thermostabilization, XTS3 benefits from a very low metal and halide content. The material grades incorporating these systems can also be produced in light colors and are ideal for making plastic parts that come into direct contact with metal components. The metal- and salt-free stabilization minimizes contact corrosion. Typical applications include housing parts, plug connectors and connector strips. The XTS1 and H2.0 systems, on the other hand, are intended for black components where contact corrosion is not an issue.

The XTS1, XTS2 and XTS3 temperature stabilization systems enable a further big improvement in the long-term thermal stability of Durethan®.



Fracture surface of aged specimen after impact test

HIGH-TECH POLYAMIDES
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Airflow management – a cost-effective alternative to elastomer combinations

We offer a wide range of high-viscosity, blow-moldable polyamides with and without glass fiber reinforcement for engine airflow management components. Typical applications include media hoses for transporting air such as charge air tubes and clean air lines. The design concept for these materials envisages them as a cost-effective alternative to elastomer combinations. The range includes highly flexible, supertough product grades such as a PA 6 grade with an elasticity modulus of only 210 MPa (conditioned). This is used in particular for extrusion blow molding of charge air tubes with integrated flexible bellows as a single-material solution.

The PA 66 grade Durethan® AKV320ZH2.0 and the PA 6 grade Durethan® BKV320ZH2.0 are new. These glass fiber reinforced compounds are primarily tailored to 3D suction blow molding of hollow components such as air ducts for supercharged engines. Designed for largescale manufacturing, both materials benefit from a wide processing window and deliver excellent surface quality.

The latest product developments involve transferring the XTS2 system to our blow-molding portfolio.

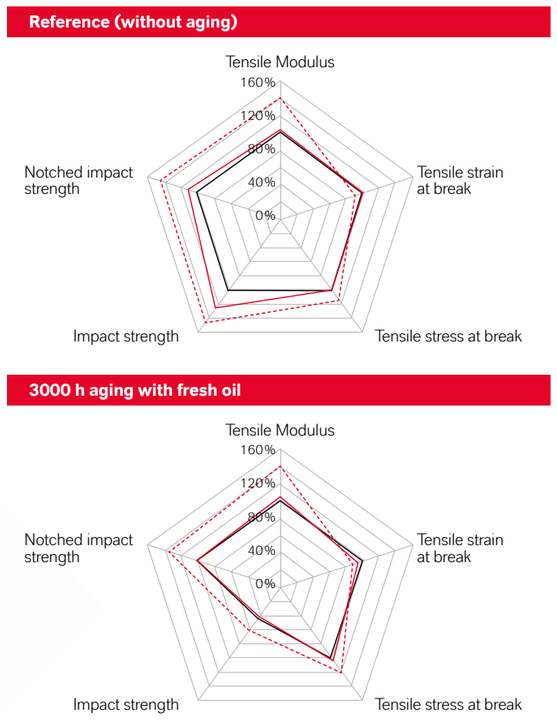
■ Prototype of a charge air tube made of Durethan® AKV320ZH2.0. The new PA 66 grade is characterized by a wide processing window and excellent surface quality.

Easy-flowing, ultra-stiff polyamides for the oil circuit

Our polyamides are also very much at home in the oil circuits of trucks and cars. They are used, for example, to manufacture engine and transmission oil pans, oil modules and even oil filter removal wrenches. Durethan® offers several advantages over materials such as die-cast aluminum. It

- allows greater design flexibility
- reduces component weight
- achieves costs savings through functional integration
- produces precise components that require no reworking

Our PA grades Durethan® AKV60 and BKV60, which are reinforced with 60% glass fiber but are still easy-flowing, are especially attractive. Their high strength and stiffness (elastic moduli of up to 20,200 MPa) mean they can be used for the construction of very large or flat oil pans and modules that have almost no warpage and do not leak as a result of creep under a sealing load.



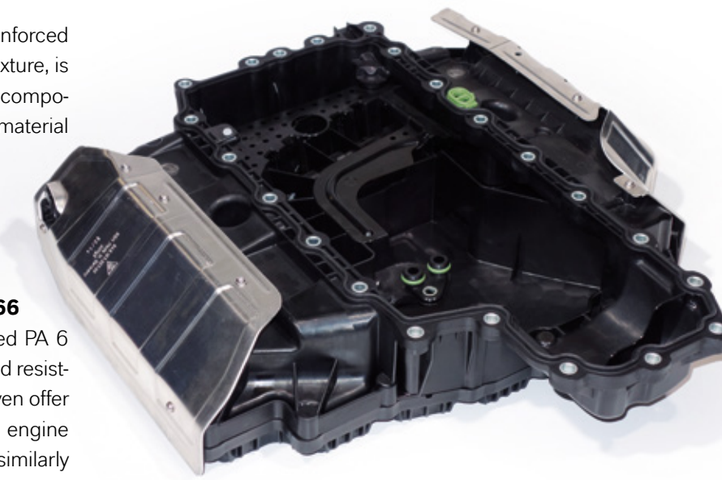
■ The mechanical properties of Durethan® AKV30H2.0 and Durethan® BKV30H2.0 are virtually identical following thermal aging in fresh and used engine oil.

The PA 6 grade Durethan® BG60XXF, which is reinforced with 60% of a special glass fiber/glass microbead mixture, is an innovative material designed especially for visible components of the oil system. Components made from this material benefit from

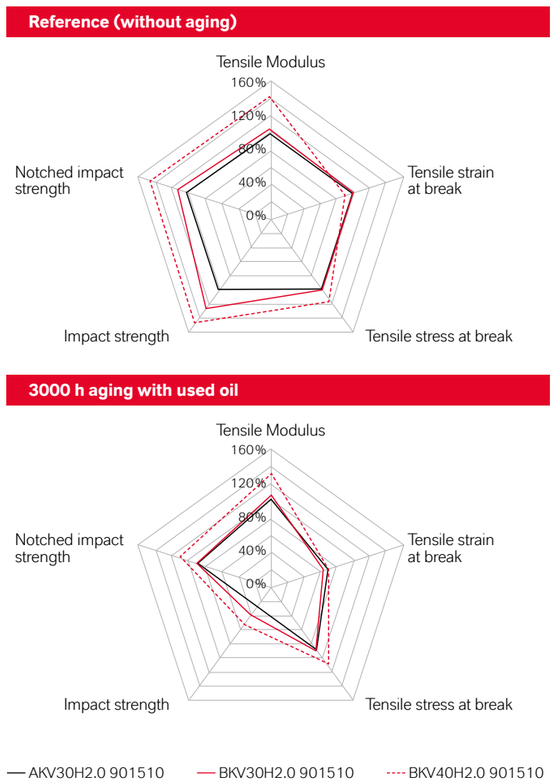
- excellent surface quality
- minimal tendency to warp
- high stiffness and strength at higher temperatures

Cost-effective alternative – PA 6 instead of PA 66

In-house tests have revealed that glass-fiber-reinforced PA 6 and PA 66 grades exhibit comparable heat stability and resistance in both new and used engine oil. PA 6 grades even offer slightly better longterm resistance to hot air. Newer engine oil pan designs therefore favor PA 6, which offers a similarly high-quality property profile but a more economical structure. One example is the oil pan module for the new six-cylinder engines of a German sports car. The upper and lower parts of the module are made from Durethan® BKV30H2.0 reinforced with 30% glass fibers.



■ Due to the lower density of the PA 6 and optimized wall thicknesses, the oil pan is more than two kilograms lighter than its aluminum predecessor.



Covers – low warpage and excellent surface quality

Even the hardware under the hood has to look good, which is why it is frequently provided with plastic covers that also offer protection. We have developed a number of PA materials to use as covers for items such as toothed belts, ignition coils and entire engines. These polyamides are reinforced with special fillers. Their advantages include

- flawless component surfaces that can be textured with a fine grain
- good flow properties and low warpage, even on large covers
- high thermal stability up to 150 °C in long-term use

Examples of such materials include the PA 6 compounds Durethan® BG30XH2.0XF, Durethan® BM29XH2.0EF and Durethan® BM40XH2.0EF. They contain a mixture of glass fibers and microbeads or mineral fillers and are also characterized by excellent flow properties. For example, Durethan® BG30XH2.0XF is over 30% more flowable than the standard material Durethan® BG30X.

HIGH-TECH POLYAMIDES UNDER THE HOOD

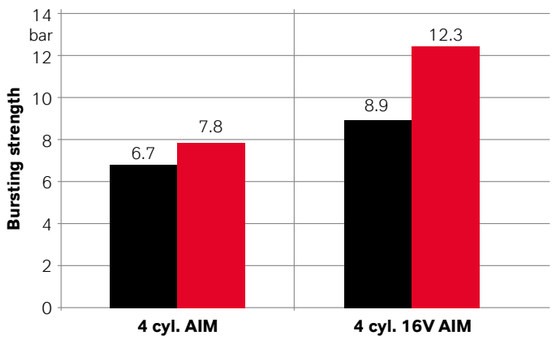
Tailor-made for cost-effective welding

Welding is becoming increasingly important as a joining technology for plastic under-the-hood components, so we have extended our portfolio of weldable PA 6 compounds. The new products cater to current trends such as higher engine compartment temperatures, higher internal pressures in hollow components and smaller installation spaces. They also have a wide processing window, which ensures a stable and cost-effective welding process.

Durethan® BKV30XWP is the material of choice for more challenging requirements relating to process reliability, weld line strength and weld resistance in IR, vibration and hot plate welding. It benefits from higher flexural strength than the standard PA 6 grade Durethan® BKV30H2.0. Potential applications include air intake manifolds and modules.

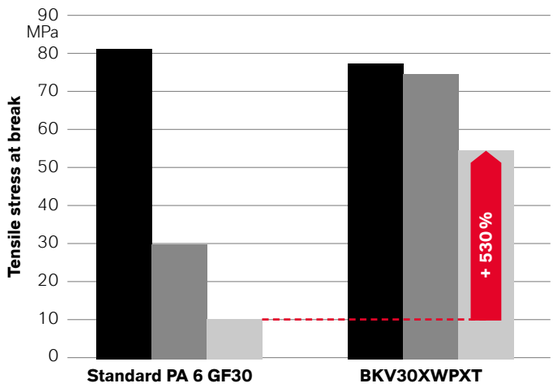
Durethan® BKV30XWPHV has a far better melt flow than Durethan® BKV30XWP, which makes it ideal for vibration, hot gas and hot plate welding. It is characterized by a very wide processing window and is used to make components such as air intake manifolds.

Durethan® BKV30XWPHV improved the bursting strength of air intake manifolds for two 4-cylinder engines compared with equivalents made of a standard PA 6 (30% glass fibers) by more than 16% in one case and nearly 40% in the other.



Durethan® BKV30XWPXT is stable at continuous service temperatures of up to around 200 °C and benefits from an unusually high postaging weld strength – both at room temperature and at the high temperatures typical of engine compartments. } Its melt has a higher viscosity than that of a typical high-temperature-stabilized PA 6 reinforced with 30% glass fibers, which makes it easy to weld. We see great potential in applications such as charge air tubes, intake pipes and hollow components in the oil circuit.

Tensile testing of vibration-welded specimens (23 °C). The weld strength of Durethan® BKV30XWPXT after 2,000 hours of aging at 200 °C is more than five times higher than that of a standard PA 6 grade with 30% glass fibers.



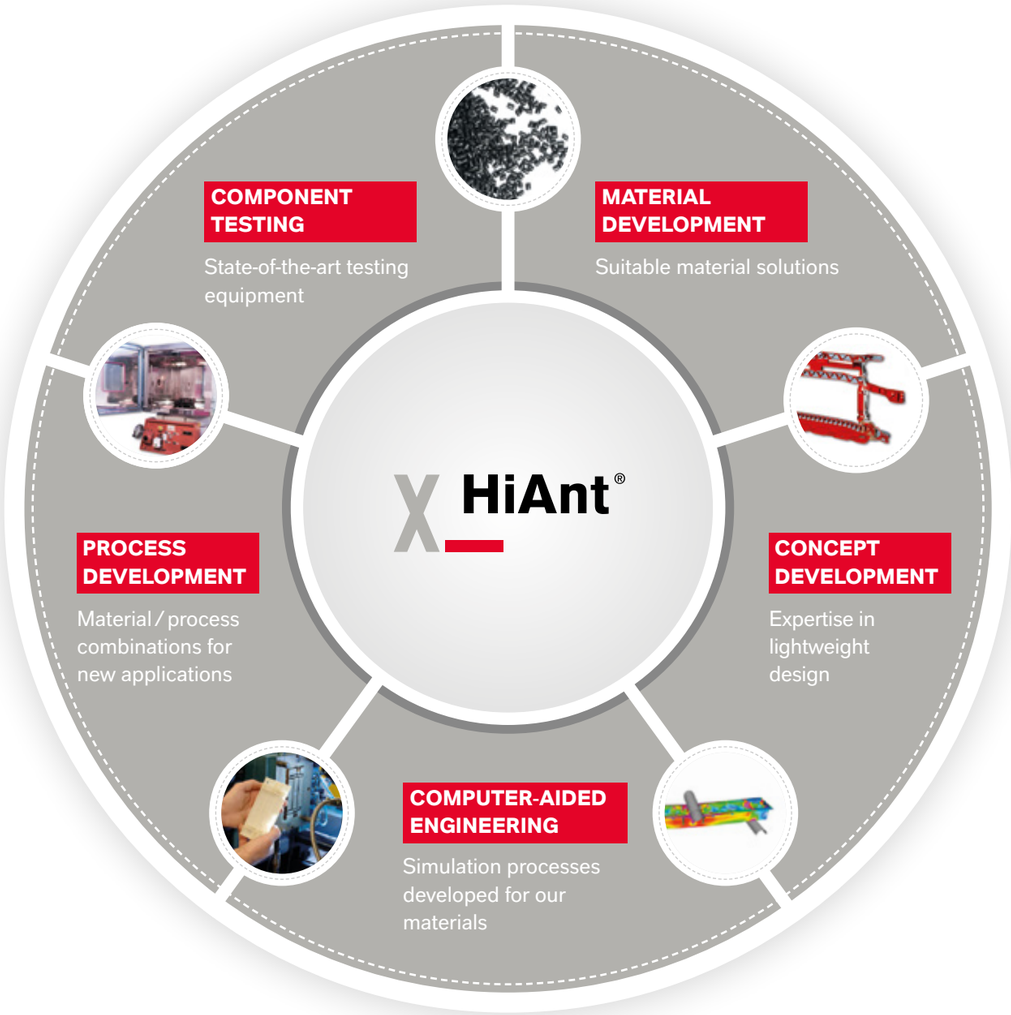
Durethan® BKV30XWPLT is optimized for laser transmission welding. Its enhanced laser light transmission results in high, quicker heat input. The joint area therefore melts faster for more cost-effective production. Potential applications include housings for oil, airbag and other sensors, and also hollow components such as air intake chambers or liquid containers with complex, mechanically sensitive internal geometries that need to satisfy stringent particle-free requirements.

HIANT® – BUNDLED KNOW-HOW FOR CUSTOMIZED SERVICE

With our HiAnt® know-how package, we support customers in developing parts made of our hightech plastics.

Services include

- materialspecific design with CAE tools, including integrative simulation
- calculation of the creep and thermal expansion behavior of our polyamides for purposes such as virtual testing of the leak behavior of oil pan/module flanges under sealing loads
- customer tests on injection molding machines with auxiliary installations for GIT and WIT in our Technical Center for Optimization of Materials and Methods
- component tests to customer standards, including all conventional vibration tests
- aging and media aging tests under climate-controlled conditions
- pendulum impact tests and oscillating compression tests on components of the vehicle cooling system
- burst pressure tests and alternating pressure and backfire tests on intake modules
- technical support for injection molding, sampling and the launch of series production



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