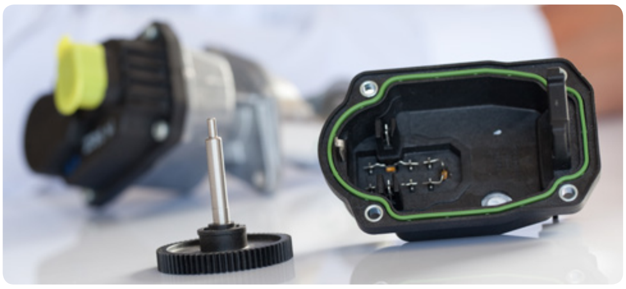
Bright Science means changing gears to improve efficiency in engines and part production

DSM's high-performance plastics for automotive gears help improve engine efficiency, reduce fuel consumption and reduce production costs.

The automotive industry continues to be driven by the need to reduce vehicle weight and fuel consumption. Around the globe, technology developments have focused on meeting new and upcoming legislation for reduced emissions in order to secure a brighter future. This is particularly apparent in the high-volume market for small- and mid-sized passenger vehicles, where the need for reduced emissions must be filled with cost-effective solutions.

Under the hood, two areas are developed to increase fuel efficiency: improving the engine's combustion cycle to generate more energy, and reducing energy losses of the engine and total vehicle. With estimations that 78 percent of the energy generated is lost through exhaust, heat loss, in-engine friction, and load change, this is an area with the potential to realize substantial gains in efficiency.



These focal areas have led to the down-sizing and down-speeding of engines to increase the specific power output, as well as boosting technologies such as turbo-chargers and super-chargers, requiring more sophisticated motor management actuators with improved performance at higher operating temperatures.

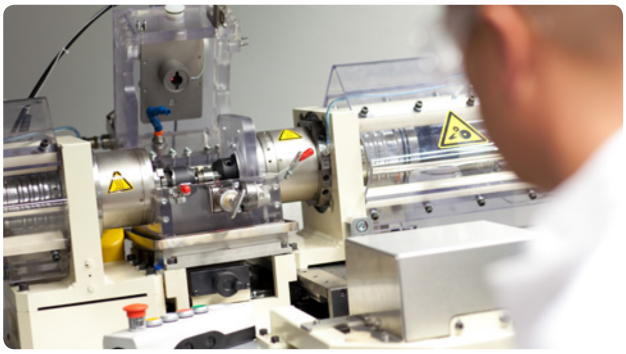
DSM's Stanyl® polyamide 46 (PA46) is one of the main polymers used in under the hood automotive applications due to its superior mechanical and tribological properties. With a melting point of 295°C, this high-performance material has been engineered to retain its mechanical properties at temperatures ranging from 100 to 170°C.

It offers best-in-class tribological behavior with up to 50 percent less wear than polyphthalamide (PPA), and works equally well in dry or lubricated conditions. Stanyl PA46 polymers have been proven successful in applications for motor management, engine control and in-engine gears, where extremely low wear and friction rates play a crucial role in performance. This includes gears and bushings for electronic throttle controls, exhaust gas recirculation, turbo control actuators, conventional and start/stop starter motors, as well as oil pump driven gears and balance shaft gears.

DSM continues to partner with OEMs and Tier-1 part manufacturers around the globe to develop and test new gear designs that contribute to lighter and more fuel efficient vehicles.

DSM's gear testing facilities

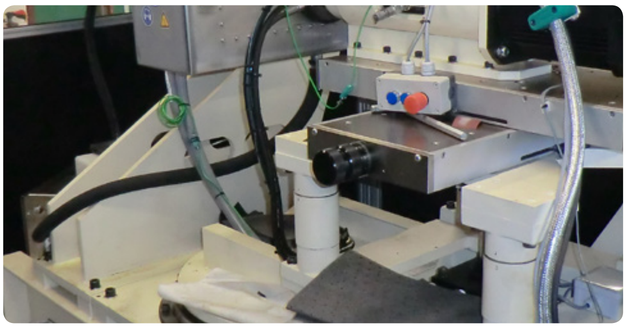
In order to best utilize Stanyl's excellent tribological properties, DSM places strong emphasis on understanding both the theoretical and practical relationship between the application and the material's wear and friction properties. Since wear and friction are affected by the material's mechanical properties, which vary with temperature, we delve into the application to gain a better understanding of the interface and environmental temperature conditions. Our approach goes beyond testing to industry standards. We link the testing parameters to the application to best simulate the actual conditions, and combine this with the extensive knowledge base of our fundamental research team to determine which material properties need to be improved, and to better understand the wear and friction of materials in specific applications.



In order to effectively carry out this advanced testing, DSM modifies its testing equipment to include precise temperature control in addition to pressure and sliding speed variables to best approximate practical applications.

Our thrust-washer testing machines include thermal management to actively control temperature – by cooling and heating – to 200°C at the frictional interface. We have also increased their mechanical stability to drastically improve accuracy on measurements such as temperature sweeps, sliding speed sweeps or wear rate runs, and we've added the ability to measure wear and friction in lubricated conditions to meet the increased demand for application knowledge in lubricated systems.

DSM has recently added a disk-to-disk tester at its Material Science Center in Geleen, The Netherlands. The disk-to-disk tester runs two disks against each other to test polymer to polymer or metal to polymer behavior at controlled temperatures up to 150°C, speeds to 2,000 rpm (3.6m/s), and a maximum normal force of 2000N.



It also tests sliding and rolling combinations to better simulate the practical conditions seen in a gear mesh. In addition to its wear and friction testing equipment, rather than conducting testing of new gear designs at external institutes, DSM now has a state-of-the-art gear tester that has been set up to test a variety of different gear drives, from spur, helical or worm gears through to high-temperature lubricated systems. This on-site gear-testing capability will help DSM and its customers to best exploit Stanyl's excellent mechanical and tribological properties for gear applications.

Fulfilling the demanding requirements of starter motors

The use of plastic gears is being expanded in starter motor applications due to the ongoing need to reduce weight and cost. With performance levels continuously on the rise, replacing sintered metal gears takes high-performance plastics with excellent mechanical and tribological properties, particularly in the newer start/stop systems. Conventional starter motors see as many as 40,000 engines starts over the lifetime of the vehicle, or up to 13 million load cycles for each plastic annulus gear tooth.

The newer start/stop starter motors raise the number of starts to 350,000 or up to 45 million load cycles per annulus gear tooth. Start/stop starter motors can decrease fuel consumption by 7 to 15 percent, and carbon dioxide emissions by 5 to 8 percent, providing a relatively easy way to improve the environmental load from passenger vehicles around the globe.

At the same time, it takes plastics with exceptional fatigue properties and wear rates to meet these demanding durability requirements. Stanyl has been proven successful in meeting these extensive requirements across a wide range of power ratings.

Case: Reducing costs in starter motor gears

One of the leading manufacturers of starter motors tried to increase the use of plastics within its range to optimize the total system cost and improve the already high power-to-weight ratio. DSM worked together with the customer to switch from sintered metal to a plastic annulus gear in one series of starter motors. This range of compact and high-power starter motors covers a wide range of engine displacements for both gasoline and diesel engines with power outputs from 0.7 to 2.5 kW. To guarantee reliable operation and a long lifetime, the new designs were subjected to extensive laboratory and field tests to cover severe operating and abuse conditions.

The shock or impact test simulates abuse of the system by imposing an abrupt stop to the flywheel, placing extremely high impact loads on the entire planetary gear drive, including the plastic annulus gear teeth in contact. The customer tests to very high requirements to ensure that the system can withstand forces far beyond the operation conditions possible once the part is actually in use. Stanyl successfully passed the required number of cycles due to the material's exceptional toughness.

Using Stanyl also helps the customer to substantially lower total part costs and reduce total weight by as much as 46 percent. Designing with plastics provides the freedom to integrate multiple functions into a single component. In some designs, using Stanyl helped to cut costs in three ways: by allowing a reduction in part count from five to one, by eliminating assembly steps and by reducing injection molding cycle times due to Stanyl's good flow and high crystallization speed.

Case: Standardizing the USCAR electronic throttle control

USCAR is the umbrella organization that supports collaborative research between Chrysler LLC, Ford Motor Company and General Motors Corporation. Together with General Motors and Continental Automotive, DSM worked to completely redesign an electronic throttle control actuator that would function across all automobile platforms. DSM was recognized as a finalist in the 2010 SPE Automotive Innovation Awards for the seven actuator components made from Stanyl PA46 and Arnite® T polybutylene terephthalate (PBT).

The new design achieves a weight savings of 15 percent while increasing performance

The new design achieves a weight savings of 15 percent while increasing performance, allows for a hood line of up to 5 millimeters lower to save fuel due to less resistance, and delivers a two-year gain in service lifetime to five. The new electronic throttle body, which entered the market in 2010 model year vehicles, meets all interface and performance requirements for all engine management systems, and will replace all existing gasoline and diesel actuators in GM vehicles by 2015.

Partnering for a brighter future

At DSM, we actively seek to partner with customers across the automotive value chain to improve their gears and actuators for motor management, engine control and in-engine applications in a cost-competitive way. Our portfolio includes a wide offer of grades that maintain their strength, durability and wear rates at extreme operating temperatures, while extending part lifetime. This enables the extension of plastic gears into more demanding applications as the automotive industry continues to work at improving fuel consumption. We back all of our material sales with extensive research and development, as well as a collaborative partnership where we support customers through grade selection, component design and thorough gear testing.

With manufacturing facilities on three continents and vertical integration in the monomer precursor to polyamides, we offer a security of supply that buys our customers peace of mind, comfortable in the knowledge that material will never be an issue with DSM.

Contact us today to discuss how DSM can help you redesign your automotive gear applications.

DSM Engineering Plastics

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