

## Innovative Thermoplastic Thrust Washer Developed by Solvay and Freudenberg-NOK is SPE Finalist

*Torlon® PAI Delivers Outstanding Friction and Wear Performance  
in Metal Replacement Powertrain Application for GM*

**ALPHARETTA, Ga., November 13, 2014** – A breakthrough powertrain component co-developed by Solvay Specialty Polymers and Freudenberg-NOK Sealing Technologies (Freudenberg-NOK) earned finalist honors Nov. 12 at the 2014 Society of Plastics Engineers (SPE) Automotive Innovation Awards Competition in Livonia, Mich.

Solvay Specialty Polymers is a leading global supplier of high-performance thermoplastics, and Freudenberg-NOK Sealing Technologies (Freudenberg-NOK) is a global leader in engineered sealing solutions. The innovative High-Load, High-Shear Geared Axial Polymer Thrust Washer (HLHS GAP Thrust Washer), used by General Motors in its 2014 Hydra-Matic 8L90 8-speed transmission, was a finalist in the powertrain category.

The Automotive Division of SPE promotes scientific and engineering knowledge relating to plastics developments in the global transportation industry. Its prestigious competition annually draws 60-80 project entries from vehicle manufacturers, suppliers, and polymer producers.

Solvay's Torlon® 4275 PAI, an unreinforced, friction/wear grade, was selected because of its exceptional capabilities including outstanding friction and wear performance at elevated pressures and velocities. Torlon® PAI, which was introduced to the automotive transmission market in 2008, is a high-strength plastic with the highest strength and stiffness of any thermoplastic up to 275°C (525°F). It has outstanding resistance to wear, creep, and chemicals – including strong acids and most organics – and is ideally suited for severe service environments. The thrust washer is attached to the sun gear of an automotive transmission and pushes with the sun gear against the needle bearing. The high-performance material was able to withstand the load applied by the planetary gear set. This allows the needle bearing to operate with high efficiency.

“The HLHS GAP Thrust Washer program provides both a template and benchmark for future component program success and opens opportunities for continued metal replacement in powertrain applications,” said Brian Baleno, global automotive business manager for Solvay Specialty Polymers.

Solvay and Freudenberg-NOK worked in close collaboration to collect a broad range of performance data through specialized testing of Torlon® 4275. Solvay used a six-lot resin testing system to gather vital information relating to tensile strength, resistance to transmission fluid, and heat aging. In addition, Solvay demonstrated the material's capability in lubricated friction and wear environments via their proprietary ASTM D3702-based friction and wear test rig.

A collaborative team approach between Solvay (resin supplier), Freudenberg-NOK (molder/manufacturer), and GM was critical to the success of the project.

“OEM vehicle manufacturers seeking to replace traditional metal components with new thermoplastic designs must have assurances that new materials can be designed, validated, and produced to meet weight and extended performance requirements while also addressing fundamental issues such as cost, quality, delivery, and

manufacturability,” explained Rory Pawl, sales director, Process Seals, and former director, Future Technology, Freudenberg-NOK.

The original thrust washer design composed of sintered metal was found to be heavy and costly. A switch to aluminum appeared to solve OEM concerns; however, the aluminum components began to fail critical durability testing. Compressive creep of the aluminum was associated with the high stress on the part while the fretting was associated with cyclic shear and torque.

Freudenberg-NOK utilized proprietary equipment to test the Torlon® PAI thrust washers under extreme conditions to provide assurance that the new component resolved performance challenges. Freudenberg-NOK’s proprietary thrust washer test machine was used to conduct a multitude of performance analyses on Torlon® 4275 thrust washers. This one-of-a-kind machine uses air pressure to apply upwards of 3000 lb. of pressure on the washer, and has the capability of spinning at 10,000 rpm. The machine also regulates oil temperature, oil flow rate, and runs components at an angular offset thanks to a unique leveling platen. Data generated by Freudenberg-NOK’s thrust washer test machine, in combination with material data supplied by Solvay, was critical in successfully validating the replacement of metallic components with an advanced thermoplastic design. This test capability opens new avenues for further use of the material and the manufacturing process to replace other transmission components, thus enabling OEMs to achieve fuel and weight savings and superior powertrain durability.

Freudenberg–NOK also implemented an innovative manufacturing process, producing the HLHS GAP Thrust Washer using its world-class Single Cavity Net Shape Molding process. This lean process uses compact, custom-engineered one-cavity injection molding machines rather than multi-cavity machines to produce high-performance thermoplastic parts. The process improves part quality and reduces scrap and waste. In fact, the approach has reduced the plant’s rejected parts per million (ppm) by a factor of 20 since its implementation. It is faster, more flexible, and results in consistent high-quality parts, eliminating engineered waste and reducing cost. The process also eliminates additional prototyping requirements, supplemental production steps, and unpredictable manufacturing variables.

The HLHS GAP Thrust Washer is being manufactured at Freudenberg-NOK’s Findlay, Ohio facility. As GM and other industry players evolve and become increasingly comfortable with high-performance thermoplastics, there are opportunities outside of thrust washers for replacement of metallic components with plastics, according to the companies. As thermoplastic performance is proven, replacement of traditional needle bearings can also be realized.

Solvay Specialty Polymers offers the broadest portfolio of specialty polymers for powertrain components including Amodel® polyphthalamide (PPA), AvaSpire® polyaryletherketone (PAEK), KetaSpire® polyetheretherketone (PEEK), and Tecnoflon® fluoroelastomers. These materials are used in a range of drivetrain components including seal rings, thrust washers, thrust bearings, bearing cages, shift fork pads, and seals.

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#### About Freudenberg Sealing Technologies

Freudenberg-NOK Sealing Technologies is the Americas joint venture between Freudenberg and Co. in Germany and NOK Corp. in Japan. Freudenberg-NOK is a leading producer of advanced sealing technologies for a variety of markets including: aerospace; agriculture; appliance; automotive; construction; diesel engine; energy; food and beverage; heavy industry; and pharmaceutical. Founded in 1989 under the legal name Freudenberg-NOK General Partnership, Freudenberg-NOK is headquartered in Plymouth, Mich. and operates more than 20 facilities across the Americas. For additional information, visit [www.fnst.com](http://www.fnst.com).

#### About Solvay Specialty Polymers

Solvay Specialty Polymers manufactures over 1500 products across 35 brands of high-performance polymers – fluoropolymers, fluoroelastomers, fluorinated fluids, semi-aromatic polyamides, sulfone polymers, aromatic ultra polymers, high-barrier polymers and cross-linked high-performance compounds – for use in Aerospace, Alternative Energy, Automotive, Healthcare, Membranes, Oil & Gas, Packaging, Plumbing, Semiconductors, Wire & Cable, and other industries. Learn more at [www.solvay.com](http://www.solvay.com).

As an international chemical group, **SOLVAY** assists industries in finding and implementing ever more responsible and value-creating solutions. Solvay generates 90% of its net sales in activities where it is among the world's top three players. It serves many markets, varying from energy and the environment to automotive and aeronautics or electricity and electronics, with one goal: to raise the performance of its clients and improve society's quality of life. The group is headquartered in Brussels, employs about 29,400 people in 56 countries and generated 9.9 billion euros in net sales in 2013. Solvay SA (**SOLB.BE**) is listed on **NYSE EURONEXT** in Brussels and Paris (Bloomberg: **SOLB:BB** - Reuters: **SOLB.BR**).

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