Ultra high-performance thrust bearings

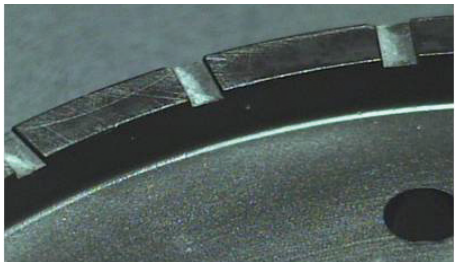
State-of-the-art thermoplastics play a major role in meeting high-performance requirements in a range of automotive applications including thrust bearings

Transmission parts such as thrust bearings are increasingly being made from ultra high-performance plastics such as PAI and PEEK instead of metal for light weight, design, flexibility and improved wear resistance

Today's powertrain is designed for high efficiency and must comply with tougher CAFE regulations and stricter global emission standards and also provide the consumer with a fun-to-drive experience at high levels of comfort and safety – and all this has to be achieved at a lower cost.

This high level of powertrain performance is dictated by new, advanced technology and innovative design enhancements. Lower displacement turbocharged engines operate at higher rpm, resulting in increased NVH levels. Weight reduction requirements permit less mass and less design space and further cost. Mass and space reductions are also needed to provide room for active transmissions that incorporate hybrid and electric drives.

Ultra high-performance thermoplastics have played a major role in meeting these performance requirements in a range of automotive applications, including thrust bearings. They have enjoyed widespread adoption over the years as a replacement for metal in a broad range of automotive applications. These ultra polymers, known for their mechanical and thermal properties, are now a proven entity because of their special ability to reduce weight and cut system costs through parts consolidation. There are no requirements for secondary operations such as machining, welding, coating or plating to create the finished part. Metal-to-plastics conversion also provides additional benefits, including corrosion resistance, chemical resistance, thermal insulation and better sealing.



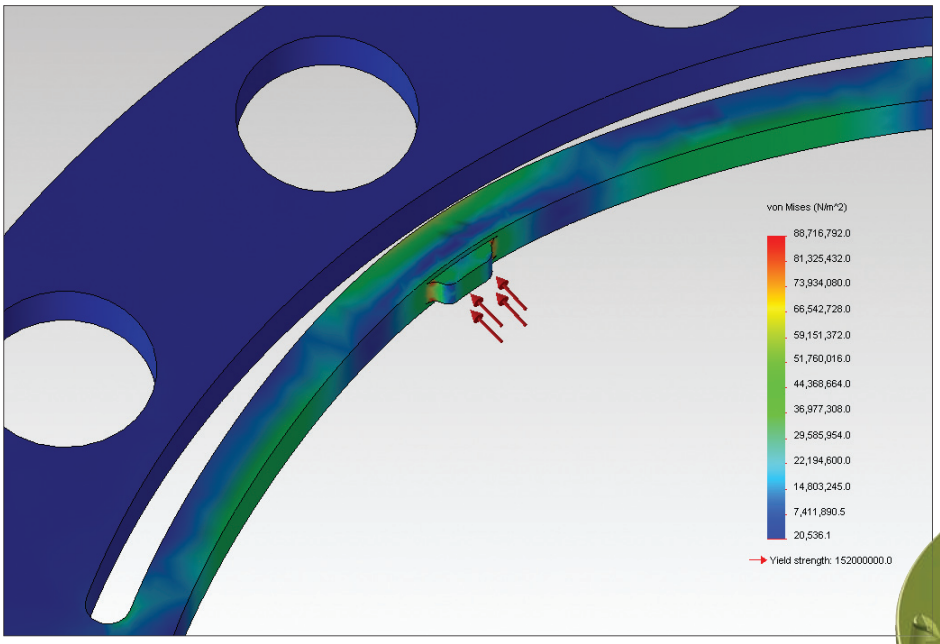
With minimal increase in oil temperature and low surface temperature levels, PAI demonstrates outstanding wear performance during ASTM D3702 lubricated thrust bearing testing at 500,00 PV

High-strength, chemically resistant ultra polymers such as PEEK and Torlon polyamide-imide (PAI) manufactured by Solvay Advanced Polymers, a Solvay Specialty Polymers company, are typically the materials of choice. Here, a high-temperature amorphous polymer such as PAI can provide temperature performance of up to 275°C, wear and chemical resistance and dimensional stability. PEEK, a semi-crystalline material, offers a continuous-use temperature up to 240°C and outstanding chemical resistance along with friction and wear performance. These materials have a long history of use in transmissions. Seal rings made of these ultra polymers can be considered an enabling technology for new transmissions due to their outstanding friction and wear performance at elevated pressures and velocities.

Thrust bearings made of ultra polymers are a metal bearing replacement option and can bring several benefits to the engineer that directly satisfy the design and development challenges of today's eco-conscious environment. These challenges include reduced design space, reduction in NVH, thermal insulation and improved wear resistance.

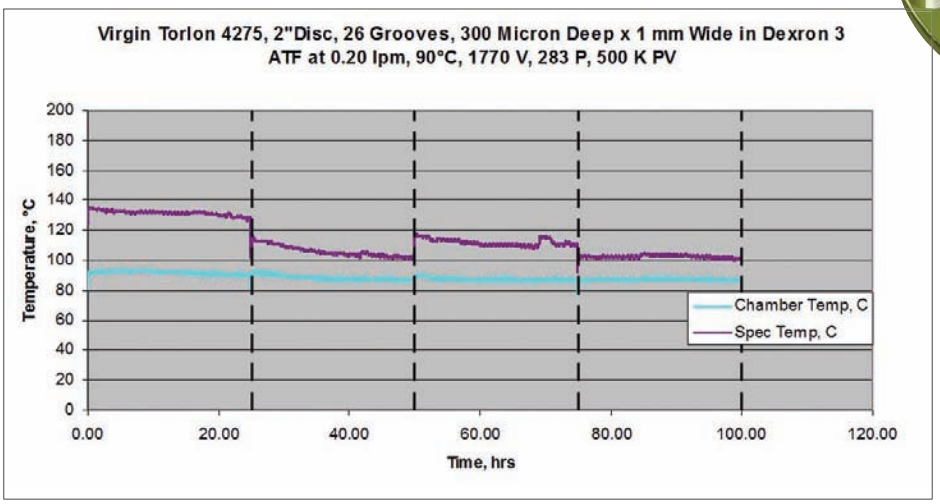
Thermoplastic thrust bearings can be designed to reduce design space, resulting in as much as a 4.2mm space savings per bearing in thickness. Additionally, depending on the system design and counter surface material, metal needle bearings could require a separate race. In these applications, a part count reduction could be realized if the thermoplastic thrust bearing is designed properly.

Ultra high-performance thermoplastics are also natural insulators and help isolate system harmonics. Therefore, drastic NVH



Left: The FEA model illustrates snap-fit feature for axial locking on a thermoplastic thrust bearing component

Below: The use of anti-rotation features (the legs) with incorporated axial locking. ID piloting is also illustrated



improvement can be expected especially because there are no moving parts. When properly designed, thermoplastic thrust bearings typically result in significant cost savings over metal bearings. Close attention is required early in the design phase to minimize mass and to achieve only the necessary function of the thrust bearing.

Thermoplastic thrust bearings can be injection molded into complex shapes, thereby eliminating costly secondary operations such as machining. This provides a very high degree of design flexibility and freedom. Features such as axial locking, anti-rotation and ID or OD piloting can be incorporated at a minimal additional cost. FEA can be used in the design phase for analysis of various features.

Thrust bearings based on PAI and PEEK have a unique combination of flexibility, wear resistance and strength at system operational temperature range, all of which is achieved without the use of abrasive materials that could wear softer surfaces, such as unhardened steel or aluminum. In addition, the coefficient of friction is reduced as the pressure and speed environment becomes more severe. This unique behavior makes these ultra polymers the material of choice where conditions are demanding or a high degree of design and safety is required.

Designing plastic components is very different than designing metal components. It is important to define system attributes early in the design phase and consider the effects on the thermoplastic thrust bearing. To achieve the highest level of performance in a thermoplastic thrust bearing, it is recommended that the molder/processor be contacted very early in the design phase.

All considerations influencing the friction and wear performance must be taken into account to ensure that the system is properly designed. This includes having a thorough understanding of the lubrication level (rate and flow direction), the counter surface materials (hardness and roughness), and the pressure and velocity of the application. With minimal increase in oil temperature and low surface temperature, PAI demonstrates outstanding wear performance. Thrust bearings made of PAI exhibit minimal wear after 100 hours of testing (ASTM D3702 thrust washer test). Thermoplastic thrust bearings can also be used in some starve-fed lubrication systems in which metal needle bearings cannot survive.

Designing with plastics poses many challenges when compared to metal alloys, but at the same time plastics offer numerous advantages. Design freedom and injection moldability deliver manufacturing flexibility and create a broad palette of design opportunities that reduce cost, enhance aesthetics and improve performance. These capabilities make ultra polymers a preferred material choice in thrust bearing applications, helping OEMs to meet weight and space requirements while complying with tough CAFE laws and stricter emission standards. ***TTi***