Clearing the way: engineering plastics in automotive windshield wiper systems

PLASTICS IN TRANSPORTATION

by Tom Miller and Jason Lipke

Windshield wipers have come a long way since the first U.S. wiper patent was issued in 1903. The original manual device has evolved into a complex unit that must function perfectly for 15 years or more under all conditions. Today's wiper systems must be lightweight, strong and durable and able to withstand sunlight and the harsh substances they encounter in use.

In meeting such stringent requirements, automakers have increasingly turned to engineering thermoplastics to gain the design freedom, performance and reduced weight and cost they need in exterior and underhood wiper components. Through the mid 1990s, plastics were mainly used in wiper covers, clips, fasteners and other exterior wiper elements.

As engineering polymers grew more sophisticated and were economically able to provide greater stiffness, better UV resistance, lower wear, better surface appearance and other essential properties, their use in wiper systems expanded rapidly. Today, auto designers use these materials in applications ranging from wiper arms and airfoils to motor bearings and gear housings.

Mercedes Benz single-arm windshield wiper system. Drive and wiper arm covers are injection molded from Ticona's impact-modified, weather-resistant, UV-stable Hostaform® acetal copolymer.

Plastics often used in wiper systems include acetal copolymer, polyester (both polybutylene and polyethylene terephthalate, PBT and PET) and long fiber-reinforced thermoplastics (LFRT). In addition to high stiffness and strength, these materials offer good fatigue resistance and low moisture absorption, so parts are dimensionally stable whether exposed to desert dryness or tropical humidity. They also are unaffected by windshield washer fluid, often containing methanol, the detergents used in car washes and road salts.

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Beyond this, these polymers also have excellent moldability. Their good melt flow enables them to fill complex, ribbed shapes easily to maximize structural integrity. When combined with improved processing methods, like gas-assist injection molding, these polymers are helping to create a new generation of wiper elements.

Exterior wiper systems applications

Acetal copolymer and PBT are often used in visible wiper components. For instance, unreinforced acetal copolymer with a weathering package and often impact-modified gives wiper covers needed UV resistance and surface finish, as well as the right level of flexibility to form an effective snap fit to the wiper arm. Advances in this area include improved acetal copolymers with proprietary UV-resistant black pigments that also aid impact and weld-line strength in thin-walled wiper covers. In some cases, wiper covers also are made of unfilled PBT to gain lower gloss finishes.

Mercedes Benz windshield wiper drive cap injection molded from Ticona's impact-modified weather-resistant, UV-stable Hostaform® acetal copolymer.

In wiper blade frames (articulated segments that hold the blade and attach to the arm), several automakers find that 30 percent glass-reinforced PBT combines good surface appearance, weatherability, tensile strength, stiffness, low creep and low weight. An impact-modified, glass-filled version of this material is used in rear wiper arms to provide the specified flexural and torsional stiffness, high breaking strength and surface look and feel. PBT is also used in unfilled grades in windshield washer nozzles.

One new material for exterior wiper applications often for use in rear wiper arms is a PBT-PET blend with 30 percent glass fibers that has better stiffness and surface appearance than PBT alone. Another new development is a glass-reinforced, UV-stabilized acetal copolymer for exterior applications such as longer wiper arms that accommodate the steeper windshield incline in some cars. A special 30 percent glass-reinforced acetal copolymer having improved stiffness is being used in many longer arms to help them resist the deflection that occurs

given the greater loads placed on them in routine operation.

Interior wiper systems applications

Plastics for wiper applications within the auto body must often meet demanding mechanical requirements. A good example is a rear wiper gear housing made of a 45 percent glass fiber-filled grade of PET. Most of this part sits within the body shell. A portion of it projects as a tower to support the wiper pivot arm. The PET provides extremely high stiffness and low creep so the tower does not deflect and the gear train remains in registration.

The motor power in this windshield wiper drive is transmitted via two worms to two cluster gears made from Hostaform® acetal copolymer, grade C 9021. The cluster gears have helical gears mated to the worms and spur gears driving a single output gear (not shown).

Acetal copolymer is often used in front wiper shaft bearings, typically in Europe. These bearings must not abrade during rotation of the steel wiper arm shaft that passes through them. In one case, an automaker chose acetal copolymer for its high lubricity, resistance to abrasion and ability to meet precise tolerances of ±0.05 mm on a 10 mm shaft.

Auto designers have turned to PBT in wiper motors to reduce weight. Glass-reinforced PBT grades, for example, have replaced aluminum and zinc die-castings in some wiper motor housings. This material is an excellent electrical insulator and provides high strength and stiffness. It is also being used in motor housing covers. In one case, a 15 percent glass-filled PBT grade is used in a housing cover to provide strength and just enough flexibility for a viable snap fit.

Nylon 6/6 is often used in the pivot bodies (or transmission housings) that enclose part of the drive linkage extending from the wiper motor to each wiper arm. Unfilled acetal copolymer has also been used in this application. In addition, neat acetal copolymer is molded to create the ball sockets that press-fit together where the two linkage arms diverge from the one arising from the motor.

Wiper tubs, which enclose the entire underhood wiper system, are often made of glass-filled PET. These large parts can weigh between 3 and 5 pounds and measure 4 to 6 feet in length. Long glass fiber reinforced PP, which is used in wiper tubs in heavy trucks, is being evaluated for use in autos because it adds strength at little or no increase in weight.

Wiper systems continue to evolve. A recent development involves "smart blades" that automatically turn wipers on using a windshield-mounted rain sensor. One such system contains a lens made of optically clear cyclic olefin copolymer (COC) as a central element in the system. Other developments that promise to drive the use of advanced plastics in wiper systems include subsystems for heated windshield washer fluids, new governmental safety standards for windshields and wipers, and modular wiper systems.

The latter incorporate the motor, linkage, pivot body and other wiper elements into a preassembled system. One design for such an integrated assembly mounts all parts on a plenum made of an LFRT that contains long glass fibers in a polypropylene matrix. This material provides the high strength, stiffness, creep resistance and low warpage that keep the entire system aligned over the long term.

Rain sensors with optical units made from Topas® COC enhance driving comfort and safety. (Leopold Kostal GmbH & Co. KG, Lüdenscheid, Germany.)

Conclusion

The use of engineering plastics in wiper systems has undergone dramatic expansion in the past decade as automakers have replaced metal in many components. They have also tapped the ability of plastics to take almost any shape in creating components that occupy less room and weigh less. The ability to do this has depended upon continuing innovation in the functional and appearance properties of acetal copolymer, PBT, PET and other resins so they satisfy the stringent mechanical, chemical and other demands placed on wiper elements. ■

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