New Polyamides Substantially Reduce Plate-Out and Boost Design Options for Connector Manufacturers

The highly competitive global market for connectors used in electrical and electronic (E/E) applications is driving a trend toward smaller designs with tighter tolerances that can take higher operating temperatures. Wall thicknesses are dropping dramatically, creating demand for higher-melt-flow resins. At the same time, OEMs are demanding lower costs, requiring molders to find ways to boost productivity.

Ascend Performance Materials, which has been producing and researching improved polyamide 66 (PA66) compounds since the 1960s through predecessor companies, has recently ramped up new technology for the connector market that provides significant improvements addressing these challenges, particularly in reduced plate-out, improved melt flow and enhanced part-to-part consistency. The new resins have been undergoing significant customer testing in the past year, and are now widely available for commercial sale. Results of those tests and the growing challenges in the E/E connector market are reviewed in this white paper.

Connector Background

Plastics resins are used to provide physical structure and to hold contact points in precise position and insulate the contacts from one another.

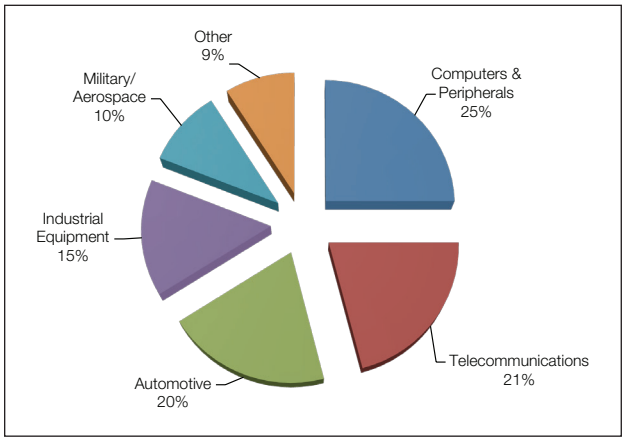
Polyamides (nylons) widely replaced thermoset plastics that were originally used for connectors and remain the dominant plastic used in the market. Now, many plastics are used for connectors, including PBT-type polyesters, liquid-crystal polymers (LCP), polyphenylene sulfide (PPS), polycarbonate and other high-end engineering plastics, as well as thermoset plastics such as phenolic and unsaturated polyester. Resin choices are based on a combination of requirements, including cost, melt flow, molding performance and physical properties.

Resins are often reinforced with glass fiber, usually 35 percent, to improve stiffness, tensile strength and dimensional stability. Growing demands for high-heat performance have led to higher loadings of flame retardants (on a relative basis), also creating greater potential for plate-out issues.

More than half of the global output of connectors is now in China, with other Asian nations representing the majority of the remaining production. Leading markets include computers, telecommunications and automotive. (See Figure 1.) Experts expect the global growth rate for connectors to slightly exceed global growth in gross domestic product, which the Conference Board projects (adjusted for inflation) at 4.5 percent in 2014, up from 2.9 percent in 2013.

FIGURE 1

Connector Markets



Data Source: "Plastics In Electronic Components: Technologies and Global Markets" (Code PLS027C), February 2012, BCC Research.

vydyne pa 66™

Additional Design Issues

Many connector tools are rather complex in design to ensure the functional requirements such as contact spacing, insulation properties and physical connection style are met. There may be latches and/or hinges designed for connection purposes. These tools typically have side action to create specific design detail, resulting in sophisticated cavity design. The complexity can lead to mold filling and venting issues, excessive downtime and increased molded-part cost. Mold designers are challenged to design the parts for functionality, and molders are challenged to produce the parts at minimal cost.

Key Performance Requirements

Strength: High strength is required to maintain the connection in all types of environments. Latches and hinges need to maintain strength for the part's life cycle. Pin retention and pull-out strength are critical to connector performance.

Electrical: A connector material must have excellent insulating properties and resist creation of a tracking path in various environments.

Flammability: Many connectors require V-2 flammability while others require V-0.

Flow: Complex connector designs and sometimes delicate mating cores and pins make flow critically important. The thinner wall sections, thin core pins and need for venting all require a material that flows well with less pressure.

Product Hygiene: Clean products are required to reduce mold deposit formation that result in downtime for mold cleaning. This will significantly add to molded-part cost.

How PA66 Fits

PA66 has many key attributes that make it a desirable material for electrical connectors:

- High strength and rigidity
- Excellent chemical resistance
- Inherent V-2 flame resistance
- Excellent resistance to tracking an electrical path
- Excellent dielectric strength and volume/surface resistivity make it an ideal insulating material
- Excellent thermal endurance (UL RTI) for use in higher-temperature applications

New Developments In Resin Performance

In 2013, Ascend Performance Materials brought online significant new compounding capacity and new technology in Pensacola, Fla., with the goal of meeting the processing and design challenges in several important polyamide markets, including connectors used for electrical and electronic applications. Ascend is now announcing significant improvements in key areas, including reduced plate-out and improved melt flow.

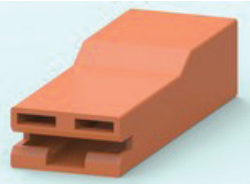
Reduced Plate-Out

Plate-out, defined as release of compounds that foul the tool, is generally a major problem for injection molders. At typical PA66 processing temperatures (280 to 320° C), there is a gradual buildup of volatiles that precipitate out of the polymer melt and condense on the relatively cold mold surface. The volatiles include unpolymerized molecular material inherent in PA66, residual material from glass sizing, lubricants and other additives. They can plug vents, reduce the speed of air evacuation from the mold cavity and impede the molding process. Cycle times and part quality are affected. Excessive plate-out leads to operational inefficiencies including vent plugging, burning, increased mold maintenance and even increased cycle times.

One expert in mold design and maintenance says that more labor hours are spent cleaning mold plates and tooling than any other tooling repair stage. It's necessary to keep mold plates and tooling clean to maintain product quality and extend tool life. Most molds are cleaned manually, adding to the expense. Downtime, however, is the biggest expense, particularly for high-cavitation, expensive tools. In some molding shops, tools are removed and staged for cleaning, often creating a backlog of maintenance work.

Ascend Performance Materials targeted this problem with development of a proprietary process in its new compounding facility in Florida. The process removes impurities that can cause excessive plate-out.

One customer test shows a 95-percent increase in a connector run cycle before the mold needed to be pulled for maintenance and cleaning (Figure 2). One competitive grade lasted about 40,000 shots before it had to be removed for cleaning, compared to 78,000 shots for the new Vydyne grade. Burning and short shots caused several cavities to be shut off over time as the vents became plugged. When the total number of cavities still open became nonproductive, the mold was removed. The ultra-clean Vydyne grade from Ascend lasted 78,000 shots before the mold had to be removed for cleaning. This extra downtime resulted in an additional $0.04 per-part cost when running the competitive grade compared to Vydyne.



The tests were conducted on a decommissioned 32-cavity connector mold on a 300-ton new Toshiba fully electric injection-molding machine at the Ascend Performance Materials' Application Laboratory in Pensacola, Fla. The part is a plug-style, positive-lock connector. (See photo above.)

The test results confirmed an accelerated plate-out lab test developed by Ascend and performed at the Pensacola application lab.

Improved Melt Flow

Ascend has optimized grades for improved flow using its proprietary compounding assets co-located with the polymerization plant in Florida. Improved flow offers advantages in processing (including reduced pressures) and increased design flexibility, including increased length over thickness (L/t) flow ratio. L/t is an experimental index that indicates the distance the leading edge of the plastic melt flow can reach in a fixed thickness and at a fixed pressure. The optimized grade has a melt flow rate of 36.8 cc/min, a dramatic improvement over the previous material available from Ascend, and even better than the PA66 from the industry-leading competitor (Figure 3).

FIGURE 2

Customer Case Study

CUSTOMER SEGMENT: Electrical and Electronic
APPLICATION: Connector
CYCLE TIME: 24 seconds, reduced from 26.6 seconds

Maintenance Intensity

Number of shots between plate-out maintenance

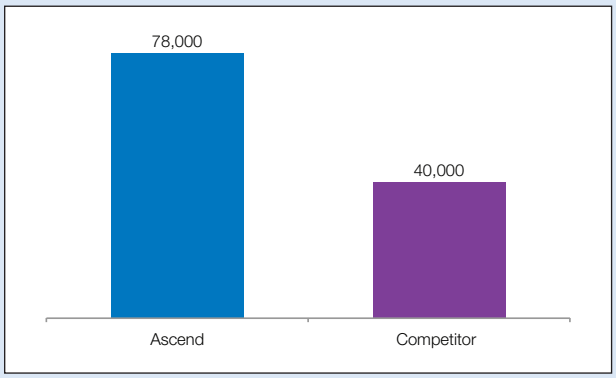


FIGURE 3

Melt Flow Comparisons

Material	cc/min
R533H NAT	27.4
R533H NT	36.8
Industry-leading competitor	34.2

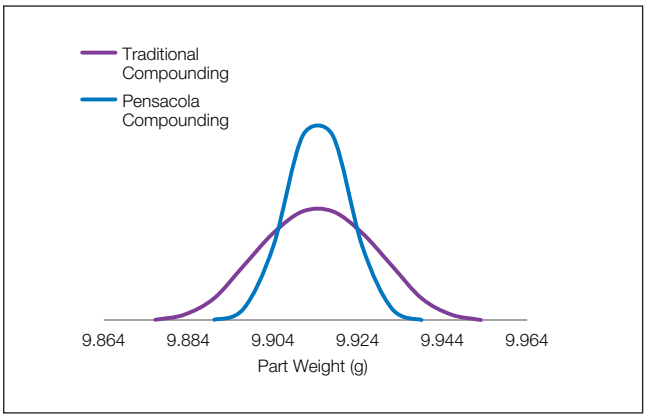
R533H NT is an optimized grade that now leads the industry in melt flow. All three resins are neat (no reinforcements or additives). Data were calculated by the Ascend Performance Materials Applications Laboratory in Pensacola Fla.

Reduced Shot-to-Shot Variability

Ascend's Pensacola compounding technology also creates Vydyne products with improved melt rheology and tighter viscosity specifications than current industry standards. This provides a larger processing window that leaves the molder with more options to fine-tune the molding process and reduce cycle time. This will translate into improved shot-to-shot control and consistent cavity pressure. Robust process control is critical to producing connectors with uniform physical properties. The end result is more consistent part weight (Figure 4) and physical properties from shot to shot. The lower injection pressures required to mold these special grades will reduce fatigue of mold components, particularly small core pins.

FIGURE 4

Injection-Molded Part Weight



Cycle Time Benefit

The cleaner molding operation with the improved Vydyne PA66 allowed a customer to reduce the cycle time from 26.6 seconds to 24 seconds, further reducing piece part cost.

Ascend Performance Materials

In 2013, Ascend added a world scale compounding line (30,000 metric tons per year) in Pensacola, Fla. The new line adds state-of-the-art capabilities for producing proprietary compounds. Applications engineers, customer service engineers and research scientists joined forces to identify improvements in compounds that will most help customers improve productivity and quality. In the E/E connector market, the fruits of that collaboration are now available for full-scale commercial sampling. The benefits include reduced plate-out, improved flow, better part-to-part consistency and faster cycle times.

Please contact your local Ascend sales representative for additional information and to arrange a sample.

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