Plus: Sage Supplier Biodiesel Refinery Special Section

green manufacturer

U.S. $10

Your guide to adopting green manufacturing practices

FMA publishing affiliate of the Fabricators & Manufacturers Association, International®

Molder strikes gold sourcing recycled plastic

Wind power: no tower required

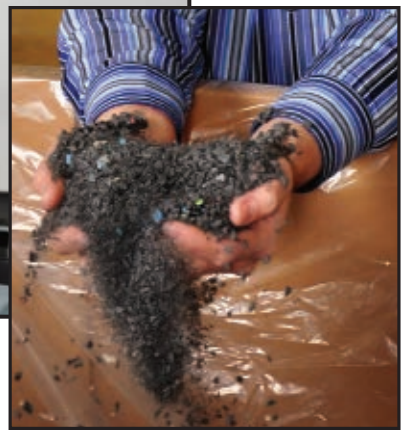
LEED® plant expansion

Ecofriendly cleaners

www.greenmanufacturer.net

Injection molder slashes part costs using recycled plastics

Formulates own raw material, shapes own destiny



AGS Technology President Christopher Racelis says the company has developed the most sustainable—and cost-effective—way to mold quality plastic components using recycled raw material.

By Kate Bachman, Editor

When most people see McDonald's golden arches, they may think of french fries or billions of burgers sold. When George Staniulis, vice president of sales and marketing at AGS Technology Inc., sees the fast-food restaurant's signature arches, he thinks about how they may someday become fodder for his company's recycled plastic formulas.

AGS Technology Inc., Schaumburg, Ill., is an ISO/TS 16949-certifed injection molder that uses its proprietary recycled plastics to produce high-quality molded components primarily for the automotive and durable goods industries. Because the recycled raw materials cost substantially less than virgin materials, the company is able to pass on to its customers significant cost savings on the resultant molded components—squaring both parties in a favorable position to take on offshore competitors head-on.

"Our business model is that we're a low-cost producer for 'shoot-and-ship' parts, using recycled plastics as our raw material," explained Christopher Racelis, AGS Technology president. "The products that we manufacture are material-intensive, so the bulk of the cost—it could be 50, 60, 70 percent—is in the raw material. So the best way to remove cost from the part is to mold the most cost-effective raw material. And that is recycled plastic," Racelis said.

AGS Technology formulates its own raw material, called Injectoblend™, matching its properties to corresponding virgin resins and to customer specifications. Traditional plastic compounders convert recycled plastic into raw material for injection molding applica-

tions by grinding the recycled plastic and then extruding it into pellets.

Conversely, AGS Technology molds its formulated plastic regrind directly and bypasses the expensive extruding/pelletizing operation.

This niche capability and efficient way to mold recycled plastics are what enable AGS Technology to produce high-quality plastic molded products at a substantially lower cost—often at or below offshore prices.

Beginnings of a Better Mousetrap

Like many great collaborations and brilliant ideas, the concept for AGS Technology's business model started with a round of beer. Racelis, Staniulis, and Virgis Gudeika, director of technology, who had all worked together at a compounding company, came up with their novel manufacturing concept while discussing some of the marketing problems and challenges they were facing.

"To be a successful plastic compounder, you need to offer the recycled material at a little lower cost than virgin plastic," Staniulis noted. "But often molders who might have saved 10 percent in raw material costs by using recycled plastics saw these cost savings evaporate because of the manufacturing problems they experienced while processing them.

"When the molder runs the part with virgin material, the part runs consistently. But with recycled material, there was more variability. The scrap rate might have gone up. These types of things would have incurred costs and eliminated any potential savings. There was always the perception among molders that recycled material would give them problems.

"We realized that if you are a molder and you embrace using recycled material that is formulated to meet all the requirements, you could proactively give your customer a low-cost molded product. We were telling this to the injection molders, but all the molders had objections that we just couldn't seem to overcome," Staniulis said.

"So we were out having a beer and strategizing on how to overcome this 'molder problem' and the answer came to us—*Be* the molder," Racelis said.

"Now, instead of making pellets and selling them to other molders, we make a formulated blend, a salt-and-pepper-type mix regrind that we put directly into our injection molding machines and shoot directly into a part," Racelis said. "We still sell raw material, but it's not in the form of a pellet—it's in the form of our customer's part.

"We came up with a better mousetrap," he added. "We feel that this process is the most sustainable for recycling plastic because we're creating the best material mix, eliminating a manufacturing step, and reducing cost."

The Deepest Cost Cuts

AGS Technology focuses on molding components from engineered materials, which typically are priced higher than components made from commodity materials and, as virgin materials, sell for $1.00 per pound and more. "Since roughly half of the cost of a part is in materials, the more material-intensive the part is and the higher the cost of the comparable virgin raw material, the better the cost savings we can provide," Racelis said.

Racelis explained the cost breakdown. Because regrind doesn't come with certificates of compliance or analysis and because of the problems inherent in its processing, it typically sells for $0.20 to $0.50 per pound. To prepare the regrind to meet the specifications of a virgin material, AGS processes it

Figure 1

AGS Technology formulates its own raw material, called Injectoblend, matching its properties to corresponding virgin resins.

further, which adds another $0.25 per pound—bringing the total to $0.45 to $0.75 per pound.

"So let's say a virgin engineered material costs $1.50 per pound," Racelis said. "With a cost differential of $0.75 per pound, my material cost is half of the virgin material cost—and this is where AGS has a sustainable competitive advantage.

"The cost of processing the regrind is the same, regardless of whether it is to be a match for a $0.60-per-pound commodity material like polypropylene or a $1.50-per-pound engineered resin like glass-filled nylon, so the cost differential on a less expensive material won't be as great. We can offer the greatest cost savings for our customers, therefore, by concentrating on pricier engineering resins," Racelis said.

Resourceful Sourcing

The process starts with sourcing the recycled materials.

AGS Technology purchases different grades of mostly postindustrial plastic regrind in 10,000- to 40,000-lb. quantities. That industrial waste can originate from several sources—including an estimated 100,000 lbs. a year removed from the aforementioned arches when their useful life as a sign ends and their useful life as polycarbonate scrap, and eventually as another molded product, begins.

Some postconsumer waste, such as polyethylene terephthalate (PET) caps of beverage containers, compact disks, and 5-gallon polycarbonate water jugs, are sources of the company's raw material regrind. When a car is scrapped, many of the interior plastic parts are removed for recycling.

Other sources may be a little more oblique, such as the straps that secure vehicles to a rail car transporting them; these are a good source of a polycarbonate polyester blend.

Some of the material is sourced from the molder's own plant floor—and other manufacturers' factory floors—from the spent runners, scrapped parts, and parts made before the first good part. This material is ground at AGS's raw materials facility.

When Gudeika purchases the regrind, he expects that it will meet certain performance specifications for a specific internal part number. But there are some knowns and some unknowns.

"Recyclers will call here and say, 'I have this polycarbonate material of a certain grade,' or 'Hey, I've got this glass-reinforced nylon. I don't know how much glass is in it.' We need to verify that the material is indeed what the guy is representing it and that the quality of the regrind is something we use," Gudeika explained.

"Our verification process includes molding ASTM or ISO specimen bars from the recycled material, testing them in our lab for various properties, and benchmarking these test results to internal part specifications," Gudeika said.

"In essence, we generate our own incoming raw material certification data," Gudeika explained.

Warehousing, Inventory Turns

Sourcing recycled plastic requires stocking a full warehouse to ensure the material is in stock when you need it, Racelis said.

"People come through here and ask, 'What're your inventory turns?' We say, 'They're terrible.' It's counterintuitive to have high inventory turns when you're dealing with the recycling market," Racelis said.

After all, recycled material is generated only when the useful life of a product is over, and someone discards it.

"Buying recycled material is not like calling up a virgin material supplier and saying, 'Send me that now' and he has it in stock. You can't expect to get the right material the same week or even the same month. You need to buy recycled material when it becomes available—and keep it in inventory to ensure a steady supply."

Figure 2

A Tier 1 supplier customer was challenged by Ford to increase the recycled content of the headliner without increasing cost or sacrificing performance requirements. AGS Technology replaced virgin impact modified PC with its Injectoblend FPC120 and decreased piece-part costs by 31 percent. The material contains a minimum 90 percent recycled content, is approved to Ford WSS-M4D926-A2, complies with FMVSS302, and passed all corresponding Ford component validation testing requirements.

Eliminating Variability, Controlling Quality

AGS Technology's in-house processing of the recycled plastic material is designed to control its properties and content. By cleaning, segregating, homogenizing, testing, and formulating the recycled material, the company eliminates the variability that injection molders have encountered with recycled plastics.

Clean, Sort. The company has standard procedures in place to systematically clean the recycled material. Metals and large chunks of foreign materials are segregated from each batch, as are light-bulk-density materials such as fines and particles.

First the regrind is run through a cleaning line. It is loaded into a tipper and tipped into a surge bin and through screens that remove larger chunks to make sure they do not continue downstream.

"To the plant generating the plastic scrap, this is their garbage. So people walk by on their breaks, throw their pop cans in there, chicken bones, whatever. We find all sorts of things—cigarette packages, cans, paper … small animal bones," Gudeika said. "Or maybe when the plastic was ground, the equipment had a hole in the screen, so really large chunks of plastic get in the regrind. Those tramp particles are not going to work in our molding presses."

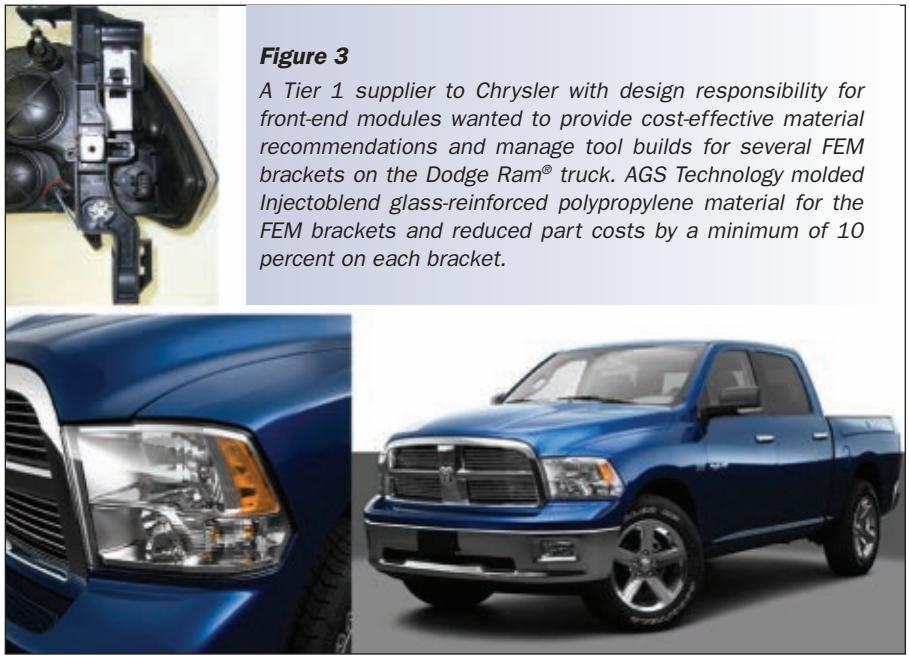


Figure 3

A Tier 1 supplier to Chrysler with design responsibility for front-end modules wanted to provide cost-effective material recommendations and manage tool builds for several FEM brackets on the Dodge Ram® truck. AGS Technology molded Injectoblend glass-reinforced polypropylene material for the FEM brackets and reduced part costs by a minimum of 10 percent on each bracket.

The material is conveyed to an aspirator that removes the lighter-bulk-density particles and fines. "When the material is ground, it creates tiny particles and a lot of dust that impedes our molding process. They clog up our filters and tend to burn faster in the barrel, which degrades the plastic," Gudeika said.

Next the regrind goes through a series of inline magnets to remove ferrous metals. The magnets capture bolts, razors, metal inserts that may have been ground up, even the grinder blade itself. The regrind then falls past a metal detector that detects the nonferrous metals—brass, copper, and stainless steel.

When the instrument detects nonferrous metal, it sends an electrical signal that directs a device to divert the regrind containing the metal. When the detector no longer senses metal, the device comes back inline and the material continues falling.

"After the regrind goes through our cleaning line, when it gets to this point, it's a clean plastic regrind. It's clear of fines and it's free of metal," Gudeika said.

Homogenize. The next step, homogenizing, is performed to ensure that the mix is consistent throughout and that the sample used for testing is representative

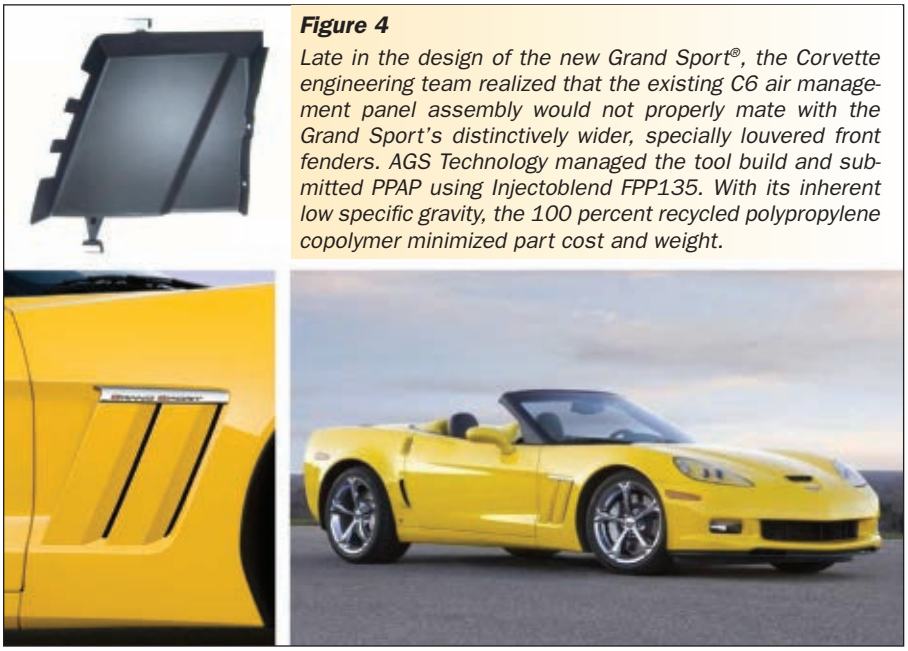


Figure 4

Late in the design of the new Grand Sport®, the Corvette engineering team realized that the existing C6 air management panel assembly would not properly mate with the Grand Sport's distinctively wider, specially louvered front fenders. AGS Technology managed the tool build and submitted PPAP using Injectoblend FPP135. With its inherent low specific gravity, the 100 percent recycled polypropylene copolymer minimized part cost and weight.

of the entire batch. The material is thoroughly mixed in a stainless steel double-cone tumble blender.

"If we just pull a sample from the top of that particular box to run tests on it, it'll be indicative of just what is on the top of the box," Gudeika said. "Who knows what's in the corner, in the layer? That's one of the mistakes a lot of recyclers make. They do what is called a grain probe sampling, borrowed from the grain industry. They insert a wand to get some material from several layers, then pour it into a container and test it.

"Well, that's faulty, with plastic especially, because if there's just a small amount of contaminant in a corner, it will adversely and dramatically affect the material properties. The only way around that is to sample everything 100 percent," Gudeika said. "And that is why we homogenize the entire lot of material."

Test. Gudeika molds the blend into test bars, or plaques. "Now we're ready to take a fingerprint of the material," Gudeika said. The lab tests determine whether the blend meets the requirements.

The company runs a full battery of mechanical and thermal tests to characterize the formula and to ensure quality, including melt flow, impact resistance, tensile, flexure, heat deflection temperature, specific gravity, and ash content (see **AGS's Battery of Tests sidebar**).

AGS Technology's testing laboratory meets ISO/TS 16949 standards. "Because we are ISO/TS, a registrar examines our lab every year to verify that the laboratory equipment is calibrated properly and that the lab technicians are using the latest techniques," Gudeika said.

Formulating. The next stage is formulating the material to meet the customer specifications. "It's a recipe, so we are very confident that when it is tested, it will hit the target right away and we can ship it. If it doesn't meet spec, I'll go back and add whatever I need to get it in spec, but obviously I'd rather not waste time doing it a second time," Gudeika said.

Virgin additives and modifiers are added as the formula requires, Gudeika said. "For example, we use modifiers to reach a desired level of impact resistance. Polycarbonate at room temperature is naturally very ductile. But at low temperatures it doesn't necessarily perform as well. So adding an impact modifier to a multipurpose polycarbonate material gives ductility at low temperatures."

Gudeika said he likes the challenges inherent in sourcing recycled materials and converting them into useful raw materials. "If it became easy, then maybe two, three, five years down the line, I would see a lot of competition. I want it to be challenging."

He added, "Sure, it makes a long week, sleepless nights. Sometimes an idea comes at 2 a.m. for a new formula. But we've had this business for roughly 15 years. Nobody's doing what we're doing. Nobody knows *how* to do it.

"This side of the mold business is more than just the polymer science and engineering; it's also imagination and art," Gudeika continued. "Historically, the approach to plastic recycling has been the 'cascade' approach. In other words, in every reuse, the material is used in a less demanding application.

"Our approach is to upgrade this recycled material and develop compounds that can be put back into a high-end application. That's what makes us unique in the industry."

Injection Molding the Product

Of course, a manufacturer must maintain a sound overall operation downstream to sustain the benefits and cost savings netted upstream. Cost savings realized in one area of an operation can be quickly undone by mistakes and missteps in another area of the operation.

The injection molding facility is impeccable and systematic about applying all of the good manufacturing processes which ISO/TS 16949 certification entails. These include *poka-yoke* errorproofing, vision system inspections, first-piece inspection, last-good-piece reference, scrap-rate tracking, standardized setup, weekly quality reviews, standard procedures posted at every machine, tool and machine maintenance records, lot traceability, some material handling automation, and full process documentation.

The facility also is equipped with sophisticated check fixtures and gauges to check the critical dimensions and features of the molded components.

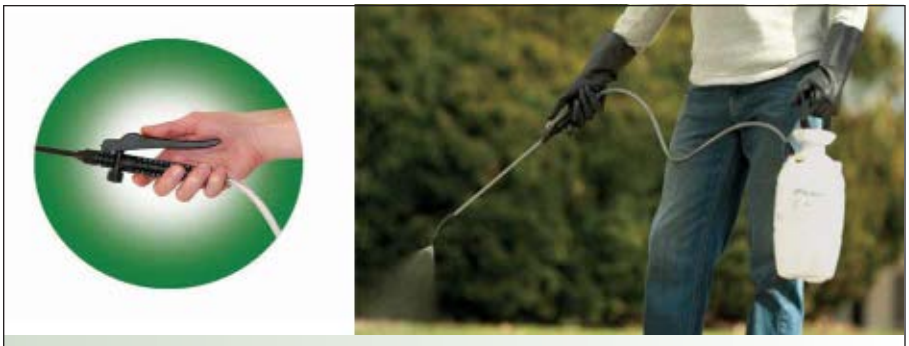


Figure 5

A manufacturer of premium pressurized sprayers needed to lower its components costs to compete with an onslaught of offshore spraying products. AGS Technology replaced the virgin acetal copolymer in the sprayer handle with its Injectoblend FPOM110 recycled acetal copolymer and reduced piece-part costs by 19 percent. In addition, the manufacturer was able to differentiate itself from the offshore competition by promoting its environmental stewardship through the use of recycled materials.

Designed for Recycled Plastic. A unique and crucial aspect of AGS Technology's manufacturing operation is that its injection molding machines, drying equipment, and material handling equipment are designed specifically to use recycled plastic as the raw material, Racelis said.

"Many materials must be dried before they are molded to ensure that they maintain the integrity of the product," Racelis explained. "Plastic has a tendency to absorb moisture. It's made of carbon polymer chains. Water causes hydrolysis, which essentially breaks the polymer chains. Typically, the impact-resistant plastics become brittle and break, so it's key to minimize the plastic degradation.

"Drying recycled material presents more challenges than drying virgin material. It takes longer to dry an irregularly shaped regrind particle than a uniform cylindrical virgin pellet," Racelis said.

"Drying material is all time and temperature. You can either go to a higher temperature or a longer time. We have the flexibility to do both." The company uses a moisture analyzer in production to check the moisture content in the raw materials, Racelis said.

Best Applications

Typical parts the company injection-molds are brackets, shields, bezels, housings, bases, filter cores, covers, and substrates.

High Volume, Lots of Plastic. "Large parts that are material-intensive show the best cost savings. However, if it's a small but high-volume part with lots of cavities, that's going to be a winner too," Racelis said.

The molder's highest volume is 2.5 million parts a year; the smallest is about 5,000 parts. "We make sense on jobs that use a lot of raw material," Racelis said. "If you only use 1,000 lbs. a year, we're not going to look that much different from a conventional molder. On 20,000 lbs. of material or more, there's going to be a big difference between what you're currently paying and what the AGS cost would be."

Staniulis cited an example: "On one PC/ABS job we use about 250,000 lbs. of material a year. The cost differential between our Injectoblend material and the corresponding virgin resin is $0.80 per lb. That's an annual savings of $200,000 for our customer, without sacrificing any quality standards.

"What could be a better testimonial to the economic benefit of using recycled plastics?" Staniulis added.

> *"The best way to remove cost from the part is to mold the most cost-effective raw material. And that is recycled plastic." —AGS Technology President Christopher Racelis*

No Assembly Required. "Most molders want to get into assembly as a value-add because they can't make money on the shoot-and-ship parts. We'll certainly do assembly, and we're very capable. But our bread and butter is on shoot-and-ship parts because of our recycled raw material advantage," Racelis said.

Any Color, as Long as It's Black. Because the colors of the recycled plastics have broad variability, using recycled plastic as the raw material makes color-matching nearly impossible, Racelis said.

Some of the scrap regrind that's available on the market changes color depending on the season. Three months before Halloween, AGS might receive shipments of orange and black scrap; red and green before Christmas.

Color restrictions are one of the reasons that AGS Technology specializes in structural, or functional, black plastic molded parts. Black is added during the formulating process to give the parts a uniform black color. "These typically are nonappearance-type items. Often these are substrates used in the interior of a vehicle," Racelis said. "We've had quite a bit of success with those types of applications.

"For example, when you look up at the roof interior headliner, there is an overhead console that holds your sunglasses and things like that," Racelis said. "Behind those appearance parts is a substrate that allows that piece to be attached to the roof; that is a nonappearance item." (See **Figure 2**.)

As part of the roof, the headliner substrate has very demanding impact and heat resistance requirements. The substrate must resist warping, even in hot climates, such as in Phoenix. Therefore, the substrate parts on the headliner are made out of highly heat-resistant materials, such as polycarbonate and polycarbonate alloys.

For vehicle exteriors, the company molds nonappearance, structural, black plastic brackets to hold fascias or modules in place. These typically are made out of glass-reinforced nylon 66 or glass-reinforced polypropylene (see **Figure 3**).

The manufacturer molds parts for under-the-hood applications such as headlamp module brackets, modules to hold the transmission control or body control, and air management panel assemblies (see **Figure 4**). Under-the-hood applications experience a lot of heat, and some airflow is managed within the engine compartment. An air management panel assembly is attached to the engine compartment and redirects the air to optimize vehicle performance.

Although the company has a lot of depth in the automotive segment, it manufactures molded products for other segments as well, such as lawn and garden and motor housings and heat shields for the industrial markets (see **Figure 5**).

AGS's Battery of Tests

Virgis Gudeika runs all the recycled raw materials through a full battery of tests in the ISO/TS 16949-registered laboratory to characterize and verify that they meet specifications:

First we'll mold sample test bars and enter the results into the computer to make sure they meet that particular specification [see **Figure 6**].

Our product data sheet basically lists all the tests we perform—tensile strength, elongation, flexural properties, melt flow rate, impact resistance, heat deflection temperature. In addition, there are environmental tests and heat aging tests.

Tensile Strength, Elongation, Flexural Properties. We use a universal tester in tension and compression modes at a fixed crosshead speed to determine tensile strength, elongation, and flexural properties. We can also add a chamber to test cold or elevated temperatures.

Figure 6

Lab technician Aaron Walker tests a Type I specimen bar in tension mode to obtain the material's tensile strength and elongation values.

Virgis Gudeika, AGS Technology director of technology, taps his resourcefulness in sourcing and formulating recycled plastics for the company's injection molding operation.

Melt Flow Rate. We use several different melt flow indexers. You input a set temperature and load. The plastic will flow out at a set rate. After so many seconds, you cut the strands coming out and weigh it and that gives you an idea of the material flow.

That's important from a processing standpoint, because if it's too thick, like mud, it may not fill the mold cavity. If it flows too easily, that may be a sign of a low-molecular-weight material that may be degraded or have poor properties.

Impact Resistance. We have a pretty heavy-duty Izod impact strength tester. There are different impact-type tests, because with plastic, especially for durable goods, it's a key characteristic. There are certain parts, such as the instrument panel, that cannot be permitted to break like shrapnel in an accident.

Heat Deflection Temperature. In the summer in Arizona, a vehicle's interior temperature can become extremely hot. So you have to target those applications, such as a top cover for an automotive instrument panel, with engineered thermoplastics such as polycarbonate.

Engineered polymers need to retain structural integrity from -40 degrees C to 25 degrees less than their specific melting point, or softening point, depending on if the polymer is amorphous or crystalline resin.

If you were to introduce a blend with 30 percent glass fiber into the same polymer, it would increase heat resistance by a few hundred degrees F.

A 40 percent glass fiber, mineral in combination, reinforced nylon 66, has a melting point of 496 degrees F, so you have to watch which type of environment this part is introduced to, to withstand under-the-hood applications.

Heat Aging. When you send a test plaque for approval, the customer requires 1,000 hours of heat-aging property change testing on a specific resin at a specific temperature. That temperature corresponds to a specific product.

For example, for glass-filled resins, the standard temperature should be 150 degrees C for 1,000 hours, so you measure all your properties before and after that. And the property should not change more than the specific percentage rate as dictated by customer specification. Customers use that data to extrapolate how much the polymer would potentially degrade after five years in service.

—Virgis Gudeika, Director of Technology, AGS Technology

One of the most difficult-to-mold products is this glass-reinforced nylon fuel filter tube.

Cost—A Value Proposition

AGS Technology is working to expand its customer base by laying it on the bottom line—price, that is. So confident are Racelis, Gudeika, and Staniulis in their low-cost business model, they have posted a module on their Web site, called AGStimator™, that enables a potential customer to get an estimate for a piece part, based on material composition, volume, and other variables, Staniulis said.

"In less than a minute, the AGStimator can provide a cost-competitive quotation for an injection molded structural part made from a choice of six of the most common high-performance AGS Injectoblend recycled materials," Staniulis said.

Of course, at the end of the day, it's quality and the satisfaction of producing a well-made product that builds pride.

"I've been known to go to the auto show quite a bit to check out vehicles with our parts," Racelis said. "I went to the Corvette museum over Christmas break with my kids, and we toured the plant there. I got to show them our parts on the vehicle."

And maybe there's some satisfaction in knowing that the way you work is keeping your kids' environment cleaner.

"It always feels good to do the right thing," Staniulis said.

Editor Kate Bachman can be reached at kateb@greenmanufacturer.net.

AGS Technology, Inc., 2015 Mitchell Blvd., Schaumburg, IL 60193, 847-534-6600, ccr@agstechnology.com, www.agstechnology.com