

Plastics Technology

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Hot-Fill Containers New Tech for OPP & PET

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Injection Molding
WPCs

p. 56



New Clear, Tough
Copolyester

p. 60



OPP & P



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INJECTION MOLDING WPC

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Cover: PET bottles today can be filled faster and hotter than ever...but polypropylene is looking more attractive, too. See what each is doing to get ahead on p. 50. (Photo: Sidel)

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PT



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Dishwasher Safe



Crystal clarity, toughness, and ability to withstand hundreds of home or commercial dishwasher cycles without cracking or crazing are major attractions of Eastman's new Tritan copolyester.

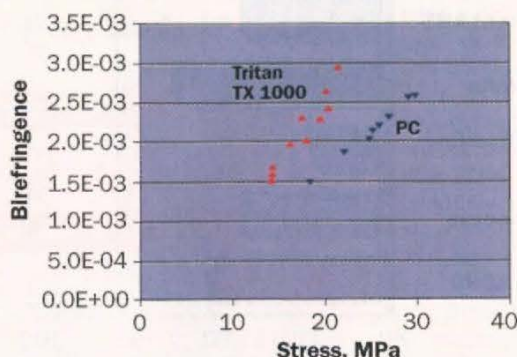
In consumer goods markets, there are countless applications for clear plastics such as copolyesters, acrylic, SAN, amorphous nylon, and polycarbonate. However, as new applications call for materials that can deliver durability, design flexibility, and easy processing, existing plastics can fall short. Eastman Tritan copolyester is a new amorphous thermoplastic aimed at filling this gap. It was launched by Eastman Chemical Co. at the recent K 2007 show in Dusseldorf, Germany.

Up to now, copolyesters have often been limited by their low heat resistance. New Tritan resin overcomes this hurdle with significantly increased heat resistance and toughness. Tritan offers exceptional clarity, low haze, high gloss, and consistent color, as well as the potential for faster molding with lower levels of residual stress. This unique balance of performance and processability is well suited to bridge the gap between previous copolyester families and other clear plastics such as polycarbonate.

New Clear Copolyester Is Tougher, More Heat-Resistant, and Processes Easier, Too

By David S. Porter and Randy S. Beavers, Eastman Chemical Co.

FIG. 1— BIREFRINGENCE VS. STRESS LEVEL



Tritan copolyester shows lower stress at the same birefringence level as polycarbonate (PC).

Designed with a higher glass-transition temperature (T_g) than traditional copolyesters, Tritan delivers greater heat resistance without sacrificing the chemical resistance and low internal stress found in copolyesters.

Products molded from Tritan have less residual stress than ones molded in other types of thermoplastics, such as polycarbonate. Combined with its superior chemical resistance, this lower residual stress level can significantly reduce the risk of product failure from environmental stress cracking (ESC). In molded polycarbonate products, ESC is often controlled through an annealing process or significant design modifications—compromises that can be largely eliminated through the use of Tritan copolyester.

Produced from a new, patented monomer, Tritan copolyester is the first of a new family of materials. Thus far, it has been shown to be suitable for injection molding, injection-blow and stretch-blow molding, sheet and flat film extrusion, and thermoforming. It is available in commercial quantities and in several grades designed for different markets. The grades differ in T_g , melt flow rate, and incorporation of mold release.

Putting it to the test

Eastman's Tritan offers many benefits for commercial and residential kitchenware and small kitchen appliances, including reusable food containers, sports bottles, mugs, pitchers, and containers for food processors and

blenders. These products often require extremely versatile designs and shapes, exceptional clarity for vivid aesthetics, and dishwasher durability—one of the biggest challenges to kitchenware design.

Dishwashers in homes and professional kitchens expose kitchenware to a harsh combination of heat, hydrolytic and chemical attack, and applied stress. In some cases, kitchenware is exposed to the dishwasher dozens of times per week. Withstanding these environmental conditions was a major design goal in the development of Tritan.

When developing this new material, Eastman tested products made with Tritan in dozens of commercial and residential dishwashers. Samples of Tritan and other materials were subjected to multiple washings simulating

overloaded dishwashers. Results demonstrated that Tritan's unique balance of properties allows molded items to withstand hundreds of cycles in commercial and consumer dishwashers with no visible crazing or cracking, a vast improvement over polycarbonate.

How it compares

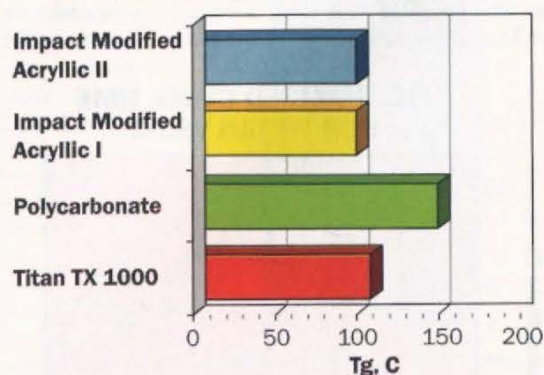
Although Tritan is a copolyester, it is similar to polycarbonate in many important respects. For example, polycarbonate has a reputation for high heat resistance and toughness. In notched Izod testing with 1/8-in. bars, polycarbonate can withstand impact of 14 ft-lb/in. with a partial break, as opposed to less than 5 ft-lb/in. for traditional copolyesters. In the same test, Tritan can resist an impact of 15.9 ft-lb/in. without breakage.

Interestingly, increasing the sample specimen thickness to 1/4 in. provides significantly different notched Izod results. Bars molded from polycarbonate withstood only 2.2 ft-lb/in. while Tritan displayed no break or partial break at impacts of 15.9 ft-lb/in. Thickness sensitivity with regard to impact toughness is a well known characteristic of polycarbonate that does not affect Tritan copolyester.

Another indication of toughness is elongation at break. Polycarbonate has a break elongation of 110% to 120%, while Tritan has a break elongation of 150% to 170%.

Although Tritan equals or ex-

FIG. 2— HEAT RESISTANCE



New Tritan has higher glass-transition temperature (T_g) than previous copolyesters.

ceeds polycarbonate in impact tests, that does not tell the whole story. A tough material does not necessarily guarantee a durable product. Products molded in polycarbonate are at greater risk of ESC, particularly in more intricate shapes. This is because polycarbonate parts may experience significantly higher levels of residual stress than parts molded of Tritan.

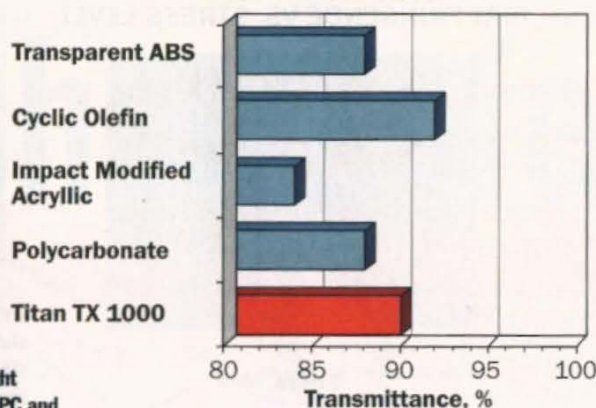
Figure 1 presents data generated during experiments to measure the stress-optical coefficient in Tritan. The stress-optical coefficient enables evaluation of residual stress levels in molded parts based on comparison of birefringence within the parts, a common tool for assessing part quality. The stress-optical coefficient for Tritan is significantly higher than for polycarbonate (164 vs. 97.2). However, the coefficient is inversely related to residual stress level. As a result, parts molded from Tritan having birefringence patterns equivalent to those seen in polycarbonate would possess lower residual stress, thereby improving the ESC performance of Tritan.

Testing revealed that under a 1% strain, polycarbonate often breaks after two to three dishwashing cycles in a residential dishwasher using a common household detergent. Under the same conditions, Tritan endures more than 250 cycles with no sign of crazing or breakage.

While products molded in traditional copolyesters tend to have less residual stress than polycarbonate, they are also less resistant to heat. The Tg of most copolyesters is around

Tritan has higher light transmittance than PC and some other clear plastics.

FIG. 4—CLARITY



80 C, as opposed to a Tg of 150 C for polycarbonates. The first Tritan product launched has a Tg of 108 C (Fig. 2), again significantly changing the performance profile of copolyesters.

Higher Tg offers several other benefits, including reduced creep under load, reduced molding cycle time, and slower physical aging (Fig. 3).

Clarity (Fig. 4) is measured by light transmittance according to ASTM D1003. Tritan, polycarbonate, cyclic olefin copolymer (COC), and PETG all exhibit very high levels of light transmission. Clear ABS and impact-modified acrylic display lower transmittance due to their multi-phasic nature.

Tritan also exhibits scratch resistance that is much better than SAN and slightly better than polycarbonate. Together with its toughness and chemical resistance, this property suggests potential uses in face masks and other sports or safety applications.

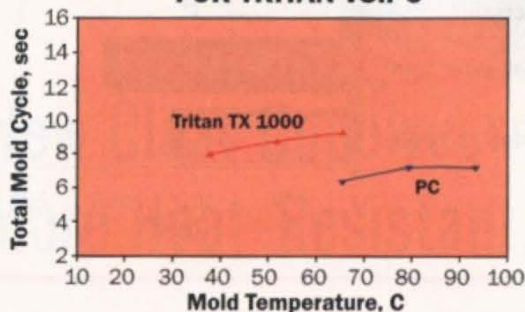
Benefits for molders

Tritan is good news for OEMs, designers, and consumers, but the new copolyester also provides substantial benefits to molders. It can reduce costs by eliminating production steps and lowering material use, shipping weights, and inventory volumes. It can also deliver faster molding cycles than many other transparent plastics. One customer experienced a nearly 20% improvement in cycle time with Tritan as compared with polycarbonate parts produced in the same mold. Tritan's melt flow is generally similar to that of polycarbonate, and its similar shrinkage allows it to be used in the same molds. It molds well with hot runners and small gates. It also thermoforms well with deep draws.

Tritan can be injection molded faster than polycarbonate in *thick sections* without concern for residual stresses. Tritan's lower stress levels eliminate the need for an additional annealing step after molding (requiring expensive annealing ovens), thereby reducing energy use and overall processing time, lowering costs, and increasing production rates. And with a 2% lower density than polycarbonate, Tritan also yields more parts per pound of resin, which can contribute to material savings.

For both extruded sheet applications and molded products, Tritan does not require predrying before thermoforming. Products can be thermoformed faster and at lower temperatures than polycarbonate sheet. The result is superior material distribution and increased design flexibility when using decorative paints and inks.

FIG. 3—MOLD CYCLE TIME FOR TRITAN VS. PC



PC molded faster in this trial with a medical luer connector. But Tritan can mold faster in thick sections without residual stress.

TRITAN COPOLYESTER

Preliminary Data Sheet^a

General Properties	
Specific Gravity	1.18
Mold Shrinkage	0.005 in./in.
Mechanical Properties	
Tensile Strength	
@ Yield	6200 psi
@ Break	7700 psi
Elongation	
@ Yield	6%
@ Break	210%
Flexural Yield Strength	9000 psi
Tensile Modulus	225,000 psi
Flexural Modulus	225,000 psi
Izod Impact Strength	
Notched, 73 F	NB
-40 F	2.4 ft.-lb/in.
Unnotched, 73 F	NB
-40 F	NB
Thermal Properties	
HDT @ 66 psi	210 F
@ 264 psi	185 F
Optical Properties	
Total Transmittance	90%
Haze	<1%
Typical Processing Conditions	
Drying Temperature	190 F
Drying Time	4-6 hr
Melt Temperature	500-540 F
Mold Temperature	100-150 F

^aUnless otherwise noted, all tests performed at 73 F and 50% R.H.

NEED TO KNOW MORE?

For further information about this company and its products, visit www.ptonline.com/suppliers.

Eastman Chemical Co., Kingsport, Tenn.
(888) 321-1021 • www.eastman.com/tritan

Dishwasher-safe

Products exposed to dishwashers must withstand heat, humidity, detergent chemicals, food, in-mold stress, and abrasion from overpacking, along with hydrolytic attack. Commercial dishwashers reach peak temperatures of about 85 C and cycle for 1 to 2 minutes. Residential units reach peak temperatures around 70 C and have cycles of up to 2 hours. Also, kitchenware used in restaurants and commercial kitchens can be washed several times a day.

Figure 5 shows the varying effects of dishwashers on a blender carafe molded in different materials. The polycarbonate container shows cracks after 10 wash cycles, but the Tritan container shows no cracks after 100 cycles. Astonishingly, containers made with this new material have been tested in over 500 wash cycles with no cracks or hazing.

Tritan in the real world

One of the first commercial applications for Tritan copolyester comes from California-based CamelBak, a provider of hydration systems for consumer, government, and industrial applications. CamelBak recently partnered with Eastman to develop the injection stretch-blow molded CamelBak Better Bottle product line using Tritan.

Since the CamelBak Bottle was first launched in polycarbonate, the company has received requests from consumers for both improved dishwasher durability and a product free of bisphenol-A (BPA), a chemical used to make polycarbonate that has been linked to potential health concerns. These requests caused CamelBak to turn to Eastman for alternative material ideas. Tritan was the answer, providing a BPA-free material that also has greater durability to withstand rugged use and dishwasher cleaning. The new CamelBak Better Bottle is scheduled to launch in early 2008 in North America.

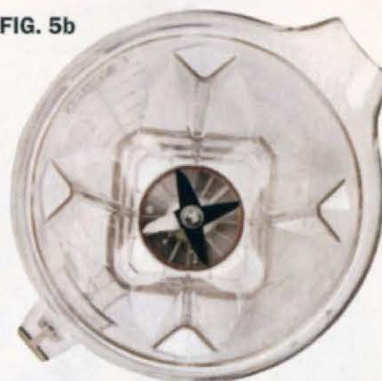
Another early application comes from the Vita-Mix Corporation, a producer of high-end kitchen blenders for household and commercial use. Vita-Mix is currently manufacturing blender containers for the newly developed Vita-Mix 5200 model using Eastman Tritan copolyester. Vita-Mix, whose brand is strongly associated with healthy, pure living, sought out a BPA-free material for its new blender. The

FIG. 5a



Polycarbonate blender carafe (above) shows cracks after 10 wash cycles while Tritan carafe (below) shows no cracks after 100 wash cycles.

FIG. 5b



CamelBak switched from polycarbonate to Tritan copolyester for reusable water bottles because Tritan is BPA-free and has better dishwasher durability.

Continued on p. 76...

COPOLYESTER

Continued from p. 63...

new-generation copolyester also delivers excellent toughness to stand up to the rigors of the blending process and washing, in addition to superior chemical resistance and improved sound dampening that ameliorates blender noise. The Vita-Mix 5200 is scheduled to launch by the end of this year.

A third application, which is due to launch in 2008, is a thick-walled soup bowl from Carlisle Food Service Products. Used in restaurants, hotels, and catering, the bowls have previously been molded of polycarbonate, polycarbonate/PET blends, and SAN. An important criterion is the ability to be washed several times per day in commercial dishwashers. Tritan molds



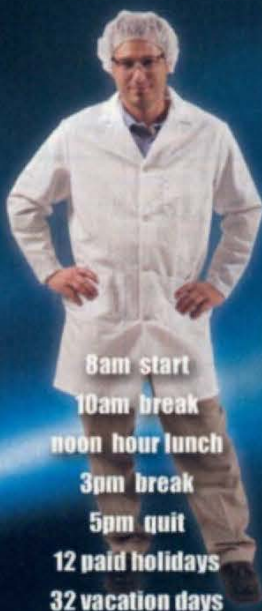
Carlisle's new restaurant soup bowl will use Tritan because it molds faster in thick sections than other resins, has lower density, and withstands multiple dishwasher cycles per day.

faster and has lower density than some materials Carlisle has used in soup bowls. Tritan can also be used in the same molds as those materials.

Less environmental impact

Reducing overall impact on the environment is a goal up and down the supply chain. Tritan has some features that contribute positively in this regard. The new-generation copolyester is less dense than materials such as polycarbonate, thus using less material to make the same products. Additionally, the material can eliminate steps in processing such as annealing, which can reduce overall energy usage. **PT**

Man vs. Machine.



8am start
10am break
noon hour lunch
3pm break
5pm quit
12 paid holidays
32 vacation days



8am start
still running...
all year
no vacation

Case Packers & Robotic Unitizing... We've Automated Everything.

Loading cases is a no-brainer, right? But if you're the guy doing the loading, it's easy to let your mind wander. We've developed a way to avoid that problem altogether. If it has to do with loading your product in a case and moving it into units, we've got you covered. Whether your product is HDPE or PET, we can get it into the case in the most efficient way.

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Vita-Mix switched from polycarbonate to BPA-free Tritan copolyester for its new blender carafe, which can be molded in the same tools as polycarbonate.

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