Public Awareness Drives Market for Safer Alternatives

Bisphenol A Market Analysis Report

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This paper was produced for the Investor Environmental Health Network, a collaborative partnership of investment managers concerned with the risks and opportunities associated with product toxicity. Through dialogue and shareholder resolutions, IEHN encourages companies to adopt policies to reduce and eliminate the toxic chemicals in their products.

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Bisphenol A Market Analysis Report Summary

In 2008, based on scientific studies showing potential health harms from low dose exposure to bisphenol A, some government agencies for the first time acknowledged potential hazards from food and water contact uses of this chemical. In a few short weeks, the chemical bisphenol A (BPA) went from being a rarely discussed, ubiquitously used substance, to becoming a chemical whose hazards were highlighted in mainstream news, driving consumer demand for alternatives that in turn invigorated retailers and manufacturers. Despite the continuing debates regarding the interpretation of the scientific data, consumers and many manufacturers and retailers erred on the side of caution – choosing to reduce exposure. This analysis reviews these marketplace dynamics, both to understand the manner in which BPA and its alternatives are being treated by market decision makers, and to understand the broader implications for investors and for public policy on chemicals.

Scientific Debate and Markets

Companies monitoring emerging science and taking strategic steps in advance of slow government regulatory processes appear to clearly have the competitive edge as "first movers" in the marketplace. Whether they are innovative entrepreneurs or old-line companies, they are grabbing market share, enhancing their branding, and otherwise prospering from public awareness of toxic chemicals in common consumer products. Consumers are not waiting around for the regulatory process to kick in.

State of Scientific Studies and Regulatory Posture

For several years, scientific studies have postulated developmental, reproductive, behavioral, and neurological effects of low dose exposure to Bisphenol A. Bisphenol A disrupts sensitive hormonal pathways in the body, acting as an estrogen, and has been linked to cancers and developmental harm. This mounting evidence has incited debate about whether this chemical is safe to use in food- and water-contact consumer goods, such as plastic water bottles:

Exemplary Statements of concern that Bisphenol A exposure causes harm

• A panel of over 30 expert scientists recently published a consensus statement on the health risks of exposure, stating that adverse health effects occur in animals at exposure levels that are below the U.S. EPA's acceptable human exposure level.[1]

• The U.S. National Toxicology Program stated in its final report on the developmental effects of BPA exposure that they had "some concern" for effects on the brain, behavior, and prostate gland in fetuses, infants, and children at current human exposure to bisphenol A.[2]

• Health Canada, a Canadian regulatory body, announced in April 2008 that Canada intends to ban the import, sale, and advertising of polycarbonate baby bottles containing bisphenol A because of concerns about the health impact of low dose exposure.[3]

[1] vom Saal, F.S. 2007. Chapel Hill. Bisphenol A expert panel consensus statement: Integration of mechanisms, effects in animals and potential to impact human health at current levels of exposure. *Reproductive Toxicology* 24(2):1-26.
[2] National Toxicology Program, Final Report on Bisphenol A. September 3, 2008. http://cerhr.niehs.nih.gov/chemicals/bisphenol/bisphenol.pdf
[3] "Canada Bans BPA from Baby Bottles." April 19, 2008. The Washington Post. Via www.washingtonpost.com

• European scientists, physicians and health advocates have stated that bisphenol A is among the most urgent "chemicals of concern" needing to be addressed by the EU REACH legislation.

Exemplary Statements that Bisphenol A exposure is safe at current levels

• At the request of the American Chemistry Council (the chemical industry trade association), a U.S. Food and Drug Administration panel issued a statement in August 2008 that affirmed their previous conclusion that the chemical is safe for use in food contact applications.

• The European Food Safety Authority made a similar statement in July 2008 that affirmed their previous decision that the chemical is safe for use in food contact applications because it is rapidly eliminated from the body, apparently basing their BPA review on studies by the chemical industry.[4]

Market for BPA in Food Contact Uses

Bisphenol A is used primarily in the production of two major plastics: polycarbonate and epoxy resin.[5] Global demand for BPA was projected to exceed 5.5 million metric tons by 2011, before the recent media spotlight on low dose exposure.[6] Low dose exposure to BPA occurs mainly through food contact applications of this chemical, yet these applications represent just a small percent of this chemical's wide variety of uses across multiple sectors.

Polycarbonate

Water and baby bottles are the products of concern for low dose exposure to this chemical, but they account for less than 10% of total North American polycarbonate use.[7] Leading suppliers of **reusable polycarbonate water bottles** to the U.S. market include Nalgene Outdoor, CamelBak, UTS and Pacific Market International. Nalgene's consumer products yield $50-$65 million in estimated annual sales for the company,[8] with bottles averaging $10 per unit.[9] "The popularity of these colorful, durable bottles, composed specifically of LEXAN(R) polycarbonate plastic, has increased in recent years, and they are generally the preferred reusable beverage container found on college campuses, in suburban fitness centers and elsewhere."[10] As of 1997, 95% of the **baby bottles** on the market were produced using BPA.[11] Recent lawsuits refer to Avent America, Evenflo, Gerber, Handi-Craft (Dr. Brown's) and Playtex as the five leading suppliers of baby bottles in the U.S.[12] In 2001, Wal-Mart sold 38.9 million units of baby bottles in the U.S., totaling $139 million in sales.[13] Excluding the sales in Wal-Mart stores, the U.S. market for baby bottles in 2001 was 60.5 million units, totaling $203 million in sales.[14]

Epoxy resin

The vast majority of food and beverage cans produced in the U.S. are coated with epoxy resins made from BPA, according to the Can Manufacturers Institute. Notably, baby formula cans are

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[4] European Food Safety Authority. EFSA re-evaluates safety of bisphenol A and sets Tolerable Daily Intake. 1/29/2007. http://www.efsa.europa.eu/en/science/afc/afc_opinions/bisphenol_a.html

[5] "Bisphenol A," *Chemical Week*, 167 (35): 42, October 26, 2005 (citing SRI Consulting data); "Development prospects of the bisphenol A market," *China Chemical Reporter*, 15 (10): 23, April 06, 2004

[6] http://www.sriconsulting.com

[7] "BPA furor rumbles on in US," *PRW*, April 28,2008, via www.prw.com

[8] 2008 WL 1923502

[9] Advertising Age, 78 (40): 1, October 08, 2007

[10] Id.

[11] http://www.chej.org/documents/BabysToxicBottleFinal.pdf

[12] See, e.g., http://www.rightsforamerica.com/news.asp?ID=6

[13] "Baby care," *MMR*, 19 (13): 30(1), September 23, 2002

[14] "Baby Care," *MMR*, 18 (12): 39, September 03, 2001 (citing ACNielsen data)

typically coated with BPA-based epoxies. This specific food-contact application offers a route of exposure to low doses of this chemical. This same institute contends that, while alternatives to epoxy coatings have been developed for certain niche applications, no currently available BPA-free alternative could broadly replace epoxies in metal food and drink can applications. The U.S. metal can industry is highly concentrated. Four firms, Ball Corporation, Metal Container Corporation, Crown Holdings and Rexam Beverage Cans Americas, dominate the U.S. aluminum can business.[15] Silgan Containers Corporation, one of six companies making steel cans, claims to hold about half of that market.

Retailers and Manufacturers Declare Intent to Move Out of Certain Uses of BPA

Retailers

In 2008, U.S. retailers such as Wal-Mart and Toys R Us have announced plans to phase out baby bottles containing BPA.[16] Some retailers were proactive about this issue, and had already made the commitment to be BPA-free. Whole Foods Market had banned polycarbonate baby products from its shelves as early as 2006, as a result of shareholder pressure.[17]

Manufacturers

Following the April 18, 2008 announcement that Health Canada will deem BPA a "dangerous substance" and ban polycarbonate baby bottles, baby bottle and sport bottle manufacturers such as Playtex and Nalgene reacted by announcing a shift to BPA-free products. Among the major bottle makers, **Gerber** appears to have been a leader in promoting BPA-free alternatives in response to consumer concerns.[18] Playtex announced that in response to "consumer confusion," the balance of its product line would be converted to BPA-free material by year-end 2008.[19] Other companies quickly followed suit. "**Handi-Craft Company**, makers of the Dr. Brown's Natural products, [extended] their baby bottle product line to include glass and polypropylene baby bottles."[20] As of late 2007, all **Avent** baby bottles were reportedly made of polycarbonate with the exception of the Via System, which is made of polypropylene.[21] However, the company reportedly planned to launch a new, BPA-free reusable bottle in summer 2008.[22] Nalgene and other polycarbonate sports water bottle manufacturers announced a voluntary phase-out for BPA containing products in response to consumer demand.[23]

While many large companies reacted quickly to a newly informed consumer population that was demanding alternatives, smaller companies had already been preparing for this shift. The company **Born Free,** for example, developed an entire line of polycarbonate-free products in response to consumer demand, creating a niche for themselves by developing these products before any regulatory action was taken. As consumer awareness grew, the demand for Born Free products was so great that some retail venues had trouble keeping them in stock. Manufacturers of BPA-free products quickly filled the gaps after BPA-containing products were taken off shelves, capturing an important part of the market.[24] Sales of BPA-free baby bottles have

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[15] Estimated, based on http://www.rexam.com/files/reports/2006ar/index.asp?pageid=26, http://www.rexam.com/files/pdf/presentations/2004analystsvisit_day1.pdf, and 2007 forms 10-K from Ball Corp and Anheuser-Busch.
[16] http://www.wildman.com/bulletin/05152008/
[17] "The Baby Bottle Blues," *Newsweek*, January 14, 2008, via www.newsweek.com
[18] See, e.g., http://zrecs.blogspot.com/2007/07/z-report-bisphenol-in-polycarbonate.html
[19] "Playtex(R) Offers Free Non-BPA Baby Bottles to Parents, Will Stop Using BPA in All Products This Year, *Reuters*, April 18, 2008
[20] http://www.handi-craft.com/pumps/News.asp
[21] http://www.associatedcontent.com/article/452200/bpafree_baby_bottles_medela_gerber.html
[22] http://zrecs.blogspot.com/2007/11/z-report-bpa-avent.html
[23] http://www.nalgene-outdoor.com/technical/bpaInfo.html
[24] "Plastic-Bottle Scare Is a Boon for Some," *New York Times*, 157 (54291): C1, April 25, 2008

skyrocketed since early 2008. BabyUniverse.com saw demand for bottles, microwave sterilizers and other BPA-free products rise 30 percent in late April/early May 2008, while Babies "R" Us reports that sales have increased fivefold over last year.[25]

Alternatives to BPA Enter the Market

Alternatives to Polycarbonates

Tritan. The primary replacement for BPA in reusable water bottles is Tritan copolyester, which was introduced in October 2007 by Eastman Chemical Company. Tritan is cleared for food contact applications in the U.S. under the FDA food contact notification scheme, and Eastman is currently petitioning the European Food Safety Authority for food contact approval.[26] "Eastman developed [Tritan] largely in response to demand for a plastic that can withstand high heat."[27] Relative to polycarbonate, Tritan is lighter weight due to its lower density, and has the stress-, water-, scratch- and chemical-resistance to allow it to hold up better in dishwashers without cracking or crazing.[28] Initial target markets for the resin were identified as housewares, small appliances, blenders, and food processors, where the resin would replace polycarbonate and acrylonitrile.[29] Eastman expects to benefit from overall growth in world copolyester demand of 6-8% per year going forward.[30]

Pacific Market International. In 2006, after noticing a rise in concern about BPA in North America, PMI, producer of the ALADDIN water bottle, began "phoning pretty much every chemical company in the world" to see whether they were developing a BPA-free plastic that offered polycarbonate's strength, clarity and resistance to imparting or absorbing flavor. Eastman was the only company with a viable product in development, and PMI began supplying CLEAN & CLEVER Tritan water bottles in February 2008.[31]

CamelBak. CamelBak began shipping water bottles made from Tritan in January 2008, and had converted all of its polycarbonate bottles to Tritan by April 2008.[32] CamelBak's smallest Tritan bottle sells for $1 more than its $8 polycarbonate counterpart.[33]

Nalgene. Nalgene introduced Tritan water bottles in March 2008.[34] Nalgene's voluntary phase out of polycarbonate and decision to convert to Tritan came "in response to consumer demand for products that do not include Bisphenol A."[35] Prices for Nalgene's polycarbonate/BPA version average $10 per unit.[36] In addition to polycarbonate and Tritan, Nalgene produces consumer bottles and containers in HDPE, PP, LDPE, PET, and stainless steel.[37] All Nalgene bottles are produced in the U.S.[38]

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[25] "Safety concerns boost business," *The Miami Herald (Florida),* May 11, 2008
[26] "Eastman launches heat resistant copolyester," October 25,2007, via www.prw.com
[27] "Companies seek alternatives for plastics additive," *Greenwire*, 20 May 2008
[28] Esposito, Frank, "Eastman boosts copolyester," *Plastics News*, 3/17/2008,
[29] "New Tritan copolyester solves crazing problem," *Modern Plastics Worldwide*, October 25, 2007; "Eastman liking Tritan," *Modern Plastics Worldwide*, 21 April 2008
[30] Eastman Chemical Company. http://www.eastman.com/Company/News_Center/News_Archive/2008/English/Corporate_News/Financial_News/080313.htm
[31] "Plastic-Bottle Scare Is a Boon for Some," *New York Times*, 157 (54291): C1, April 25, 2008
[32] http://www.camelbak.com
[33] "Plastic-bottle scare is a boon for some," *New York Times*, April 25, 2008, via www.environmentaldefence.ca
[34] "Bottle maker to stop using plastic linked to health concerns," *New York Times (National Edition),* 157 (54284): C1, April 18, 2008
[35] http://www.nalgene-outdoor.com/technical/bpaInfo.html
[36] Advertising Age, 78 (40): 1, October 08, 2007
[37] http://www.nalgene-outdoor.com/technical/bpaInfo.html
[38] http://www.nalgene-outdoor.com/technical/bpaInfo.html

Alternatives to BPA are certainly changing the plastics market. Very strong market acceptance for Tritan has encouraged Eastman to expand production capacity for the resin, as the supply currently does not meet the demand. This inequality of supply and demand indicates that the switch to Tritan occurred quickly, as the market shifted away from BPA. Eastman's main Tritan production plant is still under construction in Kingsport, Tenn., and will not be fully operational until late 2009/early 2010.[39] At that time, annual Tritan capacity is expected to be 50,000 tons.[40]

Non-Plastic Alternatives

Numerous alternative bottle materials in addition to Tritan copolyester are currently available or under development, and they represent commercially viable alternatives to polycarbonate. Cost estimates for alternatives to polycarbonate bottles vary widely. While some BPA-free bottles are selling for only slightly more than their polycarbonate counterparts, in other cases plastic bottles made without BPA can cost four times as much as conventional ones.[41]

Glass. There have been shortages of glass baby bottles since the most recent BPA scare in February 2008, with the retail website naturalbabyhome.com reporting at least a tenfold increase in sales of glass bottles in March 2008.[42] Similarly, Babies R Us saw its sales of glass bottles increase fivefold between March 2007 and March 2008. [43] Owens-Illinois has resumed production of glass infant feeding bottles for the first time in about 20 years, invigorating at least one depressed regional economy by providing jobs in one area of Michigan.[44]

Steel and Aluminum. Over the past year, SIGG, a Swiss producer of aluminum sports bottles, has seen its North American sales grow fivefold.[45] The bottles sell for $20, twice the cost of polycarbonates.[46] While the company claims that the epoxy liner on these aluminum water bottles does not leach BPA,[47], the ingredients of the epoxies are confidential, leaving open the question of whether they actually contain BPA. Aluminum water bottles are also made by Canada's Watergeeks Laboratories (thewatergeeks.com). Thermos sells a stainless steel and polypropylene sippy cup, which retails for three times more than comparable polycarbonate products from Gerber.[48] Kleen Kanteen sells an unlined stainless steel water bottle, which eliminates any concern for exposure to BPA.

Alternatives to Epoxy Resins

Possible BPA-based epoxy resin replacements include polyester-based coatings, oleoresinous materials, and other types of epoxy. The economic and technological viability of replacing BPA in can coatings varies on a case-by-case basis.[49]

Eden Foods. This U.S. -based natural and organic food company has sold most of its canned food, except the highly acidic tomato products, in BPA-free cans since 1999. The

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[39] "Event Brief of Q1 2008 Eastman Chemical Company Earnings Conference Call – Final," *Voxant FD (FAIR DISCLOSURE) WIRE*, 25 April 2008; June 3, 2008 Eastman Chemical Company at JPMorgan Basics & Industrials Conference, via www.eastman.com

[40] "Eastman Chemical upgrade to cost $100 million," *The State*, November 13, 2007

[41] "Citing Safety, Wal-Mart and Nalgene Pull BPA Bottles From Shelves," *ABC News*, April 18, 2008, via http://abcnews.go.com/Health/Story?id=4683891&page=2

[42] http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2007/04/09/BOTTLES.TMP

[43] "Glass baby bottles make a comeback," *AP*, March 1, 2008, via www.msnbc.msn.com

[44] *New York Times (National Edition),* 157 (54291): C1, April 25, 2008

[45] New York Times (National Edition), 157 (54291): C1, April 25, 2008

[46] Advertising Age, 78 (40): 1, October 08, 2007

[47] Wasik, Steve. "SIGG Quality and Safety Guarantee" April 16, 2008.

[48] "The Baby Bottle Blues," *Newsweek*, January 14, 2008, via www.newsweek.com

[49] Evaluation of Alternatives for Compounds under Risk Assessment in the EU, Bisphenol A www.miljøstyrelsen.dk/udgiv/publications/2004/87-7614-181-0/html/kap04_eng.htm

oleoresinous material used (a natural mixture of an oil and a resin extracted from various plants, such as pine or balsam fir) is the same type of material in widespread use before epoxy resins made with BPA became the industry's standard can liner in the late 1970s.[50] The BPA-free Eden cans cost 13.77% more than the industry standard cans that do contain BPA.[51] While this BPA-free can is well suited to some foods like beans, it is too fragile for use with some acidic foods (like tomatoes) or foods that must be sterilized (like baby formula).[52]

In Japan, companies line their cans with PET (polyethylene terephthalate) film lamination, instead of using a BPA-based epoxy. These cans leach only 5% as much BPA as their American counterparts.[53] Although these alternatives show promise, questions on the scalability of oleoresinous lining and the health impacts of PET lining remain unanswered.[54]

Are the Alternatives Safer?

Bisphenol A is being replaced by a number of different alternatives because of concerns that low dose exposure to this chemical may be harmful. While the safety of BPA has certainly been called into question, common alternatives to this chemical could pose new health risks. Consumers want to believe that these alternatives have been adequately tested, yet many experts believe the regulatory system lacks a complete set of testing requirements.

Evidence exists that, in many cases, these alternatives are safer. For example, BPA-free epoxy resins in can linings and steel water bottles do not appear to pose a risk for chemical exposure. However, some alternatives pose new risks. Glass baby bottles do not pose a risk of chemical exposure, yet they may be a hazard because of their fragility. However, some manufacturers are sheathing glass bottles in silicone to lower risks from breakage.

In 2004, the Danish Environmental Protection Agency published a study on alternatives to BPA. They found that "the screening of environmental and health properties of the polyester and polyamide alternatives (to BPA in food contact applications) indicates that these groups are possibly less harmful to health and the environment than bisphenol A. On the other hand, [other] alternatives may cause the same effects or more hazardous effects on both environment and health as bisphenol A"[55] After an examination of the alternatives to BPA, safety and health concerns remain. "[Tritan] may be a completely safe product, but we don't have the information we need to make that assessment," according to the policy director at Environmental Defense, the organization that led BPA opponents in Canada.[56]

The FDA requires that petitioners submit toxicology (hazard to human or animal health) data when seeking agency approval for any new food contact substance. No new safety tests were required for Tritan, as all of its components were previously approved. According to the FDA website, a chemical which may well be Tritan[57] has a cumulative estimated daily intake of

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[50] "Your BPA questions, answered." Environmental Working Group Enviroblog. March 13, 2008. http://www.enviroblog.org/2008/03/bpa-questions-answered.htm

[51] "Your BPA questions, answered." Environmental Working Group Enviroblog. March 13, 2008. http://www.enviroblog.org/2008/03/bpa-questions-answered.htm

[52] "Debate rages over safety of plastic chemical BPA in everyday items," Dallas Morning News. May 18, 2008, via www.dallasnews.com

[53] "BPA Q&A: Plastic Chemical is Difficult to Avoid." Dallas Morning News. May 18, 2008, via www.dallasnews.com

[54] http://info.sen.ca.gov/pub/07-08/bill/sen/sb_1701-1750/sb_1713_cfa_20080809_140226_asm_floor.html

[55] Evaluation of Alternatives for Compounds under Risk Assessment in the EU, Bisphenol A www.miljøstyrelsen.dk/udgiv/publications/2004/87-7614-181-0/html/kap04_eng.htm

[56] "Plastic-bottle scare is a boon for some," *New York Times*, April 25, 2008, via www.environmentaldefence.ca

[57] 1,4-BENZENEDICARBOXYLIC ACID, DIMETHYL ESTER, POLYMER WITH 1,4-CYCLOHEXANEDI METHANOL AND 2,2,4,4-TETRAMETHYL-1,3-CYCLOBUTANEDIOL

0.000075 milligrams per kilogram of body weight per day, but no toxicology studies have been completed and so no acceptable daily intake levels have been established.

It is unlikely that FDA's past reviews of BPA and alternatives fully assessed their potential for endocrine disruption—interference with human hormonal systems. In 1996, Congress asked U.S. EPA to develop a system of screens and tests for endocrine disruption, but the under-funded EPA effort has made only very limited progress and it is unclear when such a full system of screens and tests will be in place. Holes in knowledge about endocrine disruption, and similar gaping holes in knowledge about other potential health hazards from numerous chemicals produced in large quantities are symptomatic of weaknesses in the existing federal regulatory system for chemicals, as pointed out by the U.S. Government Accountability Office and numerous other commentators.[58] Public exposure to endocrine disrupting chemicals may be evidenced by the mounting rates of endocrine disruption related illness in the U.S., including thyroid disease, obesity, diabetes, and reproductive problems.

New legislation in Europe (the so-called REACH legislation) should generate substantial new information about many chemicals, and the Kid-Safe Chemicals Act has been introduced in the U.S. Congress to strengthen the U.S. chemical regulatory system. In several states, legislators have been introducing legislation to restrict bisphenol A. More timely and thorough assessments of chemicals can help reduce the potential for future public health scares, reducing market risks and uncertainties for retailers and other companies in the marketplace.

Conclusions

The market for alternatives to BPA in food contact uses has exploded. Consumers, retailers, and chemical-using manufacturers did not wait long after public awareness sparked media to pick up on the potential dangers of BPA before deciding to choose BPA-free alternatives. Markets are moving based on emerging concerns, despite chemical industry challenges to the growing body of scientific studies.

[58] U.S. GAO. Options Exist to Improve EPA's Ability to Assess Health Risks and Manage its Chemical Review Program. June 2005. www.gao.gov/new.items/d05458.pdf

Bisphenol A Market Analysis Report

I. Introduction

Commercial production of bisphenol A (BPA) began in the 1950's.[1] BPA is used primarily in the manufacture of polycarbonate plastics and epoxy resins. Demand for this chemical has grown rapidly in recent years, spurred by strength in key end markets. At the same time, markets for both BPA and end-products have become increasingly globalized, with Asian (and especially Chinese) markets and industries showing especially robust growth. As a result, producers are increasingly building new BPA plants with worldscale capacity.[2]

Heightened public awareness and the resulting concerns over health effects from exposure to this chemical through food contact applications have changed some markets for BPA. For several years, studies have chronicled developmental, reproductive, behavioral, and neurological effects of low dose exposure to this chemical. Bisphenol A disrupts sensitive hormonal pathways in the body, acting as an estrogen, and has been linked to cancers and developmental harm. These scientific data have challenged industry assurances and government regulatory approvals about the safety of BPA's use in food-contact consumer goods, such as polycarbonate water bottles.

Most recently, the U.S. National Toxicology Program stated in its final report on the developmental effects of BPA exposure that they had some concern for effects on the brain, behavior, and prostate gland in fetuses, infants, and children at current human exposure to bisphenol A.[3] The Canadian Ministry of Health announced in April 2008 that Canada intends to ban the import, sale, and advertising of polycarbonate baby bottles containing bisphenol A because of concerns about the health impact of low dose exposure. A panel of over 30 expert scientists recently published a consensus statement on the health risks of exposure, stating that adverse health effects occur in animals at exposure levels that are below the U.S. EPA's acceptable human exposure level.[4]

At the request of the chemical industry,[5] a U.S. FDA panel conducted a review of their information on BPA and then made an announcement confirming a previous decision that the current human exposure levels for BPA are safe. The European Food Safety Authority was also asked to review BPA by the chemical industry and made a similar statement in July 2008 that affirmed their previous decision that this chemical is safe for use in food contact applications because it is rapidly eliminated from the body.[6] The EFSA panel concluded, "the exposure of the human fetus would be negligible because the mother rapidly metabolizes and eliminates BPA from her body." This decision is at odds with recently issued warnings from the Canadian Ministry of Health and a U.S. National Toxicology Program panel on BPA. Other studies indicate that the rate of exposure is so high that mothers cannot metabolize all the bisphenol A in their bodies and that the chemical passes through the placenta to developing fetuses.[7] The Centers for Disease Control announced that 93% of all Americans have bisphenol A contamination in their bodies.[8]

Despite industry and government assurances, many consumers and manufacturers have moved away from this chemical in food contact uses and have embraced products they believe to be safer. The market for polycarbonate plastic bottles has been particularly impacted by this shift, and questions have been raised about the use of BPA in food contact applications.[9] The purpose of this paper is to profile the current market for BPA and determine how the changing scientific understanding about this chemical has affected the development of and market conditions for alternatives. This examination includes a case study on one of the most popular new products, Tritan copolyester.

II. BPA Production

Recent estimates of the size of the global market for BPA include 2.8 million tons in 2002 (Chemical Market Associates, Inc),[10] and approximately 3 million metric tons in 2003 (SRI Consulting).[11] The global market grew 5.7% annually from the 1990s through 2003.[12] Global consumption increased at an average annual rate of almost 10% from 2003 to 2006,[13] suggesting a 2006 market of about 4.0 million metric tons. Prior to the recent health scare, demand was projected to exceed 5.5 million metric tons by 2011.[14] Another estimate projected annual growth of 6-7% from 2005 to 2010, with U.S. growth of 3.5-4%, but faster gains in Europe and Asia.[15] As seen in the chart below, the domestic market for BPA grew steadily from 1996-2000.

While BPA supply was tight in 2007, the supply situation is expected to improve by 2009, when additional phenol capacity is due to come on stream.[16] The U.S. accounts for just less than one-fourth of global BPA demand.[17] In a recent profile of BPA as a toxic tort issue, a lawyer at Dechert, LLP reported that "U.S. manufacturers produce some 7 billion pounds of BPA annually, and business worldwide has been growing about 4 percent a year,"[18] but given the above estimates they may well be referring to world output. Asian BPA capacity rose from 355,000 tons in 2002 to 655,000 tons in 2003, with most future capacity additions expected to be in the region.[19]

According to the U.S. Department of Health and Human Services, in mid-2004, U.S. BPA production volume was 1.024 million metric tons. U.S. BPA consumption was reported at 856,000 metric tons in 2003, including 619,000 metric tons used in polycarbonate resins.[20]

Global BPA capacity 2003 and 2004	
2003 Total Capacity = 3.4 million metric tons	**2004** Total Capacity = 3.7 million metric tons
27.5% U.S.	28% North America
34.1% Europe	29% Western Europe
17.5% Japan	40% Asia
20.9% Rest of World	3% Rest of World
Source: 2003 Data: "BPA has great potential," *China Chemical Reporter*, 16 (34): 19, December 06, 2005.2004 Data: "Bisphenol A," *Chemical Week*, 167 (35): 42, October 26, 2005 (citing SRI Consulting data). Note that data from 2003 and 2004 come from different sources, so the regional delineations are not identical in the comparisons.	

Market for BPA in the U.S. 1996-2000	
Year	**Millions of Pounds**
1996	1,645
1997	1,751
1998	1,834
1999	1,964
2000	2,109
Source: Chemical Market Reporter, 260 (17): 39, November 05, 2001	

BPA Market Share

BPA is primarily supplied on a captive basis by producers of downstream plastic and chemical products. However, there are merchant vendors, such as Sunoco, which entered the market through its 2001 purchase of Aristech.[21] In 2005, Sunoco had a BPA capacity of 215 million pounds (annually) at its Haverhill, OH plant.[22] In 2003, five firms -- General Electric, Bayer, Dow Chemical, Resolution Performance Products, and Mitsui Chemical -- accounted for 67.7% of global BPA capacity.[23] Firms with U.S. BPA production capacity include Bayer MaterialScience, Dow Chemical Company, General Electric/SABIC, Hexion Specialty Chemicals, and Sunoco Chemicals.[24]

Global BPA Capacity 2005	
Company	**Thousand metric tons**
GE Plastics/SABIC*	1225
Hexion Specialty Chemicals	640
Dow Chemical	580
Bayer	900
Mitsui Chemicals	330
Sunoco Chemicals	240
Mitsubishi Chemical	200
Nan Ya Plastics	290
Other	785
Source: Bisphenol A," *Chemical Week*, 167 (35): 42, October 26, 2005 * SABIC acquired GE Plastics in September 2007	

Global Polycarbonate Capacity 2006	
Company	**Thousand Metric Tons**
Bayer MaterialScience	1210
GE Plastics/SABIC*	975
Dow Chemical**	415
Teijin Polycarbonate	200
Formosa Idemitsu	175
Thai Polycarbonate	140
Mitsubishi	125
Other	440
Source: "Polycarbonate," *Chemical Week*, 168 (7): 27, February 22, 2006 * SABIC acquired GE Plastics in September 2007 **Including Dow joint ventures	

III. BPA End Markets

Polycarbonate and epoxy resins represent the major applications for BPA. Polycarbonate's share of the market has risen sharply in recent years, approaching 70% by 2005 and 75% by 2007. By contrast, epoxies have lost share, falling to just 20% of the market.[25] Other applications, which encompass flame retardants (mainly tetra bromobisphenol-A), unsaturated polyester, poly sulfone, polyetherimide and polyarylate resins,[26] account for just five percent of the total market.[27]

BPA Markets by End-Use, 1995/6 and 2002	
1995/6	**2002**
55% Polycarbonate	65% Polycarbonate
40% Epoxy resin	22% Epoxy resins
5% Other	2% Tetrabromobisphenol A
	2% Other

Source: 1995/6 data: "BPA market favours polycarbonates," *Chemistry and Industry*, October 7, 1996. 2002 Data: "Bisphenol A," *Chemical Week*, 165 (33): 41, September 24, 2003 (citing CMAI data)

A. Polycarbonate

The manufacturing of polycarbonate is the largest and fastest growing end use market for BPA in each major producing region, accounting for 67% of global demand in 2006.[28] Global demand grew 8-9% annually during the first part of the current decade, fueled by rising demand for optical digital media such as compact discs and DVDs.[29] However, even prior to the recent BPA health scare, polycarbonate demand growth was expected to decelerate through the end of the decade, as optical media are increasingly supplanted or rendered unnecessary by MP3 players, high internet bandwidth and low-cost USB drives. Chemical Market Associates, Inc. forecast that global polycarbonate demand growth would slow to 5% per year in the 2007-2011 period.[30] SRI consulting projected annual growth of 7-8% from 2006 to 2011.[31]

Overview of Polycarbonate Consumption

Water and baby bottles account for less than 10% of total polycarbonate use in North America, and may even constitute less than 5% according to Resin Technology (Fort Worth, Texas) and Chemical Market Resources (Houston, Texas).[32]However, these two uses are of primary concern when examining the food contact applications of polycarbonate goods. Americans come into contact with BPA-containing polycarbonates in a range of other applications. Other food-contact applications include reusable food storage containers, food preparation equipment (e.g., blenders, mixers, bowls and utensils), toys, children's sippy cups, eating utensils and pacifiers.

U.S. polycarbonate market by end-use, 2005 and 2007			
2005 total market= 650 thousand metric tons		**2007** total market= 1.3 billion pounds	
Optical Media	20%	Optical Media	25%
Window glazing	20%	Window glazing	21%
Automotive	20%	Automotive	14%
Business Equipment	15%	Electrical/film/other	10%
Household appliances	10%	Medical equipment	9%
Other	10%	Recreation/safety	7%
Medical equipment	5%	Business Equipment	7%
		Household appliances	4%
		Packaging	3%
Source: 2005 Data: Polycarbonate," *Chemical Week*, 168 (7): 27, February 22, 2006 (citing Kline data) Note: they use the same %s in 2003, suggesting that the numbers are estimates and not closely tracked. 2007 Data: "Bisphenol A Under Scrutiny," *Chemical and Engineering News*, June 2, 2008, (citing ICIC Chemical Business data)			

Polycarbonate Baby Bottles

As of 1997, 95% of the baby bottles on the market were produced using BPA.[33] Most baby bottles sold in the U.S. in the mid 1990s came from manufacturing facilities in Asia.[34] According to Playtex, its products (including nonbottles) are made in the United States, Canada, China, Japan, Malaysia, Mexico, and Thailand.[35] Avent's products are primarily made in the UK, while Dr. Brown has manufacturing facilities in Germany and China.

Avent America, Evenflo, Gerber, Handi-Craft (Dr. Brown's) and Playtex are commonly regarded as the five leading suppliers of baby bottles in the U.S., and have been cited as such in recent lawsuits.[36] In 2001, Wal-Mart sold 38.9 million units of baby bottles in the U.S., totaling $139 million in sales.[37] Excluding the sales in Wal-Mart stores, the U.S. market for baby bottles in 2001 was 60.5 million units, totaling $203 million in sales.[38]

According to AC Nielsen market data, in 1993, the U.S. baby bottle retail market totaled $154 million. Of this amount, reusable baby bottles held 52 percent, or $80 million, while disposables (i.e., those designed for use with disposable bottle liners) held 48 percent or $74 million, down from a peak of 53%. In unit terms, the market totaled 73 million units, of which 38.6 were reusables and 34.4 million were disposables.[39]

U.S. Baby Bottle Market Share for Reusables and Disposables, 1993	
Reusables	**Disposables**
Evenflo 32%	Playtex 70%
Others 19 %	Evenflo 17%
Gerber 14%	Other 8%
Munchkin 13%	Gerber 5%
NUK 8%	
Chubs 6%	
Ansa 4%	
LuvNcare 4%	
Source: http://cob.fsu.edu/jmi/resources/plan.pdf	

Nursing and Feeding Accessories Market Share 2000			
Leading Brands	**Manufacturer**	**Market Share**	**Unit Sales (thousands)**
Playtex	Playtex Products	13.9	18,189
Gerber	Gerber Products	10.8	14,091
Luv N' Care	Luv N' Care	6.7	8,750
Evenflo Sensitive Response	Evenflo	6.3	8,212
Hamco	Hamco	4.1	5,381
Munchkin	Munchkin Bottling	3.6	4,692
Playtex Drop Ins	Playtex Products	3.4	4,538
Playtex Spill Proof	Playtex Products	3.3	4,425
Johnson's Health Flo	Johnson & Johnson	3.1	4,118
Evenflo Natural Mother	Evenflo	0.9	1,185
Source: Chain Drug Review, 23 (9): 58, May 21, 2001 (citing IRI data, probably excluding Wal-Mart)			

Baby Bottle Markets' Response to BPA Concerns

Many companies were affected by the changes in public awareness of the potential hazards of BPA from BPA-containing products. The following profiles provide more detailed information on the roles specific companies play in the baby bottle market, and describe some of their responses to this shift in consumer demand, such as changing product lines to accommodate a growing public awareness of these issues.

- **Handi-Craft Company**, makers of the Dr. Brown's Natural Flow products, extended their baby bottle product line to include glass and polypropylene baby bottles in response to customer concerns.[40] "Dr. Brown's offers the glass baby bottle in 3 -oz. and 7-oz. sizes. Two-packs retailed for approximately $13.00 at select stores in December 2007. Dr. Brown's introduced the polypropylene baby bottles in May 2008."[41]At www.babybungalow.com, the 4- and 8-ounce polycarbonate bottles sold for $4.29 each, while two-sets of the 3.5- and 7-ounce glass bottles sold for $13.95 and $14.95, respectively. The company's sales were $22 million in 2007.[42]
- **Playtex** Infant Care, a subsidiary of Playtex Products, which was acquired by Energizer Holdings in October 2007, is the U.S. dollar market share leader in the infant feeding category.[43] In 2006, the firm's sales of infant care products totaled $176 million.[44] Reusable and disposable bottles and liners appear to be the largest of six segments in this division. Divisional sales have grown 5% annually over the past 3 years, although market share in bottles and cups has come under pressure.[45] Playtex products are manufactured in countries around the world including the United States, Canada, China, Japan, Malaysia, Mexico, and Thailand. Playtex has announced plans to distribute one million free samples of BPA-free Playtex Drop-Ins Original Nurser Systems. It also announced that in response to

"consumer confusion," the balance of its product line will be converted to BPA-free material by year-end 2008.[46]

- **Avent** America is a subsidiary of Dutch conglomerate Royal Philips, which acquired UK-based Avent in 2006 for 250 million dollars. Avent reported global sales of approximately 61 million dollars for the year ending March 2006.[47] The firm produces 90% of its infant care products in the UK and has sales to some 60 countries. [48] Avent sells a range of babycare products including feeding bottles, breast feeding equipment, skincare products, sterilizers, soothers, travel kits, and gift items. As of late 2007, all Avent bottles were reportedly made of polycarbonate plastic with the exception of the Via System, which is made of polypropylene plastic.[49] However, the company reportedly plans to launch a new, BPA-free reusable bottle in summer 2008.[50]
- **Evenflo**, a private company, recorded 2007 revenues of $341 million, although most sales are not bottle-related.[51] Evenflo's plastic bottles are primarily made from polycarbonate, but the firm has offered glass bottles for several years as well.[52] In recent months Evenflo has reportedly begun manufacturing a series of polypropylene versions of previously polycarbonate bottles.[53]
- **Gerber** is the world's largest baby food maker. Nestle acquired Gerber from Novartis in 2007 for $5.5 billion. Bottles account for a small share of the firm's total revenues. As of November 2007, half of Gerber's baby bottle lines were reportedly BPA-free.[54] Some of the polycarbonate ones have reportedly since been discontinued. Among the major bottlemakers, Gerber appears to have been a leader in promoting BPA-free alternatives in response to consumer concerns.[55]
- **Munchkin,** a 24-employee private company, claims to be a leading manufacturer of specialty baby bottles. The firm has enjoyed double-digit sales growth over the past decade. Munchkin reports that while very few of its products contain polycarbonate plastic, it is exploring non-polycarbonate plastic replacement materials.[56] Bottles are one of the firm's 5 product lines, suggesting annual bottle sales of less than $1 million.

Polycarbonate Water Bottles

Leading suppliers of reusable polycarbonate water bottles to the U.S. market include Nalgene Outdoor, CamelBak, UTS, and Pacific Market International. The market for polycarbonate water bottles was similarly affected by the increased media attention and consumer awareness of the potential hazards of BPA. The following company profiles provide more detailed information on these leading suppliers of polycarbonate water bottles, with a focus on how new products have been introduced into the market. A number of vendors have converted from polycarbonate to Eastman Tritan resin" since early 2008, with Tritan bottles starting at about $8 at retail.[57]

" Please review our case study of Tritan in the "Non-Polycarbonate Products" section of this report for more information on this product.

- **Nalgene Outdoor** is a subsidiary of Nalge Nunc, a $115 million[58] subsidiary of Thermo Fisher Scientific. Nalgene's consumer products, the majority of which appear to be water bottles, yield $50-$65 million in estimated annual sales for the company.[59] The firm's LEXAN polycarbonate plastic bottles are generally the preferred reusable beverage container found on college campuses, in suburban fitness centers and in other venues.[60] Prices for the polycarbonate/BPA version average $10 per unit. [61] However, in 2008 Nalgene began a voluntary phase-out of polycarbonate in favor of bottles made from Eastman's Tritan polymer. In addition to polycarbonate and Tritan, Nalgene produces consumer bottles and containers in HDPE, PP, LDPE, PET, and stainless steel (by Guyot Design).[62] All Nalgene bottles are produced in the U.S.[63]
- **CamelBak** is a private held company owned by Bear Stearns. The firm's annual sales are estimated at under $2 million,[64] and include many non-bottle products. Camelbak began shipping bottles made from Tritan in January 2008 and had converted all of its polycarbonate bottles to Tritan by April 2008.[65] CamelBak's smallest Tritan bottle sells for $1 more than its $8 polycarbonate counterpart. [66]Production likely takes place overseas.
- **Universal Trim Supply** (UTS), a Taiwanese company, makes 2 million reusable polycarbonate water bottles a year for Wal-Mart.[67] With over 350 employees, UTS produces injection molded trim and (to a lesser extent) water bottles and other products at plants in Taiwan and China. [68]
- **Pacific Market International** produces water bottles, lunch boxes and other products, under the STANLEY and ALADDIN brand names. PMI's sales are estimated at between $20 and $60 million,[69] with water bottles apparently representing a fraction of total sales. PMI began seeking out alternatives to polycarbonate as early as 2001.
- **Polar Bottle** (Product Architects Co Inc) is an $850,000[70] producer of LDPE reusable water bottles with manufacturing facilities in Denver. The bottles typically retail for $9-$10 each.[71] While the firm has been producing BPA-free bottles for 14 years, its sales have doubled since 2005 and the company has added "BPA Free" stickers to its bottles to capitalize on increased awareness of the BPA issue.[72]

B. Epoxy Resins

Epoxy resins represent the second largest application for BPA. Epoxies find use in high performance coatings, electrical-electronic laminates, adhesives, flooring and paving applications, and composites. Their primary food-contact application is as coatings in steel and aluminum food and drink cans. In these applications, epoxies help protect the contents from spoilage, make it possible for food products to maintain their quality and taste, and extend shelf life.

The U.S. market for epoxy resins was 545 million pounds in 2006.[73] This BPA market has grown more slowly than polycarbonate in recent years. Demand growth for epoxy

resins in the developed world is expected to be 2-3% per year but much higher in Asia, particularly China.[74]

Epoxy Resins in Metal Cans

According to the Can Manufacturers Institute, the vast majority of food and beverage cans produced in the U.S. are coated with epoxy resins made from BPA. The primary exception is fruit cans, some of which are uncoated. Notably, baby formula cans are typically coated with BPA-based epoxies.

U.S. Metal Can Industry by millions of units			
Item	**1995**	**2000**	**2005**
Beverage Cans	98,116	100,277	99,157
Food cans	24,116	23,346	22,885
-Baby food	972	585	611
-Canned Fruit	2,301	2,098	1,508
Source: www.cancentral.com Note: Units of food cans exclude pet foods.			

Metal Can Market Share

The U.S. metal can industry is highly concentrated. Four firms, Ball Corporation, Metal Container Corporation, Crown Holdings and Rexam Beverage Cans Americas, dominate the U.S. aluminum can business.

U.S. Beverage Can Market Share	
Ball	31%
Metal Container Corp (Anheuser-Busch)	25%
Rexam	23%
Crown	19%
Source: (Estimates) www.rexam.com/files/reports/2006ar/index.asp?pageid=26, www.rexam.com/files/pdf/presentations/2004analystsvisit_day1.pdf, and 2007 forms 10-K from Ball Corp and Anheuser-Busch.	

Production of steel cans is only slightly less concentrated than the aluminum can industry. Leading vendors include Ball, BWAY Corp, Impress USA Inc., Silgan Containers Corporation, Sonoco-Phoenix, Inc. and Van Can Company. Silgan claims to hold about half the steel can manufacturing market. [75]

IV. New BPA-Free Products

Alternatives to both of the main food-contact applications of BPA (polycarbonate and epoxy resins) exist, although technical feasibility for these alternatives varies by application.

A. Non-Polycarbonate Products

Following the April 18, 2008 announcement that Health Canada will deem BPA a "dangerous substance" and ban polycarbonate baby bottles, bottle manufacturers such as Playtex and Nalgene announced a shift to BPA-free products. Whole Foods had banned polycarbonate baby products from its shelves as early as 2006,[76] and in 2008 major U.S. retailers such as Wal-Mart and Toys R Us also announced plans to quickly phase-out baby bottles containing BPA.[77]

In general, water bottle retailers appear to be converting full-scale to BPA-free alternatives, whereas baby bottle manufacturers are continuing to produce polycarbonate baby bottles as their dominant product. In a profile of the "polycarbonate price cut," reporter Eileen Gunn noted, "A significant change such as replacing one major manufacturing material for another would be disruptive, cost time and money and perhaps cause some parents to change their buying habits, so it's easier and safer bottom-line wise for these companies to keep doing what they're doing. It seems most makers of baby goods aren't going to give up polycarbonate until the government, or public outcry, forces them to. Small, niche companies like Adiri and Born Free are coming out with entire lines of polycarbonate-free products. Meanwhile, bigger, more established brands have added one or two bottles made from alternative plastic to their line-up while continuing to sell the BPA-laced ones, often tagging the word "natural" somewhere onto the product to convey a warm and fuzzy feeling about it."[78]

Sales of BPA-free baby bottles have skyrocketed since early 2008. BabyUniverse.com saw demand for bottles, microwave sterilizers and other BPA-free products rise 30 percent in the late April/Early May 2008, while Babies "R" Us reports that sales have increased fivefold over last year.[79]

Cost estimates for BPA-free products vary widely. While some BPA-free bottles are selling for only slightly more than their polycarbonate counterparts, in other cases plastic bottles made without BPA can cost four times as much as conventional ones.[80] Numerous BPA-free materials are currently available or under development, and represent commercially viable alternatives to polycarbonate. These include Tritan, a material profiled in the following case study.

Tritan Case Study

History

Eastman Chemicals began developing Tritan about five years ago, according to Debbie Baum Crain, the company's director of copolyester innovation. Customers were requesting a polycarbonate substitute that was less prone to cracking in commercial dishwashers. In October 2007, Eastman Chemical formally introduced Tritan at the K 2007 show in Düsseldorf, Germany. Tritan has since emerged as the primary replacement for BPA in reusable water bottles. Eastman expects to benefit from overall growth in world copolyester demand of 6-8% per year going forward.[81] More recently, potential

users of Tritan in the water bottle industry, such as Aladdin and CamelBak, have worked with Eastman on the plastic's development.[82]

Corporate Strategy

Eastman's focus on Tritan has taken place in the context of the firm's plan to become a regional player in PET in North America while jettisoning less profitable international PET operations. Eastman has also emphasized more specialized resins such as Tritan and Spectar copolyesters.[83] The company is in the midst of a major copolyester capacity expansion at its Kingsport, TN facility.

Composition

News articles generally refer to Tritan as a copolyester containing a proprietary or unnamed monomer. However, Tritan is very likely a polymer of dimethyl terephthalate, 1,4-cyclohexanedimethanol, and 2,2,4,4-tetramethyl- 1,3- cyclobutanediol (CAS Reg. No. 261716-94-3). This description is given in FDA FCS notification 729 (August 2007), which covers the only copolyester for which Eastman has sought FDA food contact approval since 2003; the polyester is described by the FDA as being "used as a component in the manufacture of repeated use food-contact articles."[84] The description also fits an Eastman Chemical patent sought in 2006, in which Eastman provided a description generally consistent with its Tritan literature and suggested that the patented chemical replaces polyesters and polycarbonate, combining the traits of the two.[85]

Characteristics

In general, copolyesters form when modifications are made to polyesters, such as PET, which are combinations of diacids and diols.[86] Copolyesters retain their strength, clarity and other mechanical properties despite being exposed to a variety of chemicals that typically affect other materials, such as polycarbonates. This, plus their versatility and flexibility, allows manufacturers to use them effectively in the design of both high-volume, low-cost parts as well as critical, more expensive component parts.[87]

Tritan, the first in a new family of high performance plastic materials, is unique in that it combines the best traits of polycarbonate and conventional copolyesters, mitigating the drawbacks of each. It boasts the crystal clarity, durability, low internal stress and chemical resistance of traditional copolyesters, but offers higher heat resistance that other copolyesters,[88] improved design flexibility and superior ease of processing due to its lower levels of residual stress.[89] Relative to polycarbonate, Tritan is lighter weight due to its lower density, is better able to handle vivid aesthetics (due in part to its low haze, high gloss, and consistent color), and has the stress-, water-, scratch- and chemical-resistance to allow it to hold up better in dishwashers without cracking or crazing.[90] Although Tritan has higher heat resistance than other copolyesters, it does not offer the heat resistance that polycarbonate does. Because, unlike PC, there is no need for significant design modifications in order to control for stress cracking, greater design freedom is possible. These traits combine to make Tritan especially well suited for use in kitchenware products; unlike with PC, Tritan molded items can withstand 500 cycles in commercial and consumer dishwashers with no visible crazing or cracking.

Tritan can be used without any changes in tooling, and can be used in molds designed for polycarbonate.[91] Indeed, machining is considered to be easier than with traditional copolyesters; annealing procedures can be eliminated, creating the potential for increasing production speeds and lowering energy use.[92] One Eastman customer reportedly experienced a nearly 20% improvement in cycle time with Tritan as compared with polycarbonate parts produced in the same mold.

Marketing

Eastman is marketing Tritan as a lighter, more heat- and impact-resistant, and BPA-free alternative to polycarbonate.[93] However, its ad campaign focuses less on the absence of BPA than on the fact that Tritan is the firm's first new plastics product in 30 years and, as such, features unique performance qualities and design potential. The campaign, designed by Bader Rutter & Associates of Milwaukee, is emphasizing the design freedom and flexibility offered by this "next generation" resin.[94] For example, ads depict plastic pellets morphing into the image of a colorful chameleon, and taglines read "New Eastman Tritan copolyester. The flexibility to adapt to your imagination….Let Tritan embolden your thinking, expand your design options, improve your production processes and differentiate your products."[95]

Applications

In general, Tritan is expected to compete in the same markets as do polycarbonate and acrylic plastics. Tritan is suitable for injection molding, injection-blow and stretch blow molding, sheet and fiat film extrusion, and thermoforming. It is available in several grades designed for different markets. Eastman suggests that the potential addressable market for the resin is 1.5 billion pounds.[96]

Eastman's *Tritan* trademark, which points to the various envisioned uses, covers "baby bottles; plastic water bottles sold empty; plastic pitchers, plastic plates, plastic bowls, plastic mugs; plastic carafes; plastic drinking glasses; plastic household containers for foods; plastic thermal insulated containers for food or beverages."[97] Other potential end uses include extruded-sheet applications.[98]

"Eastman developed [Tritan] largely in response to demand for a plastic that can withstand high heat."[99] Initial target markets for the resin were identified as housewares, small appliances, blenders, and food processors, where the resin would replace polycarbonate and acrylonitrile.[100] When developing Tritan, Eastman tested products made with Tritan in dozens of commercial and residential dishwashers, which expose kitchenware to a harsh combination of heat, hydrolytic and chemical attack, and applied stress. "Withstanding these environmental conditions was a major design goal in the development of Tritan."[101]

However, in what has been described as "a lucky turn of events,"[102] Tritan has emerged as the leading BPA-free alternative to polycarbonate in products like reusable water bottles. Eastman refers to current applications as just "tip of the iceberg" with regard to potential uses of Tritan.[103]

Still, sizable polycarbonate applications, such as optical media, "won't – or can't" switch to Tritan.[104] Tritan's heat resistance exceeds that of many other copolyesters, yet its heat resistance relative to polycarbonate prevents it from competing with that resin in some environments.[105]

Production

Tritan is produced through Eastman's Specialty Plastics business. The division's output is roughly 80% copolyesters and 20% cellulosic chemicals.[106] Very strong market acceptance for Tritan has encouraged Eastman to expand production capacity for the resin. Capacity is currently an issue; Eastman's main Tritan production plant is still under construction in Kingsport, Tenn., and will not be fully operational until late 2009. At that time, annual capacity is expected to be 50,000 tons.[107] Eastman expects to benefit from overall growth in world copolyester demand of 6-8% per year going forward.[108] As of April 2008, Eastman reported that the BPA scare had "sparked interest" in Tritan, but that it is too early to know how much sales volume Eastman could pick up from products switching from polycarbonate.[109]

In June 2008, Eastman formed a strategic partnership with PolyOne Corporation, a leading global provider of specialized polymer materials, through which PolyOne will be the exclusive North American compounder of filled systems with Tritan. PolyOne will apply its formulation and compounding expertise to combine Tritan with performance-enhancing additives to develop fully compounded systems for new applications and markets, with a focus on high-value, specialty, niche applications.[110] However, PolyOne is also reportedly competing with Eastman in the BPA-free plastic marketplace. Under a 2007 agreement, the firm contract manufactures Plastic Selection Group's Kostrate-brand terpolymer at a plant in China. Kostrate is a clear, tough, rigid resin based on butadiene, styrene and methylmethacrylate feedstocks which is being positioned as a BPA-free product to replace polycarbonate in sports bottles. Kostrate was first formulated in 2003.[111]

Cost

CamelBak's smallest Tritan bottle sells for $1 more than its $8 polycarbonate counterpart.[112] According to another source, Tritan CamelBak bottles retail for $8-$10, while the Nalgene version is available for $9-$10.[113] Taiwan's Universal Trim Supply has discussed custom manufacturing Tritan bottles for firms like Titan, but the cost would reportedly be as much as three times higher than with polycarbonate.[114] According to Eastman, however, the higher costs of Tritan are mitigated, since the greater strength of copolyester requires less material.[115]

Safety

Tritan is cleared for food contact applications in the U.S. under the FDA food contact notification scheme. Eastman is currently petitioning the European Food Safety Authority for food contact approval for Tritan.[116] Food contact substances must satisfy FDA requirements regarding **environmental**, **chemical** and **toxicological** risks.

- **Environmental risks.** Tritan appears to have gained environmental approval without having to present novel safety data, through an exclusion exemption under 21 CFR 25.32(j).[117] To qualify for an exemption under 21 CFR 25.32(j), a food contact substance (FCS) must be used as a component of a food-contact surface of permanent or semi permanent equipment or of another food-contact article intended for repeated use; the applicant must include a statement of compliance with the categorical exclusion criteria; and the applicant must include a statement that, to the submitter's knowledge no extraordinary circumstances exist that require the submission of a new application.[118] In this case, if Tritan is indeed the chemical identified under FDA FCN 729, it combines three substances: 1) dimethyl terephthalate (a building block of PET), 2) 1,4-cyclohexanedimethanol, and 3) 2,2,4,4-tetramethyl- 1,3- cyclobutanediol. Of these, PET copolyesters containing dimethyl terephthalate are approved under the FDA's FCS notification 85, and 1,4-cyclohexanedimethanol is approved under FCNs 87, 179 and 280. Safety data was presumably included in the environmental impact data presented in all four of these applications, for which the Agency issued "findings of no significant impact." With regard to substances intended for use in food contact housewares, the FDA says that:

  > In the past, FDA typically has not required food additive petitions containing the data described in item 5 above for food-contact articles used exclusively in the home or in restaurants. Although components of houseware articles that are reasonably expected to become components of food are food additives subject to premarket approval, in most cases, the use of such articles results in trivial levels of migration to food either because of short contact times or because the articles are manufactured using materials (e.g., alloys and ceramics) that pose little likelihood of migration to food. Therefore, the agency, because of limited resources, has not enforced the food additive provisions of the FD&C Act for such cases unless there is evidence of a potential health hazard.[119]

- **Chemical Risks.** Chemical risks relate to the chance that a food contact substance will leach into the food.
- **Toxicological Risks.** Toxicology relates to any threats to human health from substances which leach or are placed directly into foods or beverages. The FDA requires that petitioners submit toxicology data when seeking Agency approval for any new FCS. According to the FDA website, a chemical which may well be Tritan[120] has a cumulative estimated daily intake of 0.000075 milligrams per kilogram of body weight per day, but no toxicology studies have been completed and so no acceptable daily intake levels have been established. For one sub-ingredient, 1,4-cyclohexanedimethanol, an August 2000 toxicology study established an acceptable daily intake level of 0.2395 milligrams per kilogram of body weight per day, about 100 times the estimated daily intake.[121]

- **Ongoing Concerns. S**afety and health concerns remain. “This may be a completely safe product, but we don't have the information we need to make that assessment,” according to Aaron Freeman, the policy director at Environmental Defence, the organization that led BPA opponents in Canada. “Our suggestion is that people use stainless steel.”[122]

Companies Using Tritan

- **PMI** began noticing a rise in awareness about BPA in North America in 2006, and began “phoning pretty much every chemical company in the world” to see whether they were developing a BPA-free plastic that offered polycarbonate's strength, clarity and resistance to imparting or absorbing flavor. Eastman was the only company with a viable product in development, and PMI began supplying CLEAN & CLEVER Tritan water bottles in February 2008.[123] "After a thorough examination of Tritan and its benefits, we're confident we chose the most versatile polymer on the market," said Robert Harris, CEO and owner of PMI. PMI also praised the ease of transitioning to and processing Tritan. “From initial R&D testing to retail rollout, Aladdin was able to commercialize the CLEAN & CLEVER product line within eight months…. While our operations team had little experience working with copolyester molding in the past, the performance characteristics of Tritan made the transition far easier than we could have predicted” according to the firm.[124]
- **CamelBak** began shipping water bottles made from Tritan in January 2008 and had converted all of its polycarbonate bottles to Tritan by April 2008.[125] CamelBak's smallest Tritan bottle sells for $1 more than its $8 polycarbonate counterpart.[126] According to CamelBak’s specialty plastics Vice President and General Manager Dante Rutstrom, the firm began using Tritan not only because of concerns about possible health risks associated with bisphenol A, but also because a customer requested better durability in the dishwater.[127]
- **Nalgene** rolled out Tritan water bottles in March 2008.[128] It’s decision to convert to Tritan came “in response to consumer demand for products that do not include bisphenol A.”[129]
- **Vita-Mix Corp**. of Olmsted Falls, Ohio, began using Tritan to make the containers for its Vita-Mix 5200 household blender in late 2007. The transition to BPA was consistent with the company’s image as a purveyor of "healthy eating, healthy living" solutions. However, the firm also touted the performance aspects of Tritan: “[Tritan’s] unique balance of properties allows the blender containers to better withstand frequent consumer handling and cleanings with considerably reduced risk of crazing, cracking or hazing.” In addition, Tritan boasts improved sound dampening that ameliorates blender noise. According to Eastman, all of these traits were factors in Vita-Mix’s decision to use Tritan.[130] Production of the Titan-based container section of the blenders is contracted out to Laszeray Technology, Inc. of North Royalton, Ohio, which extolled Tritan’s ease of

processing with existing PC molds, alleviating the need for complicated changeovers.[131]

- **Carlisle Food Service Products** of Charlotte, N.C., a leading provider of food service supplies for the restaurant and hospitality industries, has begun using the resin in its commercial soup bowls.[132] They replace bowls made of polycarbonate, polycarbonate/PET blends, and SAN. Carlisle previewed the bowls in October 2007, in anticipation of an early 2008 roll-out. During the roll-out, the firm primarily promoted the performance aspects of Tritan – "excellent impact resistance and design flexibility for reusable dishware, … provid[ing] significantly improved dishwasher durability" – with little emphasis on the absence of BPA.[133]

Other Non-Polycarbonate Products

- **Polyethersulfone (PSE)** baby bottles have captured market share rapidly over the past year. For example, diapers.com began selling Born Free (Israel) PSE bottles in August 2007; by January 2008, they had outstripped combined sales of all other bottle brands on the website. [134][135] Israeli-made BornFree bottles are available at Buy Buy Baby in both five-ounce and nine-ounce sizes ($19 to $20 for two).[136] According to a company statement in May 2008, annual sales projections need to be adjusted upward "threefold to fivefold" to accurately reflect increased demand.[137]

  California's Green To Grow was founded in 2007 to supply BPA-free baby bottles. It sells 5-ounce PSE baby bottles for $7.49-$7.99 and 10-ounce bottles for $9.99-$10.49.[138] The firm's bottles are produced in Taiwan, at the same plant that produces bottles for Thinkbaby[139] Green To Grow was reportedly founded by two parents who were alarmed by reports that highlighted the potential dangers presented by polycarbonate plastic and frustrated over the lack of options.[140] Thinkbaby rolled out its line of PES bottles and cups in late 2007. Twinpacks of the company's bottles are sold on its website for between $16.49 and $17.

  Still, PSE bottles reportedly have been subjected to far fewer scientific tests than BPA.[141] In addition, the plastic has a yellow tinge, and is four to five times as expensive as polycarbonate. In early 2008, nine-ounce BornFree bottles sold for $10.99 at diapers.com, compared with $4.99 for eight-ounce polycarbonate bottles from Dr. Brown's.[142]

- **Glass.** There have been shortages of glass baby bottles since the most recent BPA scare in February 2008, with the website naturalbabyhome.com reporting at least a tenfold increase in sales of glass bottles in March 2008.[143] Similarly, Babies R Us saw its sales of glass bottles increase fivefold between March 2007 and March 2008. [144] Owens-Illinois has resumed production of glass infant feeding bottles for the first time in about 20 years.[145]

  Dr. Brown's (Handi-Craft Co) introduced a line of glass baby bottles in January 2008, after a growing number of parents asked for BPA-free versions of the firm's

bottles.[146] For its part, Evenflo has supplied glass bottles for the last 70 years. The firm's glass baby bottle sales rose 7% in 2006, over 100% in 2007, and were up 10% in January and February 2008. Still, according to some manufacturers, glass accounts for less than 10% of the U.S. baby bottle market.[147] Cost is one concern; a three-pack of 8-oz. Dr. Brown's polycarbonate bottles has a suggested price of $12.99, the same price recommended for a two-pack of the company's glass bottles.[148] However, Evenflo glass bottles are reportedly available for as low as $2.50 each.[149]

Breakage is also an issue, although firms such as Babylife and Silikids have recently rolled out glass bottles in shatter-resistant silicone sleeves. Wee-Go glass bottles encased in silicone sleeves are available for $20 at Greenbaby-nyc.com.[150] Patents have also been issued for shatterproof glass bottles with rubber coatings.[151]

- **Steel and Aluminum**. Over the past year, SIGG, a Swiss producer of aluminum sports bottles, has seen its North American sales grow fivefold.[152] These aluminum water bottles are lined with an epoxy that does not leach BPA, yet it has not been determined whether the epoxy contains BPA, because the ingredients of the epoxy are confidential.[153] Kleen Kanteen sells an unlined stainless steel water bottle, which eliminates any concern for exposure to BPA. The bottles sell for $20, twice the cost of polycarbonates.[154] Aluminum water bottles are also made by Canada's Watergeeks Laboratories (thewatergeeks.com). Thermos sells a stainless steel and polypropylene sippy cup which retails for three times more than comparable polycarbonate products from Gerber.[155]

Other materials are less widely used:

- **Styrene acrylonitrile,** a plastic made by German chemical producer Lanxess.
- **Polypropylene** can also be used to make baby bottles.[156] Dr. Brown's (Handi-Craft Co) recently introduced a line of PP baby bottles. Adiri's Adiri Natural Nurser baby bottle is made from a double shot C-Flex elastomer molded over a colored polypropylene core.[157] Adiri produces its $12.50 bottles in Taiwan and expects at least a 12-fold increase in sales in 2008.[158] In May 2008, PlastiPure rolled out a line of polypropylene and polyethylene baby bottles marketed as the first plastic bottles certified free of estrogenic activity.[159]
- **LDPE** sports bottles are made by Canada's Watergeeks Laboratories.
- **Polyamide**. In 2001, when concerns about the health effects of BPA hit Japan, Jex Company of Japan commercialized polyamide baby bottles, which are also lighter weight than their PC counterparts, produced with GRILAMID resins from EMS-Grivory.[160] Born Free produces polyamide bottles, although the firm has reportedly recently converted most of its product line to PSE.[161]

B. BPA-Free Epoxy Resin

According to the Can Manufacturers Institute, while alternatives to epoxy coatings have been developed for certain niche applications, no BPA-free resin is currently available that could broadly replace epoxies in metal food and drink can applications. Due to the corrosive nature of many food and beverages, can coatings must have resistance to (food) content, chemical resistance, prevention of metal migration to the food content, thermal resistance during sterilization of foodstuffs, and compatibility with container manufacturing.[162] The development of BPA-free alternatives for food contact applications is time consuming, taking approximately ten years from the testing (including pack testing, which can last up to 5 years) and evaluation of the properties to successful commercialization of the new product.[163]

According to a profile of BPA from a lawyer at Dechert, LLP, "compared to other coating technologies, coatings derived from epoxy resins provide superior adhesion to the metal surface, greater durability, and higher resistance to the wide range of chemistries found in foods and beverages. These attributes are essential to protect the packed food from microbiological contamination, which is a significant food safety issue." [164]

In 2004, the Danish Environmental Protection Agency published a study on alternatives to BPA. They found that "the screening of environmental and health properties of the polyester and polyamide alternatives (to BPA in food contact applications) indicates that these groups are possibly less harmful to health and the environment than bisphenol A. On the other hand, the polyacrylate and polymerised rosin alternatives may cause the same effects or more hazardous effects on both environment and health as bisphenol A."[165]

Alternatives Currently in Use

Possible BPA-based epoxy resin replacements include polyester-based coatings, oleoresinous materials, and PVC-based coatings. Both epoxy novolac resins and cycloaliphatic epoxy are cited by the Danish EPA as non-BPA containing epoxies, yet detailed information on these substances is not currently available. The economical and technological viability of replacing BPA in can coatings varies on a case-by-case basis.[166]

In general, polyester-based coatings "are not resistant to corrosive foods, which means the packing resistance is limited. The polyester bonds tend eventually to hydrolyze, which results in coatings that can lose their resistance and performance properties, leading to compromised container quality and potential can perforation. However, the polyester-based coatings are generally more flexible compared to epoxy coatings. Their use is limited mainly to non-aggressive food…in which the fat content of the food protects the can coating against the aggressive food ingredients." [167] "The polyester-based coatings are generally more expensive compared to the epoxy-based coatings, limiting their use mostly to cans or can components, in which their particular properties such as higher flexibility are needed."

Japanese can manufacturers have been using alternative can linings for at least a decade. In addition to the polyester-based alternative, they use another alternative made with PET. Because of the use of these alternatives, Japanese cans leach only 5 percent as much BPA as their American counterparts. However, the alternative coatings are used primarily for canned beverages that are served hot. [168] Indeed, one study suggested that hot drinks accounted for the majority of BPA in human urine in Japan in 1992, and that the widespread Japanese conversion away from BPA-based epoxy resins in those products in 1997 led to a significant decline in BPA levels.[169] Other studies have confirmed higher levels of BPA leaching in canned coffee and tea in Japan.[170] As hot drinks are not typically served canned in the U.S., both the risks associated with epoxy-related BPA leaching and the potential to mitigate the BPA risk via alternative can coatings may thus be limited.

In the United States, Eden Foods, a natural and organic food company, has sold most of its canned food, except the highly acidic tomato products, in BPA-free cans since 1999. The oleoresinous material used (a natural mixture of an oil and a resin extracted from various plants, such as pine or balsam fir) is the same type of material in widespread use before epoxy resins made with BPA became the industry's standard can liner in the late 1970s.[171] The Eden cans cost 13.77% more than the industry standard cans that do contain BPA. [172] While this BPA-free can is well suited to some foods like beans, it is too fragile for use with some acidic foods (like tomatoes) or foods that must be sterilized.[173] According to Mead Johnson, for example, "we are unaware of any alternative material that can withstand the sterilization process required for liquid infant formulas and provide the same assurance of product safety."[174]

According to the Danish EPA's report on BPA alternatives, PVC vinyl-based coatings have very good flexibility and packing resistance. PVC coatings are often used on top of a basecoat in, for example, drawn cans. "As PVC can thermally degrade during stoving, generating hydrochloric acid (HCl), additional substances or resins are often added as scavengers of HCl." The obvious exposure risk to this dangerous substance minimizes the suitability of PVC-based coatings in food contact applications.

Feasible safer alternatives to bisphenol A must be suitable replacements in the marketplace and also cause less human and environmental harm than BPA does. According to the Danish EPA:

> From an environmental point of view the alternative polyester and polyamide, depending on the specific substances, may turn out to cause less harmful effects than BPA whereas polymerized rosin and monomers from polyacrylates may cause the same or more hazardous effects on the environment as bisphenol A. From the health point of view the possible alternatives, polyesters and polyamides depending on the specific substances, may turn out to cause less harmful effects than BPA, whereas some polyacrylates may be irritating to eyes, respiratory system and skin and polymerized rosins may cause sensitization by skin contact.

V. Conclusion

Even with recent announcements by industry officials and the U.S. FDA that BPA may be safe for consumers, the market for BPA-free products continues to expand as consumer awareness of links between BPA and rising health issues grows. Consumers did not wait long after hearing about the potential dangers of BPA before deciding to choose BPA-free alternatives. Savvy investors know that regulators move more slowly than markets do. As scientific data spur public awareness, consumers are pushing manufacturers to develop safer products. Understanding this dynamic, it makes good sense for corporate strategy to be vigilant and pro-active on issues such as BPA. Companies that anticipated the shift away from BPA were able to seize markets for safer products. New scientific research on a variety of topics will continue to influence the market, with health-conscious consumers potentially causing more subsequent transformations in the marketplace, regardless of regulatory agency or industry announcements.

Appendix 1: BPA Litigation, Occupational Hazards, and Environmental Discharge

Current BPA lawsuits

During the spring of 2008, at least six separate class action lawsuits were filed against manufacturers and distributors of plastic products containing BPA; additional lawsuits are considered likely.[175] Moreover, while first generation lawsuits have generally focused on manufacturers and retailers of plastic bottles, and have sought compensatory damages only for container costs.[176] Potential costs for first-generation suits include the full value of polycarbonate bottle sales in recent years, attorney fees and costs, and punitive damages.

- March 12, 2008: A putative class action lawsuit, styled Ganjei v Avent, was filed in state court in Los Angeles, California against five leading manufacturers of baby bottles alleging consumer fraud for their failure to warn of the alleged propensity of BPA to leach out of the bottles when heated. The suit covers training cups and breast milk pumps and accessories as well as baby bottles, and alleges that the plaintiff was exposed in utero to BPA from other sources as well. The possibility thus remains open that manufacturers of other products, and of BPA itself, could be named as additional defendants. Plaintiff claims to have spent $200 on BPA-based products over the past 5 years. Plaintiff seeks general damages (unclear if these are related to the child's injuries, but the complaint does not focus on his condition), punitive damages, restitution of all sales of BPA-based products in CA over the past 5 years, and fees and costs. The complaint is available at http://www.jpma.org/cfincludes/Resources/BPA/BISPHENOL-ACOMPLAINT.pdf

- April 22, 2008: A putative class action lawsuit, Felix-Lozano v. Nalge Nunc International Corp, was filed in the United States District Court for the Northern District of California (Sacramento) against Nalgene Nunc International by a woman on behalf of herself, her two daughters and all others similarly situated. The lawsuit alleges that Nalgene knew that BPA could leach out of sports bottles, but did not warn consumers. It seeks unspecified damages (in excess of $5,000,000 in the aggregate, exclusive of interest and costs, as required by 28 U.S.C. § 1332), but does not allege personal injuries. Plaintiff seeks restoration to plaintiff and Class/subclass members all monies that may have been acquired by defendant as a result of such practices, as well as punitive damages, fees and costs. (2008 WL 1923502)

- April 30, 2008: A putative class action lawsuit, Maria Sullivan et al. v. Avent America Inc. et al, was filed in the United States District Court for the Western District of Missouri against five leading manufacturers of polycarbonate baby bottles—Gerber, Evenflo, Avent, Playtex, and Dr. Brown's—premised on misrepresentation and violation of U.S. and Missouri Consumer Protection Laws, on behalf of all U.S. consumers who purchased plastic baby bottles and training cups containing BPA. "Plaintiffs seek to recover (i) the amounts they spent to purchase defendants' products as a result of defendants' deception and lack of disclosure and (ii) the amount plaintiffs spent and will spend in the future to replace their BPA-laced bottles, liners, and cups with safe and healthful products." The suit is for over $5 million, pursuant to 28 U.S.C. § 1332(d)(2), and requests actual and punitive damages, restitution, costs and fees (as in the other suits, no personal injuries are alleged). The complaint is available at http://blogs.pitch.com/plog/sullivan.pdf. (2008 WL 2035159)

- May 1, 2008: A putative billion dollar class action lawsuit, Wilson et al v. Avent America, Inc. et al., was filed in the United States District Court for the District of Kansas against the top five baby bottle manufacturers (Avent America, Evenflo, Gerber, Handi-Craft (Dr. Brown's) and Playtex) for their use of Bisphenol A in polycarbonate plastic baby bottles and toddler training cups, in violation of Kansas consumer protection laws. As with the LA and MO suits, this one is being brought by Rights For America attorney Robert H. Weiss. (Case Number: 2:2008cv02201)

- May 6, 2008: A putative bi-lateral class action, Elizabeth Banse v. Avent America, was filed in the United States District Court for the Northern District of Illinois against Avent America, Inc. and all

producers, manufacturers and/or distributors of plastic bottles containing BPA premised upon Illinois Consumer Fraud, strict product liability and failure to warn theories. $75,000 in damages are sought. (Case Number: 1:2008cv02604)

- May 19, 2998: A putative class action lawsuit, Ashley Campbell v. Playtex, was filed in the United States District Court in New Haven, CT against Playtex and "all entities which produce, manufacture, and/or otherwise distribute polycarbonate plastic bottle products containing the industrial chemical bisphenol A," contending that they failed to adequately disclose that plastic bottle products are formulated using BPA. The actions were filed in strict products liability, breach of implied warranty, unjust enrichment and violation of CT consumer protection laws. Plaintiff claimed federal jurisdiction pursuant to 28 U.S.C. §1332, suggesting that the amount in controversy exceeds $5 million, based on punitive damages, restitution (presumably for bottle costs), attorneys' fees and costs of litigation. (2008 WL 2242329)

BPA Workplace Injuries

Data on the number of occupational injuries caused by BPA is limited. The total number of persons occupationally exposed to bisphenol A is not known, but due to its widespread use in epoxy resins and polycarbonate, it is likely in the thousands. However, exposure is likely to be negligible in many cases as the residual bisphenol A in epoxy resins and polycarbonate is low. Exposure will be in the form of inhalation or ingestion of dust and by skin contact with flakes or powder. There are concerns for eye and respiratory tract irritation, for liver effects following repeated exposure, and for reproductive toxicity during the manufacture of both bisphenol A and epoxy resins. Concern also exists for the sensitization of skin in all occupational exposure scenarios.[177]

Research shows that exposure to BPA occurs in the workplace. A cross sectional study of 42 workers whose job was to spray epoxy resin hardening agents including BADGE (Bisphenol A diglycidyl ether) and mixed organic solvents, and 42 matched control workers without BADGE use in the same machine plants, showed that concentrations of urinary bisphenol A were higher in the epoxy resin sprayers compared with the controls.[178] In addition, OSHA suggests that BPA "reacts violently with acid anhydrides, acid chlorides, strong bases and strong oxidants."[179] This description of a reactive chemical indicates that occupational injury could occur if proper precautions are not taken.

Toxics Release Inventory Data

Toxics Release Inventory data on facilities releasing BPA into environment in 2002 (pounds)

Facility	Location	Pounds of BPA
1. RESOLUTION PERFORMANCE PRODS. DEER PARK PLANT	DEER PARK, TX	57,000
2. ALBEMARLE CORP. SOUTH PLANT	MAGNOLIA, AR	41,700
3. FORD MOTOR CO. MICHIGAN TRUCK PLANT	WAYNE, MI	23,000
4. GE PLASTICS MT. VERNON INC.	MOUNT VERNON, IN	19,650
5. DOW CHEMICAL CO. FREEPORT FACILITY	FREEPORT, TX	13,964
6. SUNOCO INC. (R&M) HAVERHILL PLANT	HAVERHILL, OH	13,022
7. SVEDALA GRINDING HODGE FNDY	GREENVILLE, PA	11,878
8. AMERICAN RENOLIT CORP.	LA PORTE, IN	5,490
9. DOLPHIN INC.	PHOENIX, AZ	5,000
10. VANTICO INC.	MC INTOSH, AL	3,522

Source: Based on TRI data; http://www.scorecard.org/chemical-profiles/rank-facilities.tcl?edf_substance_id=80%2d05%2d7&edf_chem_name=4%2c4%27%2dISOPROPYLIDENEDIPHENOL

Note: Total Environmental Releases includes all reported on-site releases to air, water, and land (including underground injection). This total does not include any waste that is transferred off-site, so it does not include any environmental releases that may occur as a result of off-site disposal or treatment.

Works Cited

[1] http://www.bisphenol-a.org/pdf/FactSheet-what.pdf
[2] "Phenol: rising to the occasion," *ACN*, 10 June 1996
[3] National Toxicology Program, Final Report on Bisphenol A. September 3, 2008. http://cerhr.niehs.nih.gov/chemicals/bisphenol/bisphenol.pdf
[4] vom Saal, F.S. 2007. Chapel Hill bisphenol A expert panel consensus statement: Integration of mechanisms, effects in animals and potential to impact human health at current levels of exposure. *Reproductive Toxicology* 24(2):1-26.
[5] ACC Calls on FDA to Update Review of Bisphenol A, American Chemistry Council April 17, 2008 http://www.americanchemistry.com/s_acc/sec_news_article.asp?CID=206&DID=7249
[6] European Food Safety Authority. EFSA re-evaluates safety of bisphenol A and sets Tolerable Daily Intake. 1/29/2007. http://www.efsa.europa.eu/en/science/afc/afc_opinions/bisphenol_a.html
[7] Collaborative on Health and the Environment – bisphenol A http://database.healthandenvironment.org/index.cfm?toxinID=2898
[8] Centers for Disease Control – bisphenol A http://www.cdc.gov/exposurereport/pdf/factsheet_bisphenol.pdf.
[9] BPA is also used in the manufacture of materials (e.g., bis-glycidyldimethacrylate, A-dimethyl acrylate) found in dental sealants and composites. BPA could potentially be released during degradation of the dental materials, yet this is not an application of BPA covered in this report.
[10] http://www.bisphenol-a.org/pdf/FactSheet-what.pdf
[11] http://www.bisphenol-a.org/pdf/FactSheet-what.pdf
[12] "Development prospects of the bisphenol A market," *China Chemical Reporter*, 15 (10): 23, April 06, 2004.
[13] http://www.sriconsulting.com
[14] http://www.sriconsulting.com
[15] "Bisphenol A," *Chemical Week*, 167 (35): 42, October 26, 2005
[16] http://www.sriconsulting.com
[17] Id.
[18] http://www.masstortdefense.com/2008/05/
[19] **"**BPA has great potential," *China Chemical Reporter*, 16 (34): 19, December 06, 2005.
[20] "NTP-CERHR EXPERT PANEL REPORT on the REPRODUCTIVE and DEVELOPMENTAL TOXICITY of BISPHENOL A," US Department of Health And Human Services, November 26, 2007, via http://cerhr.niehs.nih.gov/chemicals/bisphenol/BPAFinalEPVF112607.pdf
[21] "BPA market favours polycarbonates," *Chemistry and Industry*, October 7 1996
[22] http://www.sunocochemicals.com/products/product_capsf.htm
[23] **"**BPA has great potential," *China Chemical Reporter*, 16 (34): 19, December 06, 2005
[24] "NTP-CERHR EXPERT PANEL REPORT on the REPRODUCTIVE and DEVELOPMENTAL TOXICITY of BISPHENOL A," US Department of Health And Human Services, November 26, 2007, via http://cerhr.niehs.nih.gov/chemicals/bisphenol/BPAFinalEPVF112607.pdf
[25] See, e.g., "Bisphenol A Under Scrutiny," *Chemical and Engineering News*, June 2, 2008, (citing ICIC Chemical Business data)
[26] Chemical Market Reporter, 260 (17): 39, November 05, 2001
[27] "Bisphenol A," *Chemical Week*, 167 (35): 42, October 26, 2005 (citing SRI Consulting data); "Development prospects of the bisphenol A market," *China Chemical Reporter*, 15 (10): 23, April 06, 2004
[28] http://www.icis.com/v2/chemicals/9076136/phenol/uses.html, http://www.sriconsulting.com
[29] http://www.icis.com/v2/chemicals/9076136/phenol/uses.html
[30] http://www.icis.com/v2/chemicals/9076136/phenol/uses.html
[31] http://www.sriconsulting.com
[32] "BPA furor rumbles on in US," *PRW*, April 28,2008, via www.prw.com
[33] http://www.chej.org/documents/BabysToxicBottleFinal.pdf
[34] http://cob.fsu.edu/jmi/resources/plan.pdf
[35] Company website
[36] See, e.g., http://www.rightsforamerica.com/news.asp?ID=6

[37] "Baby care," *MMR*, 19 (13): 30(1), September 23, 2002
[38] "Baby Care," *MMR*, 18 (12): 39, September 03, 2001 (citing ACNielsen data)
[39] http://cob.fsu.edu/jmi/resources/plan.pdf
[40] http://www.handi-craft.com/pumps/News.asp
[41] Id.
[42] Icarus database; note: prior year sales were radically different, suggesting that estimate may not be accurate.
[43] Energizer 2007 form 10-K
[44] Playtex Products 2006 form 10-K
[45] http://media.corporate-ir.net/media_files/irol/12/124138/CAGNY2008_FINAL.pdf
[46] "Playtex(R) Offers Free Non-BPA Baby Bottles to Parents, Will Stop Using BPA in All Products This Year, *Reuters*, April 18, 2008
[47] "Charterhouse makes quick Avent exit," *European Venture Capital Journal*: 23, June 2006
[48] http://www.consumer.philips.com/consumer/en/us/consumer/cc/_categoryid_ABOUT_PHILIPS_AVENT_AG_US_CONSUMER/
[49] http://www.associatedcontent.com/article/452200/bpafree_baby_bottles_medela_gerber.html
[50] http://zrecs.blogspot.com/2007/11/z-report-bpa-avent.html
[51] Icarus database
[52] http://www.associatedcontent.com/article/452200/bpafree_baby_bottles_medela_gerber.html
[53] http://zrecs.blogspot.com/2007/11/z-report-bpa-evenflo.html
[54] http://www.associatedcontent.com/article/452200/bpafree_baby_bottles_medela_gerber.html
[55] See, e.g., http://zrecs.blogspot.com/2007/07/z-report-bisphenol-in-polycarbonate.html
[56] www.munchkin.com
[57] http://www.blueridgeoutdoors.com/content/June-2008/BPA-free-Water-Bottles/
[58] Icarus database
[59] 2008 WL 1923502
[60] Id.
[61] Advertising Age, 78 (40): 1, October 08, 2007
[62] http://www.nalgene-outdoor.com/technical/bpaInfo.html
[63] http://www.nalgene-outdoor.com/technical/bpaInfo.html
[64] Icarus database
[65] http://www.camelbak.com
[66] "Plastic-bottle scare is a boon for some," *New York Times*, April 25, 2008, via www.environmentaldefence.ca
[67] http://titanwaterbottle.com/press.html
[68] http://www.productpilot.com/supplier_25692_make_company__Universal_Trim_Supply_Co_Ltd.php
[69] Icarus database
[70] Icarus database
[71] See e.g., http://www.bikeforums.net/archive/index.php/t-34870.html
[72] "Catch a plastic wave: Polar Bottle capitalizes on BPA-free product," *Rocky Mountain News*, May 17, 2008
[73] "Bisphenol A Under Scrutiny," *Chemical and Engineering News*, June 2, 2008, (citing Freedonia data)
[74] http://www.icis.com/v2/chemicals/9076136/phenol/uses.html
[75] Silgan Corporation 2007 form 10-K.
[76] "The Baby Bottle Blues," *Newsweek*, January 14, 2008, via www.newsweek.com
[77] http://www.wildman.com/bulletin/05152008/
[78] "The Polycarbonate Price Cut," April 18, 2008, via http://www.thestreet.com/newsanalysis/environmental-stock-picks/10412563.html
[79] "Safety concerns boost business," *The Miami Herald (Florida),* May 11, 2008
[80] "Citing Safety, Wal-Mart and Nalgene Pull BPA Bottles From Shelves," *ABC News*, April 18, 2008, via http://abcnews.go.com/Health/Story?id=4683891&page=2
[81] http://www.eastman.com/Company/News_Center/News_Archive/2008/English/Corporate_News/Financial_News/080313.htm

[82] "Plastic-bottle scare is a boon for some," *New York Times*, April 25, 2008, via www.environmentaldefence.ca
[83] "PET makers increasing capacity again in 2008," *Plastics News*, 19 (51): 4, February 25, 2008
[84] http://www.cfsan.fda.gov/~dms/opa-fcn.html at 729.
[85] http://www.freepatentsonline.com/WO2006137954.html
[86] "Dishwasher Safe," *Plastics Technology*, December 2007, Vol. 53 Issue 12, p60-76
[87] http://en.wikipedia.org/wiki/Copolyester
[88] The Tg of most copolyesters is around 80 C, as opposed to a Tg of 150 C for polycarbonates. The first Tritan product launched had a Tg of 108 C.
[89] "Eastman expanding copolyester capacity," *High Performance Plastics*, 1 May 2008
[90] Esposito, Frank, "Eastman boosts copolyester," *Plastics News*, 3/17/2008,
[91] Esposito, Frank, "Eastman touts Tritan as PC replacement," *Plastics News*, 11/12/2007; "Aladdin's (copolyester) bottle," Canadian Plastics, 1 June 2008
[92] "REFERENCE GUIDE," *Machine Design*, 7 February 2008
[93] Hockensmith, Dan "Firms adopt BPA-free bottles," *Plastics News*, 4/14/2008,
[94] "Eastman Chemical rolls out campaign; Bader Rutter handles integrated effort for firm's first new product launch in sector in 30 years," *B to B*, 92 (17): 12, December 10, 2007
[95] "Cut to the chase," *B to B*, 14 January 2008
[96] "Eastman Chemical Company at Citigroup Basic Material Conference – Final," *Voxant FD (FAIR DISCLOSURE) WIRE,* 4 December 2007; "Dishwasher Safe," *Plastics Technology*, December 2007, Vol. 53 Issue 12, p60-76
[97] US trademark 77489394
[98] "Eastman Boosts copolyester capacity in Tennessee." *Chemical Week*, 170 (9): 6, March 17, 2008
[99] "Companies seek alternatives for plastics additive," *Greenwire*, 20 May 2008
[100] "New Tritan copolyester solves crazing problem," *Modern Plastics Worldwide*, October 25, 2007; "Eastman liking Tritan," *Modern Plastics Worldwide*, 21 April 2008
[101] "Dishwasher Safe," *Plastics Technology*, December 2007, Vol. 53 Issue 12, p60-76
[102] "Companies seek alternatives for plastics additive," *Greenwire*, 20 May 2008
[103] "Companies seek alternatives for plastics additive," *Greenwire*, 20 May 2008
[104] "Hooray forBollywood," *ICIS Chemical Business*, 5 May 2008
[105] Frank Esposito, "PC usage unlikely to change; BPA anxieties spread across US, Canada," *Plastics News*, 28 April 2008
[106] "Eastman Chemical Company at Citigroup Basic Material Conference – Final," *Voxant FD (FAIR DISCLOSURE) WIRE*, 4 December 2007
[107] "Eastman Chemical upgrade to cost $100 million," *The State*, November 13, 2007
[108] http://www.eastman.com/Company/News_Center/News_Archive/2008/English/Corporate_News/Financial_News/080313.htm
[109] Frank Esposito, "PC usage unlikely to change; BPA anxieties spread across US, Canada," *Plastics News*, 28 April 2008
[110] "PolyOne Corporation; PolyOne and Eastman Chemical Company Form Strategic Alliance to Compound and Market Eastman Tritan Copolyesters," *Science Letter*, 17 June 2008
[111] "MarketPlace," *Plastics News*, 21 April 2008
[112] "Plastic-bottle scare is a boon for some," *New York Times*, April 25, 2008, via www.environmentaldefence.ca
[113] "The Nontoxic Alternatives," *New York Magazine*, April 27, 2008
[114] http://titanwaterbottle.com/information.html
[115] "Eastman Chemical upgrade to cost $100 million," *The State*, November 13, 2007
[116] "Eastman launches heat resistant copolyester ," October 25,2007, via www.prw.com
[117] See http://www.cfsan.fda.gov/~dms/opa-fcn.html at 729.
[118] http://www.cfsan.fda.gov/~dms/torguid.html
[119] http://www.cfsan.fda.gov/~dms/torguid.html
[120] 1,4-BENZENEDICARBOXYLIC ACID, DIMETHYL ESTER, POLYMER WITH 1,4-CYCLOHEXANEDI METHANOL AND 2,2,4,4-TETRAMETHYL-1,3-CYCLOBUTANEDIOL
[121] http://www.cfsan.fda.gov/~dms/opa-tedi.html

[122] "Plastic-bottle scare is a boon for some," *New York Times*, April 25, 2008, via www.environmentaldefence.ca
[123] "Plastic-Bottle Scare Is a Boon for Some," *New York Times*, 157 (54291): C1, April 25, 2008
[124] 3/27/08 press release, http://www.stanley-pmi.com
[125] http://www.camelbak.com
[126] "Plastic-bottle scare is a boon for some," *New York Times*, April 25, 2008, via www.environmentaldefence.ca
[127] Esposito, Frank, "Eastman touts Tritan as PC replacement," *Plastics News*, 11/12/2007
[128] "Bottle maker to stop using plastic linked to health concerns," *New York Times (National Edition),* 157 (54284): C1, April 18, 2008
[129] http://www.nalgene-outdoor.com/technical/bpaInfo.html
[130] "Dishwasher Safe," *Plastics Technology*, December 2007, Vol. 53 Issue 12, p60-76
[131] October 24, 2007 Vita-Mix press release, "Vita-Mix Enhances Blender Container Performance With New Eastman Tritan™ Copolyester," via www.vitamix.com
[132] Hockensmith, Dan "Firms adopt BPA-free bottles," *Plastics News*, 4/14/2008,
[133] See, e.g., October 24, 2007 Eastman press release "Carlisle Enhances Performance and Production Efficiency of Commercial Soup Bowls Using New Eastman Tritan™ Copolyester," via www.eastman.com
[134] "The Baby Bottle Blues," *Newsweek*, January 14, 2008, via www.newsweek.com
[135] *New York Times (National Edition),* 157 (54291): C1, April 25, 2008
[136] "The Nontoxic Alternatives," *New York Magazine*, April 27, 2008
[137] "Safety concerns boost business," *The Miami Herald (Florida),* May 11, 2008
[138] www.greentogrow.com
[139] http://www.greentogrow.com/faqs.aspx, http://zrecs.blogspot.com/2008/02/z-report-bpa-green-to-grow.html
[140] http://www.thesoftlanding.com/grtogrbo.html
[141] http://www.bfr.bund.de/cd/7301
[142] "The Baby Bottle Blues," *Newsweek*, January 14, 2008, via www.newsweek.com
[143] http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2007/04/09/BOTTLES.TMP
[144] "Glass baby bottles make a comeback," *AP*, March 1, 2008, via www.msnbc.msn.com
[145] *New York Times (National Edition),* 157 (54291): C1, April 25, 2008
[146] "The Baby Bottle Blues," *Newsweek*, January 14, 2008, via www.newsweek.com; "CHEMICALS: Companies seek alternatives for plastics additive," May 20, 2008
[147] "Fear weans parents off plastic bottles." AP, March 20, 2008, via http://seattlepi.nwsource.com/lifestyle/355830_parentglass21.html
[148] "Glass baby bottles make a comeback," AP, March 1, 2008, via www.msnbc.msn.com
[149] http://www.thingamababy.com/baby/2007/09/glassbaby.html
[150] "The Nontoxic Alternatives," *New York Magazine*, April 27, 2008
[151] E.g., United States Patent 3919440
[152] New York Times (National Edition), 157 (54291): C1, April 25, 2008
[153] Wasik, Steve. "SIGG Quality and Safety Guarantee" April 16, 2008.
[154] Advertising Age, 78 (40): 1, October 08, 2007
[155] "The Baby Bottle Blues," *Newsweek*, January 14, 2008, via www.newsweek.com
[156] Pesticide & Toxic Chemical News, 35 (21): 4, March 19, 2007
[157] http://www.core77.com/bullitts/2007/08/Whipsaw-Adiri-Natural-Nurser.asp?tag=materials&context_id=4&current_bullitt_id=556&current_bullitt_number=2
[158] "A better baby bottle?" Palo Alto Online News, January 1, 2008
[159] http://plastipure.com
[160] "Japanese company invests in infant polyamide bottles," *Plastics & Rubber Asia*, 16 (107): 14(1), December 2001
[161] http://thesoftlanding.wordpress.com/2008/01/26/think-baby-bottles-vs-born-free-green-to-grow-whats-the-difference/
[162] Evaluation of Alternatives for Compounds under Risk Assessment in the EU, Bisphenol A www.miljøstyrelsen.dk/udgiv/publications/2004/87-7614-181-0/html/kap04_eng.htm
[163] Ibid.

[164] http://www.masstortdefense.com/2008/05/
[165] Evaluation of Alternatives for Compounds under Risk Assessment in the EU, Bisphenol A www.miljøstyrelsen.dk/udgiv/publications/2004/87-7614-181-0/html/kap04_eng.htm
[166] Evaluation of Alternatives for Compounds under Risk Assessment in the EU, Bisphenol A www.miljøstyrelsen.dk/udgiv/publications/2004/87-7614-181-0/html/kap04_eng.htm
[167] Glud & Marstrand, 2003 cited in [167] www.miljøstyrelsen.dk/udgiv/publications/2004/87-7614-181-0/html/kap04_eng.htm
[168] "Debate rages over safety of plastic chemical BPA in everyday items," Dallas Morning News, May 18, 2008, via www.dallasnews.com
[169] "Bisphenol A levels in human urine," *Environmental Health Perspectives*, January, 2003, via http://findarticles.com/p/articles/mi_m0CYP/is_1_111/ai_98539781
[170] See, e.g., "Migration of Bisphenol A from Can Coatings to Drinks," *Journal of the Food Hygienic Society of Japan*, Vol 40, 1999, via http://sciencelinks.jp/j-east/article/199916/000019991699A0509555.php
[171] "Your BPA questions, answered." Environmental Working Group Enviroblog. March 13, 2008. http://www.enviroblog.org/2008/03/bpa-questions-answered.htm
[172] "Your BPA questions, answered." Environmental Working Group Enviroblog. March 13, 2008. http://www.enviroblog.org/2008/03/bpa-questions-answered.htm
[173] "Debate rages over safety of plastic chemical BPA in everyday items," Dallas Morning News, May 18, 2008, via www.dallasnews.com
[174] http://www.meadjohnson.com/app/iwp/MJN/Content2.do?dm=mj&id=/MJN_Home2/mjnBtnNews/mjnBtnNewsArchive/08BPASafety&iwpst=B2C&ls=0&csred=1
[175] http://www.wildman.com/bulletin/05152008/
[176] Id.
[177] European Commission 2003 BPA Summary Risk Assessment Report
[178] "Urinary bisphenol A and plasma hormone concentrations in male workers exposed to bisphenol A diglycidyl ether and mixed organic solvents," *Occupational & Environmental Medicine,* 59(9):625-628, September 2002
[179] http://www.osha.gov/dts/chemicalsampling/data/CH_221000.html