Biotechnology in Plastics

A bi-monthly newsletter monitoring developments
In industrial biotechnology that impact the plastics industry.

Summer 2004

Biotechnology

Maggie Baumann of G.H. Associates attended the **World Congress on Industrial Biotechnology** April 20-22 in Orlando FL. The congress was organized by the Biotechnology Industry Organization (Bio.org) and the ACS (American Chemical Society). Larry Drumm of Biolarry Consulting who co-authors this newsletter organized a session and led a workshop at the conference. Although G.H. Associates had done work in the area of biorenewable materials in the past, we did not realize the progress that has been made in industrial biotechnology. Developments in medical and agricultural biotechnology have contributed robust techniques and technologies that have contributed to industrial biotech. Experts predict that by 2010, 10-15% of all chemicals and polymers will be biobased.

Recognizing the significance of this emerging field, we are launching a biotechnology newsletter that will track important developments in industrial biotechnology with particular emphasis on polymeric materials, processes and applications. We believe that with the current surge in energy prices, the area of industrial biotechnology will continue to get more attention from large chemical companies. We are publishing the inaugural issue of the Biotechnology In Plastics newsletter in early July, 2004. The first three issues are free; the annual subscription is $49.00 for 6 issues. If you are interested in receiving an issue every other month please sign up at http://www.polymerplace.com.

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With the current high gas prices you might be interested in knowing that there is a growing production base for biofuels. Motorists may not be filling up with corn stalks when they pull into a gas station in a few years, but they will be driving cars fueled in part by plant-based bioenergy. Advances in industrial biotechnology are making it possible to increase the amount of agricultural products and waste materials that can be converted to transportation fuels. This means the biotech industry, in partnership with farmers, energy companies and transportation interests, can forge a future with greater energy security.

Most Americans are aware of the domestic ethanol industry, which converts corn kernels into ethanol that is added to gasoline. But the bigger promise of fuel farming has gone untapped. By using different bioenergy feedstocks, we can reduce oil consumption and carbon dioxide emissions while breathing new economic life into the farm sector.

The major breakthrough for the production of energy will come from companies that are perfecting enzymes to cost effectively convert cellulose – the tough material in plant cell walls to sugars. Currently, ethanol is produced using the starch from the corn kernel, as opposed to the woody (cellulosic) material in the stalk and leaves. Conversion of cellulose to sugar and then ethanol will allow these and other agricultural waste products to be processed into ethanol.

The economic impact could be huge. The ethanol industry, principally using corn, produced 1.6 billion gallons of ethanol in 2000, or slightly more than 1 per cent of all US gas consumption. Using enzymes to convert agricultural waste containing cellulose could increase ethanol production by a factor of 10.

Unlike current ethanol production, ethanol from cellulose is considered “carbon neutral”-the carbon dioxide it gives off is the same carbon dioxide that was taken in by the plants from the

atmosphere as they grew. Using cellulosic biomass to make energy would also significantly reduce energy requirements needed to produce ethanol vs. current technologies.
Right now, companies are just beginning to build first-generation biorefineries to convert biomass into bioenergy. As more biorefineries sprout around the country, they will increase demand for biotech enzymes and for biomass feedstocks, leading to economies of scale. This development is good for the biotech industry, the agriculture industry, our energy situation and the environment. It also means farmers will be able to harvest two crops from every field- food and energy-or to shift production from food and textile crops to dedicated biomass crops that will be in demand as more biorefineries are built.

In the final analysis, the development of energy production through industrial biotechnology is a winning solution for everyone.
This appeared in the June/July 2003 issue of Bio News and was written by Brent Erickson, BIO's vice-president for industrial and environmental biotechnology.

In additional to the energy benefit for biorefineries, the chemical intermediates for polymers and the biopolymers themselves will benefit from lower cost raw material. This lower cost will accelerate the development of new raw materials, new polymers, and new products of all kinds based on biotechnology. These lower costs will also increase the penetration of the products into specific market segments and allow higher growth rates.

GPEC 2004 in Review

The SPE Global Plastic Environmental Conference (GPEC) 2004 was held February 18th and 19th in Detroit, Michigan. Conference attendance was slightly lower than achieved at GPEC 2003. However, the attendance exceeded the conference committee expectations given the current economic climate. Once again there was a wide range of attendees with participants coming from as far away as Europe and Asia. From a functional perspective, attendees and presentations ranged from basic research to process to marketing. Forty-seven papers were presented that in affect covered the plastic supply chain. Student participation was also high given the number of student posters present.

GPEC had thorough conference coverage from industry news sources. This year three trade journals elected to cover the proceedings. The extensive coverage illustrates that industry interest in environmental issues remains quite high. Sixteen organizations provided sponsorship support for the conference.

This year there were three keynote speakers. The first speaker, Ms. Donna Davis, President of the Society of Plastics Engineers, addressed the opening assembly. Ms. Davis spoke on plastic product development.

The second keynote speaker was Rod Lowman, President of the American Plastics Council, addressed the lunchtime assembly on the first day of proceedings. Mr. Lowman spoke on current plastic environmental issues and the solutions being enacted.

The final keynote speaker was Ms. Stephanie Baker, Marketing Executive for KW Plastics, addressed a lunchtime assembly on the final day of the proceedings. Ms. Baker presented the marketing hurdles overcome by KW Plastics with their successful introduction of a paint container produced from recycled polyolefin.

The conference culminated in the Divisional Environmental Awards Ceremony held prior to the conclusion of the conference. Interest in the award ceremony was quite high given the audience attendance level. Environmental awards were presented to ten organizations in seven different award categories. Award recipients were well represented considering that awardees ranged from academia to industry, Fortune 100 companies to entrepreneurial concerns. We, as both a Division and Conference Committee, were overall pleased and impressed by the overall interest and enthusiasm expressed in the award program. In closing it is important to consider increasing

ones state in the future of the Plastics Environmental Division. The Division is the principal forum for discussion of the environmental issues facing the plastics industry today.

Next year's GPEC conference will be held February 24-25, 2005 in Atlanta, Georgia. There will be two sessions on industrial biotechnology with a focus on biorenewable polymers. For more information go to: http://www.4SPE.org.

Bio.org

BIO's Industrial and Environmental (I&E) Section represents life science, biotechnology and industrial companies that apply novel technologies to help resolve important challenges in manufacturing and improve environmental performance. I&E companies develop or use enzymes, whole cell systems or other biologic processes to revolutionize manufacturing and chemical synthesis.

Since 1997, BIO's I&E Section has provided its members a unified, powerful voice in Washington and beyond, helping develop and gain approval of vital legislation and environmental applications of biotechnology. In 2000, BIO formed an Industrial and Environmental Section Governing Body to help support and govern the Section. Company executives who are leaders in the fields of Biotechnology, chemicals, polymers and fuels make up the governing body.

The first wave of biotechnology came with medical applications of the science. Later, scientists develop ways to enhance agriculture and food crops through biotechnology – the second wave. Industrial and environmental biotechnology is the "Third Wave" in biotechnology. It is playing a growing role in the United States and around the world, as interest in cleaner, more sustainable industrial processes and prevention of environmental damage increases. But that growth is not without challenges – economic, legislative and regulatory – that must be anticipated and met. More importantly, when the proper audiences understand the societal benefits of industrial biotechnology, they can foster policy development and an economic climate that encourages growth in this important industry segment.

BIO's I&E Section offers significant services and benefits to its members, and the section has seen a significant increase in membership over the past three years. Major corporations such as DuPont, DSM, Genencor, Novozymes, Dow, Codexis, Diversa, Cargill and Cargill-Dow are members of the I&E Section. The Section membership also includes smaller companies, national laboratories, and law and consulting firms.
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ANTEC - 2003

The Society of Plastics Engineers recently held their Annual Technical Conference in Chicago, IL May 16-20, 2004. Maggie Baumann of G.H. Associates presented a paper during the Marketing & Management Division session that was heavily attended.

Maggie Baumann's **"The Impact of Biotechnology, Nanotechnology, and the Environment on the Chemicals and Plastics Industries"** dealt with how "disruptive technologies," are creating significant new market opportunities, but perhaps even more importantly, are forcing changes in how industry conducts business. While a number of biotechnologies have been in

use for over 50 years (e.g., nylon intermediates from corn), a number of newer ones have been under development by academia, government, and industry in the search by industry for ways to reduce our dependence on petroleum and create fewer or more benign byproducts to be used in place of more conventional chemical manufacturing processes. However, the economics have been complex for these processes but a lot of progress has been made to reduce the costs to manufacture these biorenewable products.

Nanocomposites and nanochemistry are now being commercialized today and are on the upward slope of the demand curve, ensuring that they will become an increasingly important area for industry in the near future. A copy of the paper is available. Please go to http://www.polymerplace.com .

At ANTEC in May 2005 (Boston MA) there will be a New Technology Forum on Biotechnology and Plastics.

Building Blocks/Raw material sources and developments

Enzyme/Biocatalysts developments

Iogen Bio-Products (Ottawa, Canada) focuses on making high quality enzymes for industries that process fiber. The company has three primary enzyme markets: pulp and paper, textile, and animal feed.

In extensive research, Iogen determined that enzymes produced by the company could effectively break down the lignin in waste plant matter, releasing cellulose to be converted into ethanol. This is a key development to drive down costs of the bio-ethanol.

In April 2004, Iogen of Ottawa, Canada celebrated the world's first commercial run of its bio-ethanol, which is processed from, agricultural and forestry scrap. With 160 employees, Iogen operates a unique cellulose ethanol demonstration plant at its Hunt Club site. The next step is to open several commercial plants to deal with market demand.
Brian Foody is the President of Iogen. He anticipates as many as 20 such plants across the country –and perhaps in other parts of the world- all of them placed in agricultural/rural regions with access to waste needed for refining, including straw, stalks, leaves, corn cobs an d branches.

With $21 million in the pot, the government of Canada is a financing partner in Iogen, along with Petro Canada ($24.7 million) and Shell Global Solutions ($46 million). Unlike grain processing ethanol distillers recently supported by federal funding, Iogen is flying solo in perfecting the use of non-food residues of the growing process.

Proponents of Cellulose ethanol argue that it has great potential to help reduce greenhouse-gas emissions, since the feedstock is readily available as a by-product of farm crops.

Shell's Duncan McLeod said the leap forward by Iogen clearly indicates that renewable fuels are no longer a dream but a reality. He estimated the global market for fuels such as cellulose ethanol will grow to $10 billion by 2012.

There are three clear advantages to biomass-based fuel…It's cheaper to produce; crops can be used for their food value and residue/waste products can be used as raw materials for industrial products; and reduction of greenhouse gases is about three times greater when compared to grain-based ethanol.

The actual commercialization of cellulosic-based processes as embodied in the Iogen announcement has come years ahead of what many had predicted. It shows how quickly biotechnology developments are coming.

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End Use Markets and Trends

"Fresh-in-natural" marketing is boosting perimeter sales for a new crop of retailers using NatureWorks™ PLA packaging in their fresh food aisles.

Made from 100 percent field corn, NatureWorks PLA offers the interesting brand story of a clear, "nature-based" package for fresh and natural foods. A number of U.S. and European supermarkets are now capitalizing on the unique appeal of the made-from-corn containers to bring attention to delicatessen, bakery, dairy and produce items.

"NatureWorks PLA is a retail reality – it is on store shelves at several major grocery retailers, and these early adopters are finding the packaging to be an effective marketing tool for generating department and item sales," said Lisa Owen, global business leader for rigid packaging, Cargill Dow LLC. "The 'fresh-in-natural' concept speaks to consumers' aspirations to do something better for their families and the environment. Consumers seem to feel good about food inside a natural package, viewing the entire offering as more fresh and wholesome."

Leading the trend toward nature-based packaging is Wild Oats Markets, which last year was the first North American retailer to launch NatureWorks PLA packaging in its Portland, Ore. stores. In the first three months of the packaging's debut, Wild Oats experienced a 4 percent jump in deli sales. Customers' tremendous response to the packaging led Wild Oats Markets to expand NatureWorks PLA throughout the fresh market departments of its 77 stores.

This spring, a number of U.S. food retailers began using NatureWorks PLA, which has exponentially increased the retail presence of the nature-based packaging:

- Farm Fresh Supermarkets, a SuperValu company with 35 stores in Hampton Roads, Va., offers two-sizes of cold food containers for shoppers to fill up at their salad bars;
- Natural foods retailer Earth Fare, which has nine locations throughout the Southeast United States, packages produce, bakery and deli items in NatureWorks PLA;
- In the New York City area, specialty retailers Citarella, Garden of Eden Gourmet, Market Basket and Turco's serve up their gourmet "to-go" fare, and fresh produce and baked goods in the containers from corn;
- Ellwood Thompson's Natural Market, Richmond, Va., packages all of its in-store deli items in NatureWorks PLA.

In addition to these U.S. retail locations, cups made from NatureWorks PLA will be used to serve lemonade this summer at the National Mall in Washington, D.C. The National Mall's foodservice supplier Guest Services debuted the cups at the grand opening of the World War II Memorial over the Memorial Day holiday weekend, and expects to use more than 200,000 cups during the summer season.

Retail interest in nature-based packaging is also strong in Europe. For the U.K. and Irish retail markets, packaging manufacturer Europackaging recently introduced a full-line of packaging items from NatureWorks PLA, including a notable product extension – merchandise carrier bags. Europackaging is the first company to offer blown-film bags made of the nature-based material for both general merchandise and luxury shopping bag applications.

Fresh Selection of Packaging Ideas

Available in both disposable containers and film, NatureWorks PLA is targeted for packaging salads and other cold deli items, sliced meats and cheeses, baked goods like cakes and cookies, and other fresh foods. In addition, NatureWorks PLA can be used for disposable tableware items such as cups, bowls, cutlery; and film carrier bags.

For more information about NatureWorks PLA, please visit the Web site http://www.natureworkspla.com.

In general we recommend you visit the Cargill- Dow website, http://www.cd-poly.com.

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Alliances

DuPont and Tate & Lyle PLC announced May 26, 2004 a joint venture to create products from renewable resources such as corn for numerous applications including clothing, interiors, engineered polymers and textile fibers.

The new company – DuPont Tate & Lyle BioProducts, LLC – is equally owned by DuPont and Tate & Lyle and will be based in Wilmington, Del. The company plans to construct its initial commercial manufacturing plant adjacent to an existing facility in Loudon, Tenn., with startup scheduled for 2006. A pilot facility in Decatur, Ill. has been operating for several years.

The joint venture will use a proprietary fermentation and purification process developed jointly by DuPont and Tate & Lyle to produce 1,3 propanediol (PDO), the key building block for DuPont Sorona® polymer. As DuPont's newest polymer platform, Sorona® offers unique properties such as stain-resistance, exceptional softness, comfort stretch and recovery, and UV- and chlorine-resistance when compared to polyester and nylon. Sorona® can be used in a variety of applications including textile apparel, interiors, engineering resins and packaging. The new bio-based technology uses less energy and employs renewable resources – replacing the need for traditional petrochemicals now used to produce 1,3 propanediol (PDO).

"As a science company, DuPont is committed to business and research initiatives that meet customer and market needs while delivering both shareholder and societal value," said John Ranieri, vice president and general manager – DuPont Bio-Based Materials. "Sorona® is an excellent example of putting science to work by integrating biology with materials science. Sorona® combines the emerging discipline of metabolic engineering (the capability for biology to produce valuable products) with the leading polymer engineering capabilities of DuPont."

"The joint venture is further evidence of Tate & Lyle's strength in innovation, our success in developing key industrial partnerships and our ability to generate value-added product growth. It is a natural fit with our core skills in fermentation of natural products," said Iain Ferguson, chief executive – Tate & Lyle PLC. "Partnerships are an important component of our strategy to build our business and we are delighted that our relationship with DuPont continues to advance. This is also a good example of the excellence of Tate & Lyle's research and development capability in delivering a product from renewable resources that can selectively replace those made from petrochemicals."

John D. Halberstadt of DuPont has been named president of the joint venture. He will report to a board of managers with representatives from both parent companies.

Sorona® is currently manufactured from petroleum-based PDO, and is available commercially from DuPont. It is used to produce clothing and fabrics with superior softness, dyeability, and a natural stretch. Bio-PDO™ corn-derived chemical and Sorona® polymer made from Bio-PDO™ will be available in 2006.

Last year, the U.S Environmental Protection Agency presented DuPont with its annual "Presidential Green Chemistry Award" for the company's research leading to the development of the bio-PDO process.

Note: Biotech processes are often lower cost than conventional processes..

DuPont's bioprocess for making 1,3 propanediol requires 40% less capital and has a 25% lower operating cost than the chemical process for making the same product. Because of a different

impurity profile the polymer made from biological based 1,3 propanediol had improved properties and actually created a superior product to that of the chemically based 1,3 propanediol.

Tate & Lyle is a world leader in ingredients. Its core competence is to take corn, wheat or sugar, and add value to these raw materials through technology. As a result of continuous innovation, it offers an ever-wider product portfolio of versatile and functional ingredients. These products include Cereal Sweeteners, Starches, Sugars and Citric Acid. Tate & Lyle products have wide applications in the food, beverage, pharmaceutical, cosmetic, paper, packaging and building industries. With headquarters in London, Tate & Lyle operates more than 40 plants in 24 countries, almost all in Europe and the Americas. It employs 6,700 people in its subsidiaries with a further 2,800 employed in joint ventures. Sales in the year ending March 31, 2003, totaled £3,167 million. More details are available on this website: http://www.tateandlyle.com

For more information on DuPont go to http://www.dupont.com.

References: The stories in *Biotechnology in Plastics* come from a variety of sources including Company Press Releases, Interviews, and trade publications, e.g. *Plastics News* and newswires.

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