



Genomatica is a chemical company that commercializes novel bio-manufacturing processes to sustainably produce a variety of industrial chemicals that impact all major industries and provide the materials that comprise the world we live in. The company enables the production of sustainable chemicals through a compelling proprietary platform that fundamentally transforms the way in which natural processes can be used to convert low cost, renewable feedstocks into high-value chemicals. Genomatica views sustainable chemicals as chemicals designed and manufactured using renewable raw materials and processes that are efficient, effective, safe and environmentally responsible.



Through its bio-manufacturing processes, Genomatica is enabling the chemical industry to transform its feedstock base and take the "petro" out of the "petro-chemicals" business. For example, one of the company's processes uses 100 percent renewable feedstocks (sugar and water) and genetically engineered organisms to create a commonly used chemical intermediate, 1,4-butanediol (BDO). This chemical is a major component of many plastics that find their way into components of automobiles for example, and fibers for apparel such as Spandex. All of the BDO produced in the world today is made from oil- or natural gas-derived feedstocks. Genomatica's bio-manufacturing process requires less energy and lower capital investment compared to traditional chemical processes that use petroleum- or natural gas-derived feedstocks. The process is about 30 percent less energy intensive than a typical producer creating the same chemical with a petro-based process.

As hydrocarbon-based energy costs continue to rise over the long term and show high volatility, chemical producers are actively seeking a means to reduce their exposure to the cost and volatility of energy and to reduce their carbon and environmental footprint. Genomatica's bio-manufacturing processes allow chemical producers to reduce their reliance on hydrocarbon feedstocks by switching to renewable feedstocks, a more diversified starting point for production that reduces supply risk. Most importantly, producers will be able to produce these sustainable chemicals at a lower cost, providing the means to significantly improve their operating margins and profitability outlook.

Genomatica is also developing a rich portfolio of other chemicals that are being targeted for production by its bio-manufacturing processes. The company targets chemicals with global markets that each



exceeds \$1 billion worldwide. Chemicals are also selected for development based on other economic and chemical characteristics.

Not only is Genomatica's approach sustainable and cost-effective, the process is the result of tenaciously applied science, not serendipity. Genomatica is the rare company that combines computational modeling with wet lab processes and process engineering. Proprietary computer models simulate and tests all of the possible biochemical ways that a chemical could be created, and then focus in on the most efficient path from feedstock to chemical. This is a process that can be repeated time and again for any chemical product of interest. Using the "blueprints" generated by the modeling, researchers bring those designs to life through genetic engineering of microorganisms to create microbes that are optimized to produce the chemical. Experienced process engineers then design the complete bio-manufacturing process that first uses the microbe to convert the renewable feedstocks into the chemical via fermentation, and then separates and purifies the resulting solutions to generated highly pure samples of the chemical that meet the industry established chemical product specifications.

As a given chemical process is being developed and validated from the lab-scale to demonstration-scale and up to commercial-scale, Genomatica will form partnerships with chemical manufacturers or others to license the process. Genomatica's partners will build and run the manufacturing facilities and market and distribute the chemical and derivative products. In this way, Genomatica is working together with chemical producers to enable a transformation of the chemical industry to a more sustainable world.

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Christophe Schilling, Ph.D., CEO and Co-founder

Together with Dr. Bernhard Palsson, Schilling founded the company in 2000. Schilling has been instrumental in forming the integrated technologies that generate Genomatica's ongoing value and establishing the company's vision to enable transformation of the chemical industry through sustainable bio-manufacturing. He is an inventor on a number of patent filings surrounding the company's core technologies and is a co-author of numerous scientific articles on systems biology and modeling.

As company president, Schilling secured commercial collaborations and licensing transactions with global Fortune 1000 companies including Dow Chemical, Cargill, DSM and Unilever. Under his direction, Genomatica secured over \$10 million in research and development funding through over 30 federal research awards from agencies including the Department of Energy, National Institutes of Health, Department of Defense and the National Science Foundation. He led the company's successful efforts to secure over \$20 million in financing from leading venture capital firms in 2007, which has enabled the current phase of the company's growth. Today, he leads a team of over 35 dedicated researchers and other employees, bringing sustainable chemicals to the world.

Schilling has received a number of scientific and business awards including the 2003 top 100 young innovators award from MIT's Technology Review magazine, and an R&D100 award for SimPheny, the company's modeling software.

Schilling received his doctorate in bioengineering from the University of California, San Diego, where he was a Powell Foundation and Whitaker Foundation Fellow. He also holds a bachelor's degree in biomedical engineering from Duke University, where he was a Howard Hughes Undergraduate Research Fellow.

Mark J. Burk, Ph.D., Chief Technology Officer

Mark Burk joined Genomatica in September 2006, bringing over 20 years experience in building and managing diverse research teams in both academia and industry. Prior to Genomatica, he served as senior vice president of research and development at Diversa Corporation, where he built and managed a research team of over 120 scientists.

Early in his career, Burk fulfilled a National Institutes of Health postdoctoral appointment at the Massachusetts Institute of Technology with Professor K. Barry Sharpless, who won the 2001 Nobel Prize in chemistry. Burk spent five years in the central research and development department of DuPont in Wilmington, Delaware. He served four years on the faculty of the Department of Chemistry and BioChemistry of Duke University, then assumed a director position at Chiroscience Pharmaceuticals in



Cambridge, England, where he led efforts to commercialize technology that he had developed while at DuPont and Duke.

Burk received his bachelor's degree from Rutgers University and Ph.D. in chemistry from Yale University. Burk has published over 75 peer-reviewed scientific manuscripts and is an inventor on over 30 issued patents. Burk has delivered many lectures and seminars covering topics ranging from chemistry and high throughput screening to biotechnology, evolution and metabolic engineering. He has received numerous awards for his innovative research achievements.

Burk currently serves on the scientific advisory board of Materia Inc. and the editorial board of the journal *Advanced Synthesis and Catalysis*.



Genomatica Breakthrough Replaces Petroleum with Sugar in Major Chemical Process

Sustainable fermentation proven to produce a key industrial chemical used for making plastic, rubber and fiber products

SAN DIEGO, Sept. 16, 2008 – San Diego-based Genomatica Inc., a sustainable chemical company, has proven a novel bio-manufacturing process capable of producing thousands of tons of a commodity chemical in a single facility. The foundational chemical, 1,4-butanediol (BDO), is a key raw material in the manufacturing of hundreds of plastic, rubber and fiber products. BDO has a worldwide annual production value estimated at more than \$4 billion across the automotive, textile and consumer goods industries.

Genomatica achieved this breakthrough by engineering a microorganism that has the potential to produce BDO in a global-scale manufacturing plant in less than one year. Prior to this effort, no one had published evidence of microorganisms capable of producing BDO. The Genomatica process is expected to offer substantial cost savings to chemical producers compared with petrochemical-based processes, as well as provide a 100-percent renewable pathway by using sugar instead of petroleum as the main input.

Genomatica first produced BDO in February 2008, and subsequently improved the productivity of the process 1,000-fold in the following few months. Concurrently, the company created strains of the bacteria that were tolerant of the concentrations needed to produce large volumes of BDO at reduced cost.

“This demonstration of sustainable chemical bio-manufacturing is a huge leap and illustrates the power of Genomatica’s unique technology and process,” said Christopher Gann, chief executive officer of Genomatica. “By using advanced computational modeling and evolution-based methods to rapidly engineer living organisms, Genomatica can produce valuable chemicals from renewable feedstocks at low cost.”

BDO and the Rising Cost of Chemical Feedstocks

BDO is one of the world’s most important commodity chemicals, with approximately 3 billion pounds produced annually. BDO is a key precursor to specialty plastics, solvents, fine chemicals, pharmaceuticals, exterior and under-the-hood automotive components, electrical and electronics components, as well as apparel fibers. Currently, the chemical is manufactured only from non-



renewable petrochemical feedstocks – based on oil and natural gas – through energy-intensive petrochemical processes. With the Genomatica process, this segment of the chemical industry can move toward sustainable production.

The rising cost of oil and natural gas has caused dramatic increases in the price of chemicals worldwide, straining chemical manufacturers, impacting customers downstream in the value chain and even increasing prices for the consumer.

“Genomatica’s breakthrough technology has the potential to move the chemical manufacturing industry from current petrochemical processes to modernized bio-manufacturing for a number of very important and widely used industrial chemicals,” said Harvey Blanch, professor of biochemical engineering at the University of California at Berkeley. “Chemical manufacturers that take advantage of Genomatica’s process can reduce cost with a sustainable process using 100-percent renewable inputs.”

Because of rising oil and natural gas prices, the search for new processes to produce existing high-volume chemicals from alternative feedstocks in a cost-competitive manner has intensified. Genomatica is leading the way to a solution with biotechnology to meet demand for greater feedstock flexibility and sustainability. BDO is the first product the company has disclosed in its rapidly maturing pipeline, which targets several other commodity chemicals to be produced using microorganism-based fermentation.

The Genomatica Technology Platform

Genomatica’s breakthrough was made possible by the power and pace afforded by the company’s integrated technology platform. Genomatica scientists use the platform to rapidly create new forms of microorganisms through traditional genetic modification, which is guided by detailed designs created with proprietary computational modeling techniques. With these models, the company exhaustively explored all ways to make the targeted chemical and then zeroed in on the optimal designs, providing the precise “blueprints” for further development.

In a complementary fashion, Genomatica uses its deep understanding of biological adaptation to create organisms that thrive under adverse conditions while further increasing their production of the desired chemical product. Normally microorganisms experience inhibition of growth and productivity when they produce a nonnative material; here, exactly the opposite is true. By engineering organisms in this manner, Genomatica can open the door to new bio-manufacturing processes, gaining substantial economic benefits relative to traditional hydrocarbon-based petrochemical processes, while helping the chemical industry advance its sustainable development initiatives.



Genomatica is currently working on improving the yield and productivity of its BDO process while scaling manufacturing output to meet the demands of large bioreactors. The company estimates that within a year its BDO process will cost less than non-renewable, hydrocarbon-based processes, even if oil prices drop to \$50 per barrel.

New Genomatica Chemical Process Targets Ailing Ethanol Assets

First-ever bio-manufacturing process to produce methyl ethyl ketone from renewable feedstocks proven in rapid order

SAN DIEGO, Feb. 25, 2009 – Researchers at Genomatica Inc., a sustainable chemical company, have developed a bio-manufacturing process for methyl ethyl ketone (MEK), a commonly used industrial solvent with a global market valued at more than \$2 billion. The rapid development breakthrough demonstrates that Genomatica’s technology can repeatedly target specific chemicals that previously could only be produced from petroleum-based feedstocks. Genomatica’s research proves these chemicals can be manufactured inside organisms using renewable feedstocks.

In the second half of 2008, on the heels of its first breakthrough, 1,4-Butanediol (BDO), Genomatica targeted MEK and began development. By extensively leveraging unique capabilities of Genomatica’s technology platform, researchers have successfully created the first organism known to bio-manufacture MEK from sugar in the laboratory. The process converts sugar and water into this valuable chemical, most prominently used as a solvent in paints and coatings for furniture.

Genomatica executives selected MEK because it can be produced in existing ethanol manufacturing facilities left idle by a recent market contraction. Because of a recent downturn in demand for corn ethanol, many small- and mid-sized manufacturing facilities have been forced to cut production or shut down. These facilities are also facing serious concerns regarding the long-term competitive outlook for profitable ethanol production. To make better use of those investments, Genomatica developed a sustainable chemical process that would use the same equipment, temperatures and processes. With minimal additional investment, plants will be able to produce a chemical valued at significantly higher prices than ethanol.

“Shortly after our first chemical breakthrough, we envisioned the profile of an ideal chemical for the current economic environment. The Genomatica engineering team immediately determined that MEK fit the profile and set to work,” said Christopher Gann, chief executive officer of Genomatica. “I am



confident in our technology, but was still surprised and pleased when they produced the proof-of-concept so quickly.”

The Manufacturing Opportunity

Genomatica targeted MEK for development because it presented a unique opportunity to use existing facilities designed for corn ethanol manufacturing. The Renewable Fuels Association has estimated that 10 or more companies have shut down 24 ethanol plants over the last three months. This represents about 15 percent of the country’s ethanol production.

“We have invested in several commodity processing plants and clean energy development projects, but we are facing a difficult economic and regulatory environment,” said David Kolsrud, ethanol producer and president of DAK Renewable Energy. “Many ethanol producers will be keenly interested in a process that would give new options for a strong return on investment and sustainable job growth for the community.”

Small- to mid-sized ethanol producers are a particularly good fit for the manufacturing opportunity offered by Genomatica’s breakthrough. As the industry adjusts to changes in demand, smaller farmer-owned or -operated plants will face unique challenges. While larger operations can restructure to lower costs or access capital for upgrades, smaller producers face a more uncertain future. As Genomatica refines the process for MEK and develops other chemicals to use existing ethanol infrastructure, it can offer additional product options to small producers.

MEK will offer existing plants the opportunity to transform their production from lower-value corn ethanol to higher-value chemical production.

“Using existing infrastructure like ethanol plants will allow the end-chemical customer to drive down the cost of their initial investment in sustainable chemical manufacturing,” said Gann. “Most chemical producers and consumers are looking very closely at capital costs so they are eager to use existing manufacturing assets more fully.”

The Genomatica Technology Advantage

Genomatica’s technology portfolio consists of proprietary computational modeling, “wet lab” microbe modification and specialized process engineering. With computational modeling, Genomatica’s researchers examine all possible biological pathways to create target chemicals from various low-cost, renewable feedstocks. In this case, they explored all plausible paths from glucose and sucrose to MEK,



and selected the optimal version. Researchers then used the computer models to design the ideal microbe and made all the modifications necessary to turn this design into reality.

Armed with the “blueprint,” researchers create microorganisms through traditional genetic modification. In the case of MEK, this resulted in a microbe able to produce significant amounts of MEK in a matter of only a few months. Combined with Genomatica’s understanding of biological adaptation, they can develop organisms that thrive under adverse conditions while further increasing their production of the desired chemical product. With deep experience from the traditional chemical industry, Genomatica then designs the complete process to produce the chemical and drives costly inefficiencies from every stage of the process, from raw material preparation and fermentation to separation and purification.

“With this second breakthrough, Genomatica has proven an important component of the technology: to predict and then rapidly build an organism that produces the target product,” said Jay Keasling, professor of chemical engineering and bioengineering at the University of California, Berkeley, and chief executive officer of the Joint BioEnergy Institute. “So much of what we do in biotechnology is trial and error, but this represents a unique step in the industry.”

The MEK Market

About 400 million pounds of MEK are bought and sold in the United States each year, and approximately 100 million pounds are imported from overseas. Worldwide installed capacity for manufacturing is just less than 3 billion pounds per year, and the market is broadly valued at \$2 billion per year. MEK is a non-toxic solvent used in coatings and paint, also known as butanone. MEK also acts as a processing tool for synthetic rubber and polyester resin products.

Because it is expected to be cost-advantaged against traditional manufacturing techniques for MEK, with a low-capital outlay, Genomatica’s process could allow for additional domestic production capacity of MEK to reduce imports that are derived from fossil fuels. As with Genomatica’s previously announced BDO product, the company will continue to refine and develop the process to increase the cost advantage and efficiency. Genomatica will offer a licensing model to allow other manufacturers to directly produce MEK from the process.

Continued Progress with 1,4 Butanediol

In September 2008, Genomatica announced a novel bio-manufacturing process for the production of 1,4-butanediol (BDO) from renewable feedstocks – sugar and water. Since that announcement, the company has continued to improve the process, making it more cost effective and productive.



The current strain of microbe has been improved to tolerate and continue production in a 10 percent solution of BDO. In typical bio-manufacturing processes, microbes become less effective in higher-concentration solutions. Because of Genomatica's unique adaptive-evolution method, the organism's growth and survival has instead been linked to higher production of BDO. The company is now developing the process engineering plans for a demonstration plant to bio-manufacture BDO; Genomatica expects to initiate construction of the plant later this year.