Industry’s roadmap for harnessing biotechnology for a more circular economy

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ABSTRACT

Methods and uses of biotechnology have the potential to hasten the transition to a more circular economy. This article discusses five separate times throughout a typical product lifetime where biotechnology can have an influence, beginning with the capacity to produce many commonly used chemicals and materials using renewable feedstock to minimize greenhouse gas emissions at the so-called “beginning-of-life.” This includes a discussion of innovative materials, a holistic approach to engineering for enhanced lifetime outcomes, compostability, and the possibility for reuse and up-cycling at the end of life, all of which contribute to a circular flow of materials. We suggest concrete actions that chemical and materials makers, designers, and brands may take.

Key Words: *Biotechnology; Circular economy; Bio based economy*

INTRODUCTION

Biotechnology is positioned to hasten the shift to a more circular economy. Five important times throughout a typical product lifetime will be emphasized in this article as locations where biotech can have an influence. This gives a broader perspective than focusing just on using renewable feedstock to minimise greenhouse gas emissions and our dependency on fossil-derived feedstock. These leverage points are discussed in this article, along with advice for chemical producers, product makers, and brands. While recycling and reuse are crucial components of a more circular economy, fresh, virgin-quality material is still required to supply the ever-increasing demand for commodities as a result of economic expansion. It is preferable for any such ‘new’ output to come from renewable sources like biomass, sugars, sunshine, and CO2, rather than non-renewable fossil fuels like coal or crude oil. Bio-based processes that use renewable feedstock produce better Lifecycle Analysis (LCA) outcomes than traditional processes that start with fossil-derived feedstock. Over 50% reduction in global warming potential has been observed in Genomatica’s first two commercial technologies, the production of bio-based 1,4-butanediol (BDO), which is used in plastics and spandex fibers, and the production of bio-based butylene glycol (BrontideTM BG), which is used in cosmetics.

This ‘better start-of-life’ approach is especially beneficial for chemicals and goods that are seen to be closer to the end user, such as textiles and personal care. Geomatics said in early 2020 that it has produced the world’s first ton of a precursor chemical required to build nylon-6, which is widely used in garments, carpet, and some technical plastics. This achievement received a lot of attention from the business press, social media, and possible partners, as well as receiving prizes for innovation. Many people were drawn to the value proposition of having a carpet made entirely of renewable resources. Another advantage of replacing fossil sources with renewable feedstock for the manufacturing of current monomers is the potential for a large effect across multiple product value chains. Some commonly used compounds have yearly market sizes in the millions of tons. The development of competitive bio-based methods has significant consequences for these compounds since they may be substituted “at source.” As a result, all items made with those renewable-source chemicals will get a higher sustainability rating.

Growing abilities in programming biology are exciting because they open up possibilities for building new, better-suited materials with desired qualities. Companies like Avantium and DuPont are working on novel materials that enable for thinner, lighter beverage packaging, which means less material is utilized. These material advances are aided by new methods for producing specific compounds or monomers from bio-based feed stocks, which are fundamental elements of innovative polymers and materials. As a result, a bio-sourced material with increased functional qualities and suitability for a variety of applications may be created. In the meanwhile, Bolt Threads and Modern Meadow are using biology to create materials that may be used to replace silk and leather, respectively. These innovative materials can not only save energy and minimise waste, but they can also be made from renewable resources, lowering their environmental impact (e.g. greenhouse gas emissions) and enhancing their advantages. One practical problem with these novel materials is that widespread adoption can take several years. DuPont’s Polytrimethylene Terephthalate (PTT), Nature works’ poly-lactic acid, and Novamont’s polymers are just a few of the examples. We admire and appreciate these firms for their long-term commitment to realizing their commercialization and sustainability potential. More of these kinds of examples are required all throughout the world.

To create a product with a positive consequence at the conclusion of its life cycle, we must start by designing more intelligently. Additional may be done to provide product designers with more information and support when they evaluate the usage of various materials, such as more extensive understanding of their constituents and manufacturing process (their beginning-of-life narrative), degradation or durability, and lifetime effect. Information regarding directing end-of-life alternatives, such as how to choose materials that are biodegradable when possible or, on the other hand, items with great durability and stability, should and should be supplied. Manufacturers benefit from the same sorts of data since they can influence their suppliers.

Many items are interested in composting near the end of their product life cycle, and it may provide attractive alternatives to existing products. Co-op in the United Kingdom replaced 180 million single-use shopping bags with biodegradable alternatives produced from Novamont’s Mater-Bi, as an example. It’s not unexpected that certain biodegradable materials are made utilizing bio-based techniques, which provide extra benefits by reducing the production-related environmental footprint by using renewable feed stocks. PLA, such as Ingeo from Nature Works and Mater-Bi from Novamont, are examples of biodegradable materials. Compostable items also serve as a reminder of the complexities of sustainability. Some customers have been heard advocating for things that would decompose naturally. While this may appear to be a simple concept, we should not overlook the significant societal benefits of materials that rely on industrial composting facilities instead; they can provide significant societal benefits when targeted at regions with appropriate and well-implemented community-wide collection systems.

The return of waste materials into the overall flow of materials is perhaps

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the most crucial and high-impact area where new technology is required. The employment of chemical processes in the conversion of Municipal Solid Waste (MSW) into methanol and ethanol by Enerkem exemplifies the growing number of technologies capturing diverse waste streams and transforming them into valuable products or feed stocks for other conversion technologies. Instead of sending garbage to the landfill, it makes sense to use it as a low-cost feedstock for new products. The sorts of trash that can be handled by upcycling (creative reuse) technology, the types of goods that can be generated, the process complexity, and cost are just a few of the main concerns that need to be answered. Too far, the majority of waste-handling operations have tried to produce fuels as end-products, such as ethanol, which has a low value in contrast to the original value of the materials. Rather than settling with down cycling of the material flows, we should be looking for strategies to transform MSWs back into virgin-quality monomers or polymers. Waste does not have to be converted back into its original elements; instead, it can be returned to the larger material fluxes, avoiding down cycling. Biology has the ability to overcome this problem by developing custom-designed organisms and technologies that can convert diverse waste streams straight into higher-value, widely-used compounds. In the transition to a more circular economy, these technologies may be able to close the loop and create new goods from old materials.

CONCLUSION

Producers of chemicals and polymers, as well as processors, brands, designers, and manufacturers of products, may all take specific steps to speed up the changeover. Manufacturers may demand larger percentages of renewables from their supply chains, research and prepare for new bio-based products, and switch to biodegradable alternatives when possible. Product designers may make more holistic material selections that consider both the beginning and conclusion of a product's life cycle. Brands have the opportunity to educate, inform, and energize their customers, as well as create clear differentiation, while providing more sustainable products – and an increasing number of brands, as evidenced by their corporate social responsibility reports and other public statements, are setting bold targets for their long-term sustainability initiatives. The collaboration of all parties involved, including local governments, waste-handling organizations, and technology suppliers, can lead to the creation of a new generation of loop-closing technologies. There is much work to be done, and going forward will need a mix of many practical initiatives that every one of us can do.