Bio-Based Materials

Most industrial chemicals are from non-renewable sources, traditionally made using fossil-based raw materials. Bio-based materials, on the other hand, are created using renewable biomass sources.

These biomass sources may include plants, animals, forestry materials, waste from sugar refineries and rice processing industries, fungi, and algae. Bio-based materials, such as bio-based plastics, are categorized according to their feedstock hierarchy as first, second, and third-generation materials. There can sometimes be confusion between bio-based materials and biodegradability (the ability to be rapidly broken down by microorganisms under natural conditions)— not all bio-based materials are biodegradable, and not all biodegradable materials are bio-based.

First-Generation Bio-Based Materials

First-generation bio-based plastics are derived from food crops such as corn, soybeans, or sugarcane. Because these plastics compete with the world's food supply for land, energy, and resources, technologies involving alternative feedstocks are being developed and are encouraged when possible.[1] Intensive agriculture can cause environmental damage in many areas, including biodiversity loss and soil erosion; for some environmental impacts, such as water, land use, and eutrophication, first-generation biomass is often found to be no better than fossil fuel as a feedstock.[2]

Second-Generation Bio-Based Materials

Second-generation feedstock is generally defined as non-food crops (such as switchgrass) as well as the residues from first-generation crops. Some non-food crops may be grown on non-arable land, but others compete with food production for land and water. Residues may include sugarcane bagasse, cornstalks, or forest residues.[2] As these are byproducts, their impact is lessened compared to first-generation feedstock.

Third-Generation Bio-Based Materials

The third generation of bio-based plastics can encompass diverse kinds of feedstocks and innovative extraction technologies. These include algae—which is cultivated aquatically and so has little land use demand—whey, and municipal solid waste (MSW).[2]

Are Bio-Based Plastics Better for the Environment?

When evaluating the sustainability impact of bio-based materials, it's important to consider both the resources that are required to produce the feedstock and the potential alternative uses of the organic materials. Some waste, like residues from agriculture and forestry, can play an important role in the ecosystem when left in place, such as preventing erosion, restoring carbon to the soil, and providing wildlife habitat.[2] Additionally, certain waste may need to be shipped long distances due to the concentration of production sites (e.g., most rice husks are transported from Asia), adding to the upstream carbon footprint.

Previously unutilized waste, such as residual MSW, is an advantageous feedstock for bio-based plastics, as it solves multiple problems at once—how to dispose of the waste, how to source new materials, and how to get the most use out of our resources. A recent paper found MSW and sewage to be the preferred feedstocks for biofuel when assessed on multiple criteria, including preserving non-renewable resources and reusability of biomass.[2]

Additionally, the end-of-life treatment of the material should be considered. While not all bio-based materials are biodegradable (and vice versa), there is significant overlap between bio-based and biodegradable materials. Bio-based materials that are also biodegradable may be less likely to be recovered at the end of life. Biodegradation only takes place under certain conditions; if these are not met, the material may be disposed of in a landfill or discarded to pollute the environment. Likewise, mechanical recycling of biodegradable plastics is not typically feasible. While it may be technically possible for some materials, it requires levels of sortation and careful handling that are generally unavailable at recycling facilities—more often, biodegradable plastics are treated as a contaminant.[3]

UBQ™ as Third-Generation Bio-Based Material

UBQ™, which contains more than 50% bio-based content, is proudly part of the third generation of bio-based materials. This reflects its lack of reliance on agricultural land and other in-demand resources, as well as the ground-breaking nature of its efficient conversion technology. UBQ™ is a long-lasting bio-based material that can be disposed in existing recycling systems without damaging the recyclability of the plastics stream. The third generation of feedstock represents a significant step towards a more environmentally responsible future.

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[1] Essity; IKEA; Royal DSM; & Tetra Pak (April 2018). Renewable Materials for a Low Carbon and Circular Future. Ellen MacArthur Foundation. https://emf.thirdlight.com/link/g3v87qjjw2ut-n4id1g/@/preview/1?o

[2] Wellenreuther, C.; & Wolf, A. (2020). Innovative feedstocks in biodegradable bio-based plastics: A literature review. HWWI Research Paper, No. 194. Hamburg: Hamburgisches WeltWirtschaftsInstitut (HWWI). http://hdl.handle.net/10419/228761

[3] Fredi, G., & Dorigato, A. (2021). Recycling of bioplastic waste: A review. *Advanced Industrial and Engineering Polymer Research*, 4, 159-177. https://doi.org/10.1016/j.aiepr.2021.06.006