GREENBLUE®

FEATURE: CARBIOS

Chemical Recycling
Making Fiber-to-Fiber Recycling
a Reality for Polyester Textiles

CARBIOS: Using Enzymes to "Biorecycle" PET

CARBIOS S.A., based in Auvergne, France, has financed a multi-million euro public-private research consortium called the THANAPLAST™ project to explore enzymatic bioprocesses to "reinvent the lifecycle of plastics", specifically polyethylene terephthalate (PET) and polylactide (PLA). CARBIOS is developing three technologies: 1) a 100% biological pathway to synthesize poly D-lactic acid (PDLA) in-vivo (inside a cell); 2) a process for embedding proprietary enzymes into flexible films and rigid packaging, allowing them to fully biodegrade outside of controlled environments such as commercial composting; and 3) enzymatic depolymerization of PET into its monomers purified terephthalic acid (PTA) and ethylene glycol (EG).

CARBIOS's process for biorecycling PET starts with engineering enzymes that will selectively degrade PET materials by breaking the ester bonds holding PTA and EG molecules together that form the polymer. The process operates between 60-70°C (140-158°F) resulting in a 90% yield of monomers in approximately 40 hours. Higher yields can be obtained with more time but result in diminishing returns. CARBIOS

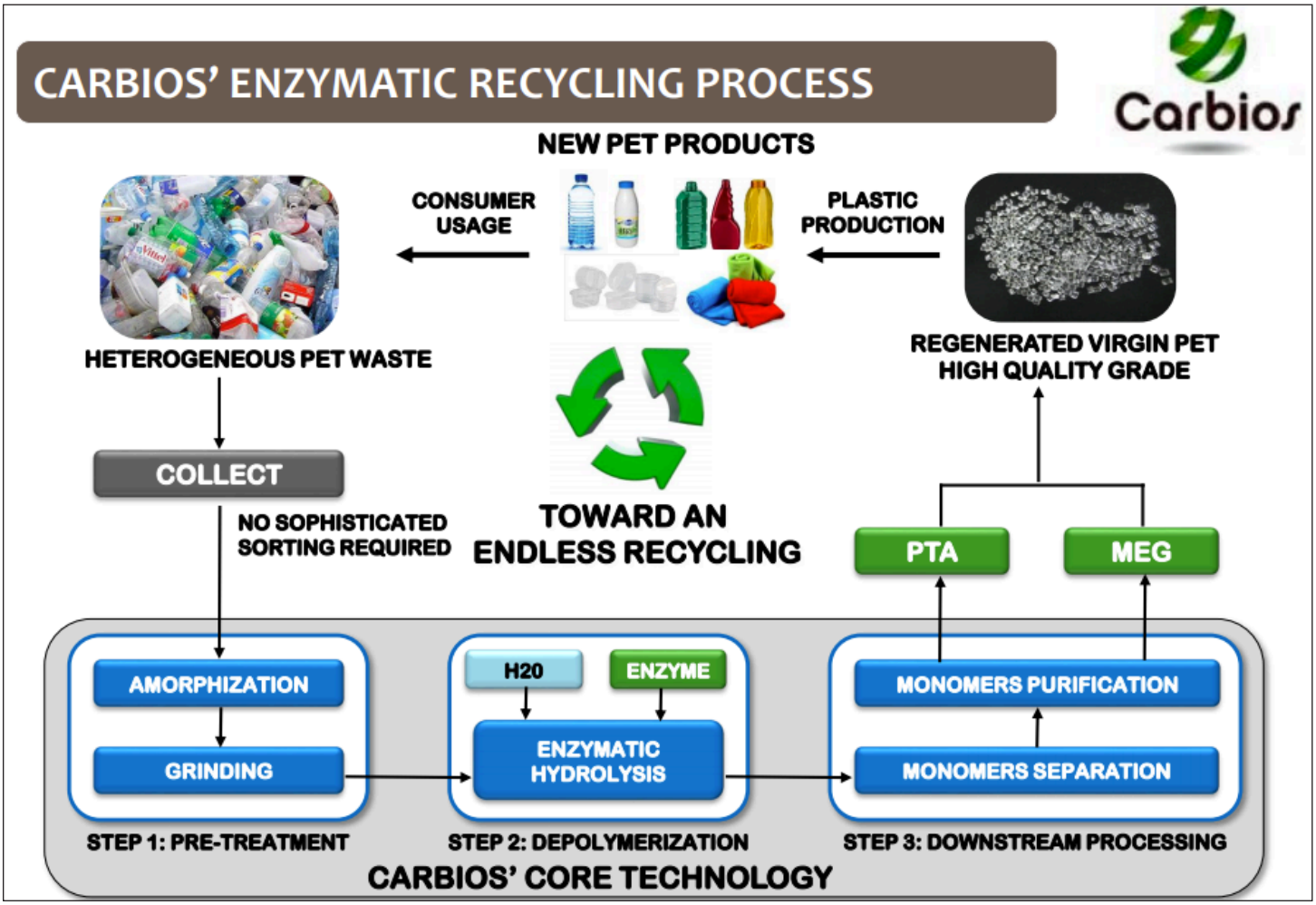

IMAGE COURTESY OF CARBIOS, 2017

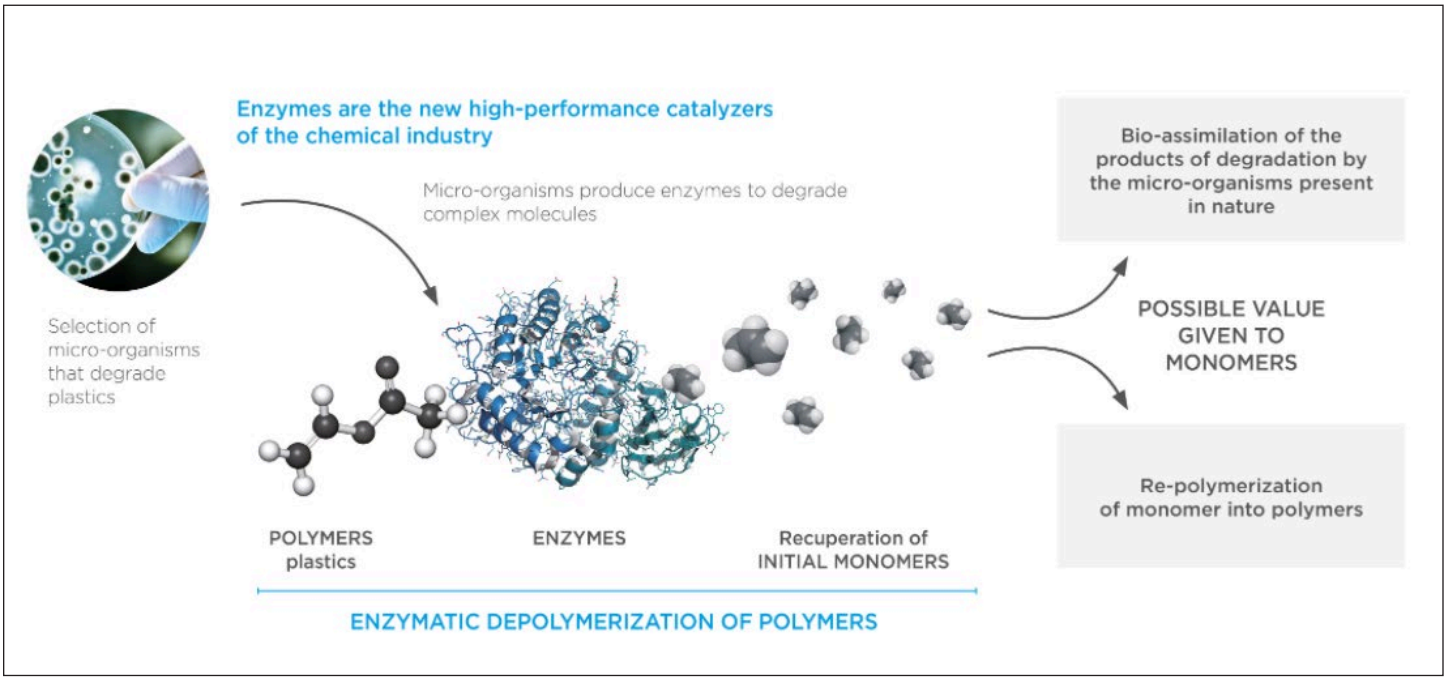

IMAGE COURTESY OF CARBIOS, 2017

is working to shorten the depolymerization residence time while boosting yield by experimenting with sequencing of enzymes and other process optimizations. Enzymatic depolymerization works for both PET textiles and PET rigid plastics. Non-PET fibers from blended fabrics are unaffected. All dyes, pigments, the catalyst antimony trioxide, and all other chemicals used as additives, backings, or finishes (e.g., durable water repellents) are also removed. All non-PET materials are treated as waste by-products and, because the process does not use any solvents, the effluent after primary treatment can be sent to a wastewater treatment facility. Solids are sent to landfills or incinerators depending on local regulations governing the location of the operation. Monomers are purified for sale to PET resin producers.

Currently, the company plans to partner with selected PET resin producers, co-locating their operations so CARBIOS's bioreactor can feed purified monomers directly into PET resin reactors to make new resin. The company is also exploring the value of locating its biorecycling facilities closer to sources of PET feedstocks in order to ship purified monomers to resin producers.

CARBIOS has successfully finished its five year R&D program. Its initial focus will be on PET packaging because there is an existing collection infrastructure for these materials and the level of material complexity is significantly less than textiles. Like other forms of chemical recycling, the CARBIOS process can help PET packaging recyclers overcome typical recycling challenges of complex, colored and opaque materials and a variety of contaminants. CARBIOS will also pilot textiles depolymerization trials, but would like to see more of a demand signal from brands and textile suppliers or extended producer responsibility regulations mandating the recycling of textiles before it makes large investments in processing these feedstocks. CARBIOS stated that it will probably require a minimum of 70-80% PET content for textile feedstocks to ensure it is profitable to biorecycle PET textiles.

The THANAPLAST™ R&D program ended June 30, 2017, after five years, on time and on budget. The path to commercialization for CARBIOS's biorecycling of PET is to scale production from its current 300 liter reactor to 3,000-5,000 liters by 2018. CARBIOS plans to include textile partners for this phase of R&D. By 2022, the company plans to build a demonstration plant with a capacity to produce 10,000-30,000 metric tons of PET monomers. Licenses will be granted worldwide after completion of this phase.