



*J. Serb. Chem. Soc.* 85 (12) S550–S558 (2020)

SUPPLEMENTARY MATERIAL TO

## Understanding bioplastic materials – Current state and trends

SANJA JEREMIC<sup>1</sup>, JELENA MILOVANOVIC<sup>1</sup>, MARIJA MOJICEVIC<sup>2</sup>, SANJA SKARO BOGOJEVIC<sup>1</sup> and JASMINA NIKODINOVIC-RUNIC<sup>1\*</sup>

<sup>1</sup>*Institute of Molecular Genetics and Genetic Engineering, Vojvode Stepe 444a, 11042 Belgrade 152, Serbia and* <sup>2</sup>*Athlone Institute of Technology, Dublin Road, Athlone, Co. Westmeath, Ireland*

*J. Serb. Chem. Soc.* 85 (12) (2020) 1507–1538

TABLE S-I. Global PLA producers

Brand name	Supplier	Material	Application	Description	Patent No
Ecovio®	BASF SE, Germany	film	versatile	Ecoflex®( fossil based) + PLA	
PLA-HI-GF10	Clariant, Switzerland	filament	3D printing	glass fiber reinforced PLA	
PLA 3D				NatureWorks Ingeo™ Biopolymer 3D850 with Clariant Hostanox® P-EPQ® and Hostavin® ARO 8	
	Danimer Scientific, US (formerly known as Meredian Holdings Group Inc. and MHG)			custom made copolymers with PLA	
RESOMER® (product range)	Evonik, Germany	pellets, filaments	medical devices	PLA/PCL, PLA/PEG, PLA composites	

\* Corresponding author. E-mail: [jasmina.nikodinovic@imgge.bg.ac.rs](mailto:jasmina.nikodinovic@imgge.bg.ac.rs)

Futero PLA	Futero, Belgium	pellets	raw material	Galactic and Total Petrochemicals join forces to create Futero, a joint venture dedicated to the production of PLA	WO 2015/086613
Bio-Flex®	FKuR, Germany	granules	raw material	PLA containing copolyester and additives	
Recycled PLA	Loopla (Galactic), Belgium	granules	raw material		WO2010118954A 1 WO2010118955A 1
ECOLOJU®	Mitsubishi Chemical, Japan	film, sheet	versatile		
BIOCRYL RAPIDE™	Mitek Sports Medicine, US		medical implants	PLA/PLGA plus $\beta$ -TCP	
Ingeo (product range)	NatureWorks, US	resin, fiber-grade resin, monofilament	raw material		US5247059A US5142023A
EarthFirst™	PACO Label, US	film	labels, packaging	Based on NatureWorks® PLA	
CornLeaf	Radici Group, Italy	fibres, nonwovens	versatile	Based on Ingeo PLA	
Sulzer PLA	Sulzer Ltd, Switzerland	pellets	raw material	Production technology was jointly developed with Purac	
EcoPlan	SK Chemicals, South Korea	film	packaging film, fiber for sanitary products		10501604
Styrex BioFoam	Synbra Technology BV, Netherlands	foam	technical products, packaging solutions		EP3053947A1
Luminy PLA (high heat, low heat, standard, PDLA)	Total Corbion, Netherlands	resin	raw material	Total Corbion PLA is a joint venture between Total (FR) and Corbion (NL). Corbion was previously called Purac.	

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PLAneo® Thyssenkrupp pellets raw material  
(different AG, Germany  
MW)

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TABLE S-II. Global PHA producers

Brand name	PHA type	Supplier	Application	Production t/year
VersaMer™ PHA	PHOHHx, PHNHHp, PHNHHpHN:HUD:	PolyFerm Canada Inc.	Raw materials (pellets, latex)	
Ecoman		Shenzhen Ecomann Biotechnology Co., Ltd. Kaneka (Japan)	Bags, printer filaments Food	75000 5000
PHBH™X131A PHBH™ X331N PHBH™ X151A	PHBV copolymers PHBHHx		packaging materials, agricultural and civil engineering materials, marine materials, etc.	
Minerv -SB™ Minerv -SC™	PHA	Bio-On, (Italy)	Automotive, beverages, electronics, foodpack, fibers, pharma	10000
Natureplast		Natureplast (France)	Agricultural applications; consumer applications	
AirCarbon™	PHA (unclear)	Newlight Technologies (USA)	Electronics, construction, apparel etc.	
Nodax™	(PHB-HH)	Danimer scientific (USA)	Detergent bottles, coffee containers, paper cups and plates, plastic bags, foam containers, baby wipes.	

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Biocycle	PHBV	PHB Industrial, (Brazil)	Veterinary applications, agricultural, packaging	10000
Biomer	PHBV, PHBH, PHBO	Biomer Biotechnol. (Germany)		
Enmat	PHBV PHBV/PLA	TianAn Biopolymer, (China)		2000
Biogreen	PHB	Mitsubishi Gas Chemical Company, Inc.	Film, bags	
TephaFLEX Mirel , Mvera	P4HB P3HB	Tepha (USA) Metabolix, (USA) Or Yield10 Bioscience	Medical materials Agricultural applications; caps; closures	50000
Hydal	Mcl-PHA	MHG Bio, (USA) Bochemie (Czech)		20
SogreenTM	Etyl 3-HB P(3HB,4HB)	Tianjin GreenBio (China)		10000
Solon		RWDC Industries (Singapore) Mango materials (USA) Full Cycle Bioplastics (USA) Bluepha Co. Ltd. (China)		4000 3000

TABLE S-III. Patents related to PHA

Patent	Year	Patent No
Method for producing polyhydroxyalkanoic acid, and microbes	2020	US2020109423A1
Method for producing polyhydroxyalkanoates (pha) from organic waste	2019	US20190360008A1
Transformant that produces PHA copolymer containing 3HH unit, and method for producing PHA	2018	WO2018021046A1
Process for extraction of bioplastic and production of monomers from the bioplastic	2016	WO2016085396A1
Method for decomposing polyhydroxyalkanoic acid, and microorganism preparation	2015	WO2015122190A1
<i>Pseudomonas</i> mutant strain and application of <i>Pseudomonas</i> mutant strain to production of (R)-3-hydroxybutyrate	2015	CN104328062A
Method of producing polyhydroxyalkanoates (PHA) from oil substrate	2014	WO2014032633A1
Green process for producing polyhydroxyalkanoates and chemicals using a renewable feedstock	2012	WO2012149162
Process for producing microbial copolyesters from sucrose- containing feedstocks	2011	EP2780461A1
Copolyester degradation bacterial strain of beta-hydroxy- butanoic acid and beta-hydroxyl radical valeric acid, and breeding method	2008	CN101245365A

TABLE S-IV. Patents related to starch and cellulose

Patent	Year	Patent No
Starch		
Addition of biodegradability lending additives to plastic materials	2019	WO2018006061A1
Biodegradable polymer composition and method of producing the same	2019	WO2020037394A1
Process for preparing biological substrate-based degradable packaging material	2018	WO2020034958A1
Biodegradable plastic	2018	WO2019155398A1
Carbohydrate-based polymeric materials	2017	WO2018125897A1
Biodegradable polymer-based biocomposites with tailored properties	2016	WO2016138593A1
Process for producing starch from microalgae	2016	WO2017130106A1
Partial shell for packaging a food product	2016	WO2018041779A1
Coated particles and methods of making and using the same	2016	WO2017091463A1
Starch/thermoplastic polyurethane (TPU) composite material	2012	CN102585485B
Cellulose		
Method for manufacturing crystal nano-cellulose	2019	WO2019221535A1
Method of producing three dimensional autologous fat graft	2019	WO2020035734A1
Process for producing a nanocelulosic material comprising at least two stages of defibrillation	2018	WO2020014762A1
Device and method for producing nanocellulose	2018	WO2020015884A1
Nanostructured polymer-based compositions	2018	WO2018187782A1
Nanocellulose-reinforced corrugated medium	2017	WO2017192476A1
Cellulose derivative and use thereof	2016	WO2017061190A1
Method for manufacturing a cellulose product	2016	WO2017160218A1
Multi-phase bacterially-synthesized-nanocellulose biomaterials	2016	WO2016113400A1
Modified bacterial nanocellulose and its uses in chip cards and medicine	2016	WO2016174104A1
Methods of producing bacterial nanocellulose from cassava bagasse	2014	WO2016029432A1

TABLE S-V. Global PBS producers

Brand name	Supplier	Application	Description	Production t/year	Patent no.
FD92 (PM/PB)	Mitsubishi Chemical Performance Polymers (MCP) Japan / PTT MCC Biochem	Barrier packaging	It is derived from natural resources such as sugarcane, cassava and corn. It is compostable at open-air landfill site in an ambient condition (30°C), without requiring a specialized composting facility.	3000	US 20180058010A1

FZ71 (PM/PB)		Coffee capsule cutlery	It is derived from natural resources such as sugarcane, cassava and corn. It is compostable at open-air landfill site in an ambient condition (30°C), without requiring a specialized composting facility.	3000	US 20180058010A1
FD72 (PM/PB)		Injection molding articles for general purpose	It is soft and flexible semi-crystalline polyester with excellent properties	3000	US 20140021574A1
FZ79AC		Paper coating	It is soft and flexible semi-crystalline polyester with excellent properties	3000	
FZ91 (PM/PB)		Coffee capsule cutlery	It is compostable at open-air landfill site in an ambient condition (30°C), without requiring a specialized composting facility.	3000	US 20180058010A1
FZ78TM		Synthetic fiber	It is derived from natural resources and It decomposes into biomass, carbon dioxide & water BioPBS FZ78TM - Natural Colored Resin (max thickness 74 microns)	3000	
Bionolle 3001 MD	SHOWA DENKO Japan	Trash bag, plant pot, filament, yarn, net, bottle, gloves, container, laminated paper, tray, comb, frame of fan and peg	Stable under ordinary conditions it becomes biodegradable in the presence of microorganism, e.g. compost, wet soil, fresh water, seawater and activated sludge.	5000	US20030015826A1

Bionolle 1903 MD	SHOWA DENKO Japan	It is an aliphatic polyester resin that has the versatility of common plastics. It becomes biodegradable in the presence of microorganism, e.g. compost, wet soil, fresh water, seawater and activated sludge.	5000	US20020094444A1
Bionolle 3020 MD		It is an aliphatic polyester resin that has the versatility of common plastics. It becomes biodegradable in the presence of microorganism, e.g. compost, wet soil, fresh water, seawater and activated sludge.	5000	US7265188B2
Bionolle 1001 MD		Stable under ordinary conditions it becomes biodegradable in the presence of microorganism, e.g. compost, wet soil, fresh water, seawater and activated sludge.	5000	WO2010151798A2
Bionolle 1020 MD		Stable under ordinary conditions it becomes biodegradable in the presence of microorganism, e.g. compost, wet soil, fresh water, seawater and activated sludge.	5000	WO2016105217A1

Eco-Solutions GP330-1	Minima Technology Co., Ltd. Taiwan	Injection process	Eco Solution GP300 is a PLA (polyactide) based alloy with PBS (Poly Butylene Succinate) and is certified as a biodegradable resin and meet ASTM D6400, EN13432		CN105152255A
Eco-Solutions GP330-S			Eco Solution GP300 is a PLA (polyactide) based alloy with PBS (Poly Butylene Succinate) and is certified as a biodegradable resin and meet ASTM D6400, EN13432		CN105152255A
Eco-Solutions GP335C			Eco Solution GP300 is a PLA (polyactide) based alloy with PBS (Poly Butylene Succinate) and is certified as a biodegradable resin and meet ASTM D6400, EN13432		CN105152255A
EnPol G4560	Ire Chemical Limited South Korea	Monofilament, multifilament	G4560 is biodegradable, aliphatic polyester based on the monomers, 1,4-butanediol and succinic acid.	3500	WO2016189228A1
Bio-Flex® S 5630	FKuR Kunststoff GmbH and Fraunhofer UMSICHT Germany	Flat sheet extrusion and injection process	Made of PLA/PBS blends	3000	N.A.



TABLE S-VI. Global Bio-PE producers

Brand name	Supplier	Application	Description	Production t/year
HDPE	Braskem Brasil	Thermoplastic s, bags, boxes	Exhibits high stiffness, low gels content, excellent appearance of films, good mechanical and optical properties.	200000
LDPE LLDPE	(producing 45 different materials)			
Terralene	FKuR Germany (producing 7 diff. mat.)	Buildings, constructions, termoplastics	Is polyethylene reinforced with 30% glass fiber, exhibits high stiffness.	20000
Cardia Biohybrid BL-F, H-F	Cardia Bioplastics Australia	Bottles, standard, bags, shopping, blow molding	Homogenous blend of thermoplastic starch (TPS) with polyethylene (PE). It is compatibilized to offer a high level of mechanical strength	
Yparex® RENEW 0H	The Compound Company Netherlands (3 diff. mat.)	Packaging, extrusion	Possesses good melt flow index, melting temperature and the level of functional groups	30000-60000
TRUCIRCL E™ MCGB Duramaze™ CC HDPE	SABIC Saudi Arabia MCG BioComposites Netherlands	Packaging food Pipes	Is a 100% recyclable linear low density polyethylene (LLDPE). Its typical size is 0.0156 inch. The product should be stored in a cool, dry, and sanitary area to achieve maximum stability.	
ParsaBio™ 6010	Parsa Polymer Sharif Iran	Injection molding, thermoplastics	Linear low density polyethylene (LLDPE) grade by Parsa Polymer Sharif.	18000
Solaplast 1312	Algix USA	Ellectronics, cellular phones, bottles	Is an ethylene vinyl acetate base resin (EVA) with food-grade aquatic biomass and an odor adsorbent.	27000
Nano4elec – BioPE EC12	Nano4 Greece	Building constructions, electrical markets, switches	Is an electrically conductive bio-based polyethylene (PE) grade.	