Showa Denko K.K.
A chemical company with
individualized products

APPLICATIONS

Mulching film | Trash bag | Plant pot | Filament | Yarn | Net |
Bottle | Gloves | Container | Laminated paper | Tray | Comb | Golf tee |
Foamed tube | Frame of fan | Peg

Bionolle™ is an **aliphatic polyester** resin that has the versatility of common plastics and is stable under ordinary conditions. Bionolle™ becomes **biodegradable** in the presence of microorganism, e.g. in compost, wet soil, fresh water, seawater and activated sludge. It will decompose completely into water and carbon dioxide, and is therefore called **"Eco-friendly material"**.

bionolle
BIODEGRADABLE ALIPHATIC POLYESTER

HISTORY

Showa Denko succeeded in the commercial production of Bionolle™ in 1993; the first commercially produced PBS-polyester in the world. Since then, we have been supplying Bionolle™ to the market and improving its quality. It is applied in a variety of applications to provide solutions to environmental issues.
To contribute to the building of a sustainable society, we have developed Bionolle™/Starch compound in 2006 and Bionolle™/Starch/PLA compound, named Bionolle Starcla™ series, in 2011. We are now advancing the development of bio-based Bionolle™.

CERTIFICATIONS

DIN CERTCO
Bionolle™ 1000 series
Bionolle™ 3000 series

OK Compost
Bionolle™ 1000 series
Bionolle™ 3000 series

GreenPla
All Bionolle™ grades

7W0164, 7W0158
compostable

Bionolle™ shows good processability towards films, sheets, filaments, laminates, molded foam products and injection-molded products. The scope of application fields is growing and it is currently used not only in agriculture but also in fishery applications, civil engineering and construction and for common household goods.

Grades

1000 SERIES (PBS) AND 3000 SERIES (PBSA)

Bionolle™ 1000 series
polybutylene succinate (PBS)
-O-$(CH_2)_4$-O-CO-$(CH_2)_2$-CO-

Bionolle™ 3000 series
polybutylene succinate adipate (PBSA)
-O-$(CH_2)_4$-O-CO-$(CH_2)_{2,4}$-CO-

MFR (g/10min)	Grade	Process
1-3	1001 MD 3001 MD	Blown film extrusion Extrusion blow molding
4-9	1903 MD	Foam extrusion
20-34	1020 MD, 3020 MD	Injection molding

Two different grades of Bionolle™ grades are commercially available. Polybutylene succinate (PBS), known as the 1000 series, and polybutylene succinate/adipate (PBSA), the 3000 series. High modulus and slow biodegradability can be seen in the 1000 series whereas the 3000 series exhibits low modulus and fast biodegradability. With specific formulations, rigidity and speed of biodegradation can be controlled.

	Bionolle™		Conventional Plastics		
	1000 series	3000 series	PP	HDPE	LDPE
Density (g/cm³)	1.26	1.23	0.9	0.95	0.92
Heat of Combustion (kJ/g)	23.6	23.9	43.9	46	46
HDT at 0.45MPa (°C)	97	69	145	110	88
Degree of Crystallinity (%)	35-45	20-35	56	69	49
Melting Point (°C)	114	94	164	130	108
Glass Transition Temperature (°C)	-32	-45	5	-120	-120

Typical properties; not to be construed as guaranteed values.

Mechanical Properties

HIGH QUALITY PRODUCT

Bionolle™ 1001 MD and 3001 MD have a MFR of less than 3 g/10 min. This makes these grades suitable for blown-film extrusion and facilitates the production of thin, high quality film by using conventional blown film extruders. Film made of Bionolle™ shows excellent mechanical properties similar to film made of LLDPE.

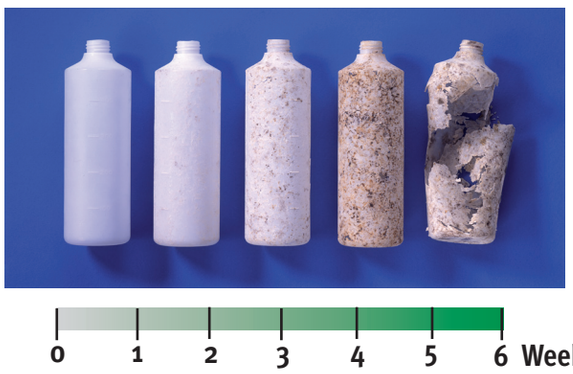
			Bionolle™		LLDPE
			1001 MD	3001 MD	
Tensile Stress at Yield (MPa)	ISO 527-3	MD	31	18	13
		TD	31	18	11
Tensile Stress at Break (MPa)	ISO 527-3	MD	62	40	43
		TD	59	45	22
Tensile Elongation at Break (%)	ISO 527-3	MD	660	780	370
		TD	710	970	420
Young's Modulus (MPa)	ISO 527-3	MD	470	320	330
		TD	540	340	370
Tear Strength (N/mm)	ISO 6383-2	MD	3.6	4.4	10
		TD	11	23	200
Impact Strength (kJ/m)	ASTM D3420		24	29	22
Heat Seal Strength (N)	SDK method*)		3.5	1.5	1.2
Haze (%)	ISO 13468-1		42	20	7

*) 120 °C, 0,2 MPa, 1 sec., 15 mm in width
Typical properties; not to be construed as guaranteed values.

Biodegradability

COMPLETELY AND SMOOTHLY

BIODEGRADATION IN COMPOST
In matured compost at 45 °C



Bionolle™ has been used for compost bags and mulching film for a long time and obtained compostability certifications from DIN CERTCO and OK Compost. This proved compostability and biodegradability of Bionolle™.

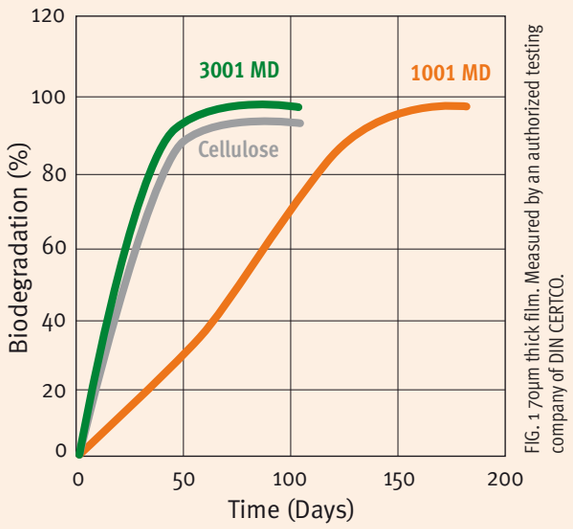


FIG. 1 70µm thick film. Measured by an authorized testing company of DIN CERTCO.

FIG. 1 IN COMPOST
Biodegradation under controlled composting conditions of EN13432. Bionolle™ shows biodegradation rates that satisfy all certifications of compostability in the world.

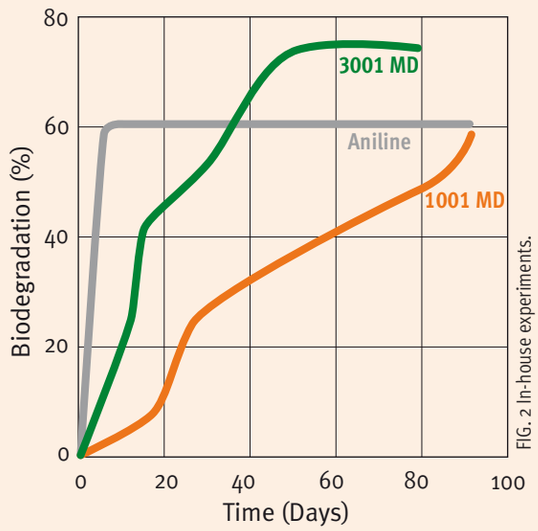


FIG. 2 In-house experiments.

FIG. 2 IN ACTIVATED SLUDGE
Biodegradation in activated sludge under conditions of ISO14851. Bionolle™ shows steady biodegradation similar to that in compost.

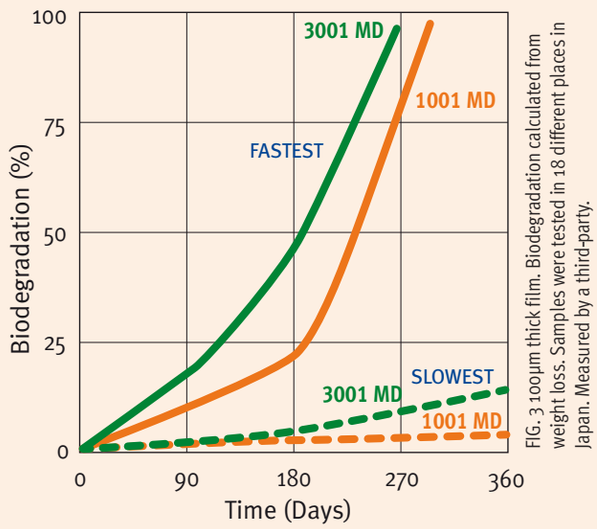


FIG. 3 100µm thick film. Biodegradation calculated from weight loss. Samples were tested in 18 different places in Japan. Measured by a third-party.

FIG. 3 IN SOIL
Biodegradation in soil under natural condition. The speed depends on temperature, humidity, fertility of soil etc.

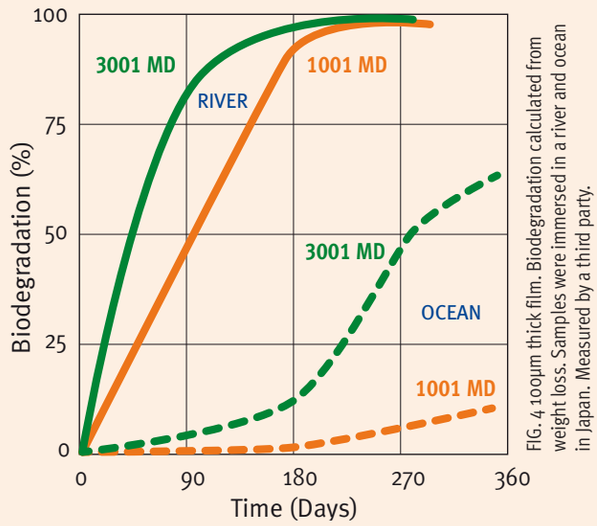


FIG. 4 100µm thick film. Biodegradation calculated from weight loss. Samples were immersed in a river and ocean in Japan. Measured by a third party.

FIG. 4 IN WATER
Biodegradation in water under natural condition. The speeds depend on conditions of water, nutrient content and so on.

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CAUTION

(1) Bionolle™ has not been approved for use in medical, cosmetics or food contact applications. Please be sure to contact our sales person in advance in case of using Bionolle™ for those applications.

(2) Rates of biodegradation vary largely by the surrounding environment and Bionolle™ may undergo hydrolysis by moisture in the air. Consequently, the mechanical properties will be deteriorated. Customers and users are requested to make their own independent determination that the products are suitable for the intended use.