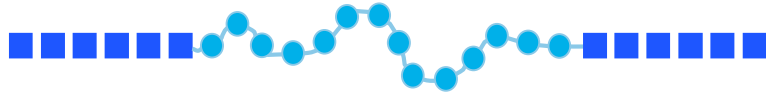


PLA (polylactic acid) / KURARITY™ compound for packaging applications

KURARITY business promotion dept.
Elastomer Division

kuraray

Advantages of KURARITY™ as a modifier of PLA



KURARITY™ as “MAM” structure
-> Made by controlled living anionic polymerization

Features of “MAM”

High polarity

Soft, Flexible

High Flow-ability

Advantages as modifier

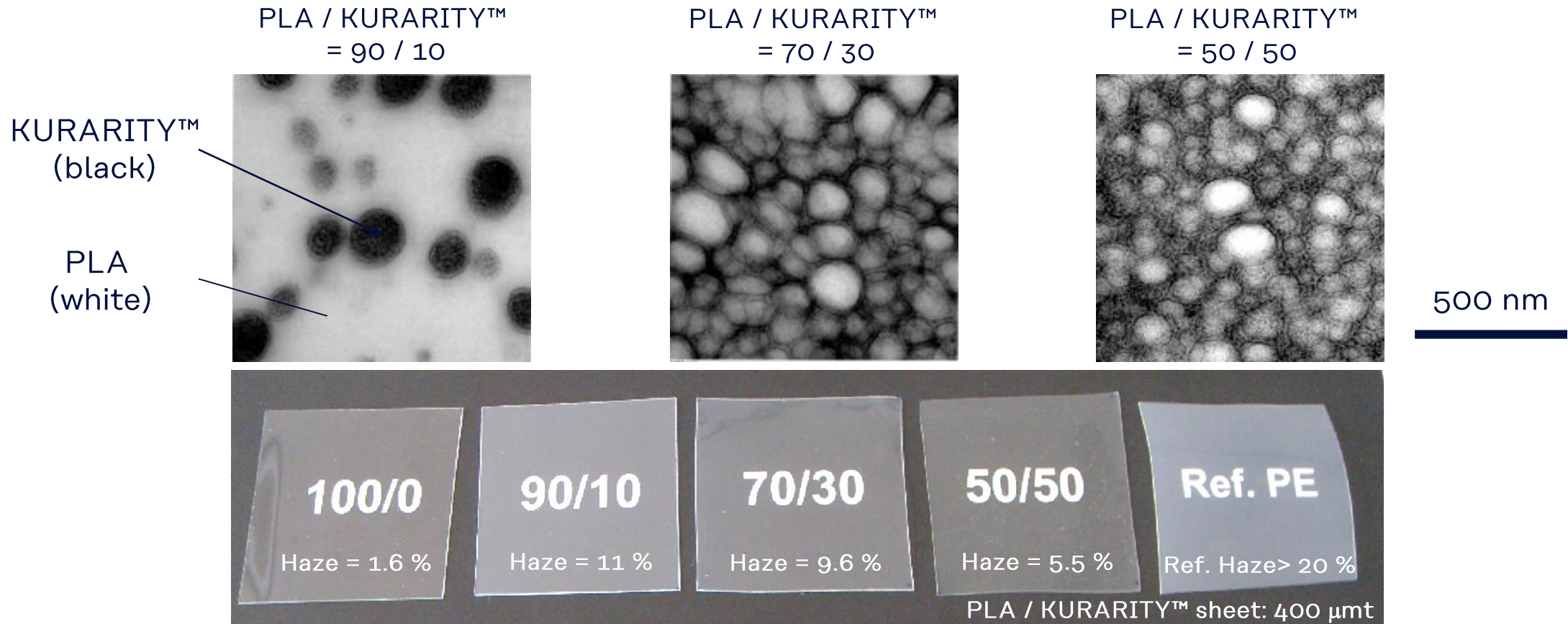
Good miscibility leads keeping transparency

Can make flexible formulation

Good heat seal ability

Excellent evaporated metal adherence

Morphology and Transparency of PLA / KURARITY™



- ✓ When KURARITY™ was added over 30 wt%, the matrix phases were consisting of KURARITY™
- ✓ PLA / KURARITY™ formulations showed better transparency compared to PE

Mechanical Properties of PLA / KURARITY™ (Injection molding)

				Ref. 1	Ex.1	Ex.2	Ex.3	Ex.4	Ex.5	Ex.6	Ex.7	Ex.8	
PLA	Extrusion grade, MFI = 6*			100	90	80	70	90	80	70	70	70	Ref: LDPE
Modifier	KURARITY™ LA2250				10	20	30				20	10	
	KURARITY™ LA4285							10	20	30	10	20	
Hydrolysis resistant	Carbodiimide type			1	1	1	1	1	1	1	1	1	
Items	Methods	Conditions	Units										
MFR	ISO 1133	200 deg.C, 2.16 kgf	g / 10 min	4.1	11	12	21	5.3	5.2	6.6	6.8	3.7	1.5
Flexural modulus	ISO 178	2 mm / min	GPa	3.5	2.9	1.7	0.4	3.1	2.8	2.6	1.2	1.9	0.18
Tensile elongation at break	ISO 527-2	50 mm / min	%	4.4	16	48	77	7.5	150	180	27	38	100
Tensile strength at break			MPa	62	54	34	23	61	55	47	50	51	13
Charpy impact	ISO 179-1	Notched	kJ / m ²	2.4	3.8	20	N.B	3.2	3.4	8.0	31	13	NB

*210 deg.C, 2.16 kgf

- ✓ By adding KURARITY™, PLA can be high flow and softer
- ✓ Ex.3 was extra flexible because the matrix phases were consisting of KURARITY™

Heat seal abilities of PLA / KURARITY™

		Ref. 1	Ex.1	Ex.2	Ex.3	Ex.4	Ex.5	Ex.6	Ex.7	Ex.8	
PLA	Extrusion grade, MFI = 6*	100	90	80	70	90	80	70	70	70	
Modifier	KURARITY™ LA2250		10	20	30				20	10	
	KURARITY™ LA4285					10	20	30	10	20	
Hydrolysis resistant	Carbodiimide type	1	1	1	1	1	1	1	1	1	
Heat seal temperature [deg.C]	Methods	Heat seal time [sec]									
80	KURARAY	2	-	+	-	-	-	+	-	-	-
		4	+	++	+	-	-	++	-	-	+
		6	+	++	+	+	+	++	+	+	+
100		2	++	++	+	-	++	++	++	+	+
		4	++	++	+	-	++	++	++	+	++
		6	++	++	++	+	++	++	++	++	++

*210 deg.C, 2.16 kgf

++: Strongly sealed , +: Sealed, -: Not sealed

Thickness: 65 μmt, Prepared by extrusion molding with T die, Molding temperature: 200 deg.C

✓ PLA/KURARITY™ compounds showed good heat seal ability except Ex.3

Mechanical Properties of PLA / KURARITY™ film**

				Ref. 1	Ex.1	Ex.7	Ex.8
PLA	Extrusion grade, MFI = 6*			100	90	70	70
Modifier	KURARITY™ LA2250				10	20	10
	KURARITY™ LA4285					10	20
Hydrolysis resistant	Carbodiimide type			1	1	1	1
Items	Methods	Conditions	Units				
Thickness	---	---	µmt	50	50	50	50
Tearing strength (MD / TD)	ISO 6383-3	100 mm / min	MPa	12 / 10	10 / 10	6 / 7	9 / 10
Tensile elongation at break	ISO 527-3	300 mm / min	%	3.8	2.3	130	47
Tensile strength at break			MPa	83	59	51	50
Tensile modulus			GPa	3.5	2.7	1.7	2.1

*210 deg.C, 2.16 kgf

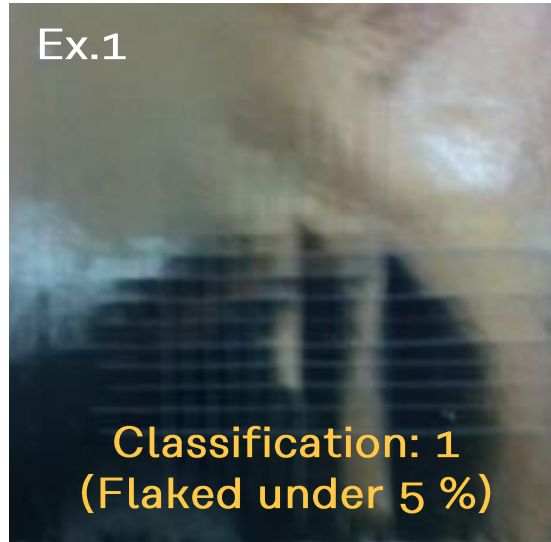
**Blow molded film

✓ By adding KURARITY™, PLA film can also be softer

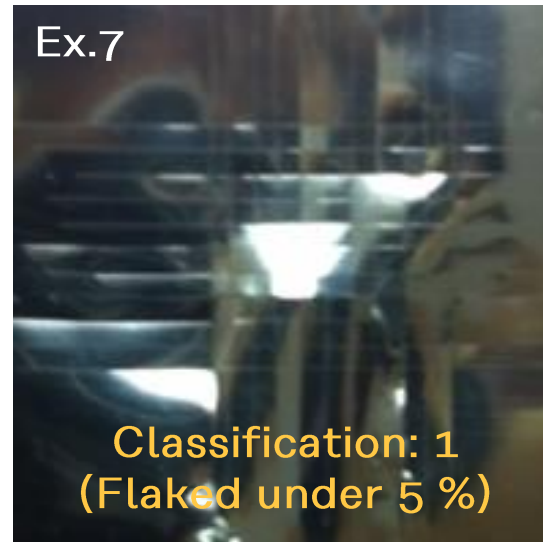
Evaporated metal adherence to PLA / KURARITY™ film (Cross-cut, T type peeling)



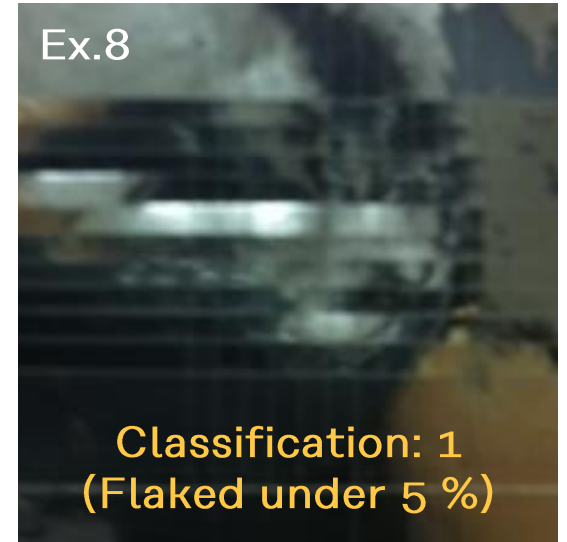
Adhesion force: 22 g / 15 mm



Adhesion force: 47 g / 15 mm



Adhesion force: 210 g / 15 mm



Adhesion force: 99 g / 15 mm

✓ PLA / KURARITY™ films showed better adherence to evaporated metal

Test conditions:

Evaporated metal: Aluminum, Thickness: 100 nm

- Adhesion test (T type peeling test): Peel speed: 250 mm / min, condition: 23 deg.C, 50 % RH

- Adhesion test (Cross-cut test): Number of cuts=10 x 10 (1 mm) (Kuraray method), Classification: 1 (excellent adhesion) - 5 (poor adhesion) (ISO 2409)

Printability of PLA / KURARITY™ film



✓ PLA / KURARITY™ film shows excellent printability.

Formulation: PLA / KURARITY™ = 70 / 30 (wt%)
Print method: Inkjet printer for house use

Typical properties (Bi-axially oriented film**)

				Ref. 1	Ex.1	Ex.2	Ex.3	Ex.4
PLA	Extrusion grade, MFI = 6*			100	86	83	80	80
Modifier	KURARITY™ LA2250				14	13	12	17
	KURARITY™ LA4285					3.3	8.0	3.3
Hydrolysis resistant	Carbodiimide type			0.50	0.43	0.42	0.40	0.40
Items	Methods	Conditions	Units					
Thickness	---	---	μm	25	25	25	25	25
Tensile elongation at break (MD / TD)	ISO 527-3	300 mm / min	%	180 / 85	140 / 140	170 / 120	130 / 110	170 / 120
Tensile strength at break (MD / TD)			MPa	95 / 92	83 / 100	74 / 94	100 / 99	100 / 98

*210 deg.C, 2.16 kgf

**T-die film: Extrusion temp.: 200 deg.C, Bi axially orientation cond.: 60 deg.C, Simultaneous, 2 x 2

- ✓ Bi-axially oriented PLA / KURARITY™ formulation showed same level tensile strength around 100 MPa and better elongation compared to those of PLA (Ref.1).

Summary

By adding KURARITY™, PLA compound shows;

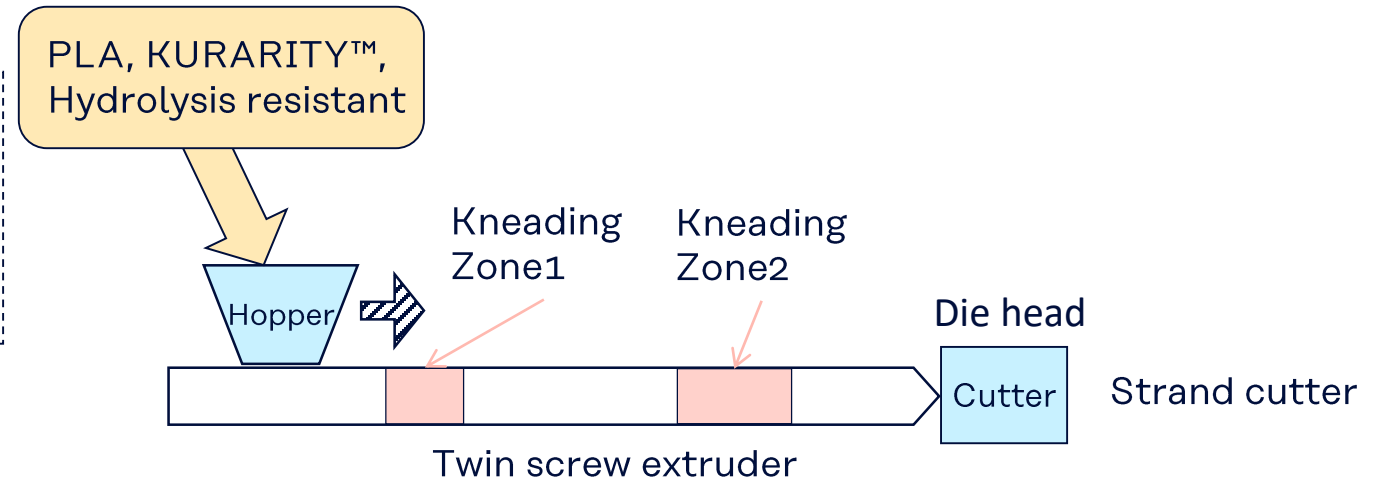
- ✓ Good miscibility which leads better transparency compared to LDPE
- ✓ Higher flow ability and more flexible than PLA
- ✓ Good heat seal ability
- ✓ Excellent evaporated metal adherence
- ✓ Excellent printability

Test compounding conditions (Ex.1 ~ Ex.8)

Equipment example

Twin extruder: ZSK 25 (Coperion)

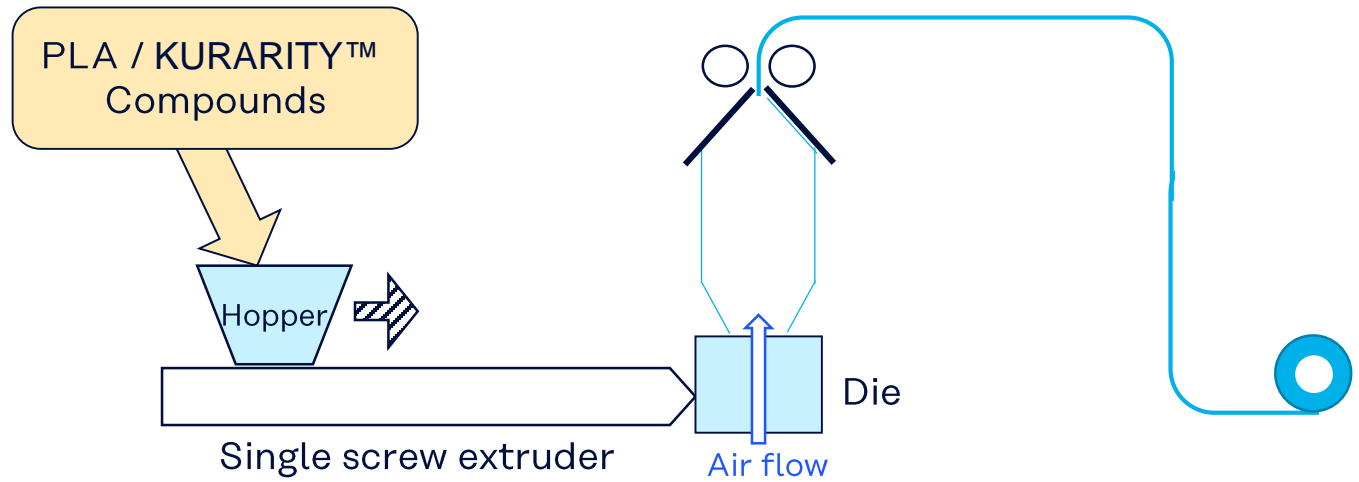
Screw: 25mmf, L/D=54



Temperature [deg.C]	C2 (hopper)	C3~C11	C12	Die head
	50	190-210	180-200	170-190
Screw rotation [rpm]	250			
Vent	Pull			
PCW temperature [deg.C]	30-50			

Test blown film extrusion conditions (Ex.1 ~ Ex.8)

Equipment example
 Extruder: Screw: 65 mmφ, L/D = 32
 Die: 150 mmφ, Lip width: 1.2 mm
 Film: 400 mm width, 50 μmt



Temperature [deg.C]	Cylinder			Die	
	C1	C2~C5	Head	D1, D2	D3
	170-190	180-200	180-200	180-200	170-190
Screw rotation [rpm]	20-25				
Production rate	30-45 [kg / hr], 10-15 [m / min]				
Air flow rate [m ³ / min]	25-35				

Kuraray Co., Ltd.
Elastomer Division
Tokiwabashi Tower
2-6-4, Otemachi
Chiyoda-ku, Tokyo, 100-0004, Japan

✉ elastomer@kuraray.com

→ www.kuraray.com

→ www.elastomer.kuraray.com

© Kuraray Co., Ltd. 2022

Precautions should be taken in handling and storage. Please refer to the appropriate Safety Data Sheet for further safety information. In using SEPTON™, HYBRAR™ and KURARITY™, please confirm related laws and regulations, and examine its safety and suitability for the application.

For medical, health care and food contact applications, please contact your Kuraray representative for specific recommendations. Even so, users must conduct their own assessment, revisions, registrations as well rely in their own technical and legal judgment to establish the safety and efficacy of their compound and/or end product with SEPTON™, HYBRAR™ and KURARITY™ for any application. SEPTON™, HYBRAR™ and KURARITY™ should not be used in any devices or materials intended for implantation in the human body. Nothing contained herein constitutes a license to practice under any patent and it should not be construed as an inducement to infringe any patent and the user is advised to take appropriate steps to be sure that any proposed use of the product will not result in patent infringement.

KURARITY is a registered trademark or trademark of Kuraray Co., Ltd.

kuraray