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AGENDA

MARCH 20 - BRUSSELS

	TECHNICAL ADVANCEMENTS	REGULATORY RECOMMENDATIONS	DIGITAL TOOLS AND STAKEHOLDERS´ RECOMMENDATIONS
11.30-12:00	**Recycled materials for automotive sector** Ainara Telleria, Cikautxo Beñat Madariaga, Maier	**PRE-1000 tool** Andromeda Scoppio, Plastics Recyclers Europe	**Sustainability Assessments & EcoProfiles** Julia Cilleruelo, GreenDelta
12:00-13:00	**Lunch Time**		
13:00-13:30	**Results from home appliances pilot: washing machine** Ainara Telleria, Cikautxo	**POPs Regulation** Ana Rita Neiva, Coolrec Mathilde Taveau, Plastics Recyclers Europe	**Digital Product Passport** Teresa Oberhauser, Circularise
13:30-14.00	**Coffee Break and Networking**		
14:00-14:30	**Food-contact solutions** Ana Rita Neiva, Coolrec.	**Food-contact Regulation for recycled plastics** Mathilde Taveau, Plastics Recyclers Europe	**Stakeolders´ engagement** Eve-Liis Roosmaa, Tallin university
14:30-15:00	**Recap for the parallel sessions and closing remarks**		
15:00-15:30	**Networking**		

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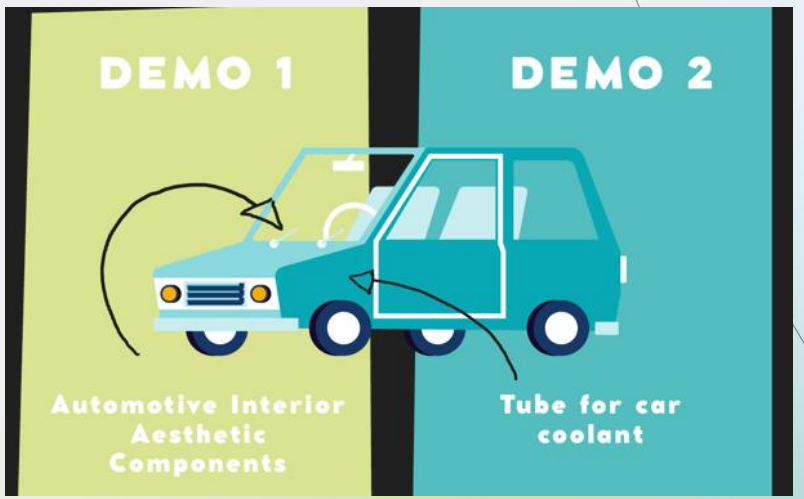
RECYCLED MATERIALS FOR AUTOMOTIVE SECTOR

DEMO 1: Automotive interior

DEMO 2: Automotive cooling circuit and its elements



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RECYCLED MATERIALS FOR AUTOMOTIVE SECTOR

OBJECTIVE

Demonstrate the possibility to use recycled materials in two different automotive applications.

Feasibility of the manufacturing processes (injection moulding and extrusion) using recycled materials.

Analyse the level of fulfillement of the technical specifications with demonstrators with different recycled material levels.

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Ainara Telleria Echaniz

PRIMUS project
www.primus-project.eu

Material development for fluid handling division at

cikatek
R&D and Innovation Centre

PRIMUS WP4 leader is experienced in material development for automotive industry. After a Chemical Degree, she did her masters in Applied Chemistry and Polymeric Materials followed by the PhD in Inorganic Chemistry. She is working at CIKATEK R&D and Innovation Centre for the past 8 years, developing new materials for the automotive industry, focused on the automotive cooling system and its elements.

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Beñat Madariaga Aurrekoetxea

PRIMUS project
www.primus-project.eu

R&D+I Project Leader at

PRIMUS WP4 DEMO 1 leader is experienced in managing development projects of plastic injected parts for automotive industry. He has a B.Sc. Degree in Polymer Engineering. He is working at MAIER R&D and Innovation Centre for the last 14 years, developing new finishings and applications for the automotive industry, focused on the automotive interior and exterior decorative and functional plastic parts.

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RECYCLED MATERIALS FOR AUTOMOTIVE SECTOR

Automotive interior

CONTENTS

1. Description of the Fascia-Central Console.
2. Champion formulations.
3. Manufacturing of the demonstrators.
4. Validation of the parts.

1. Description of the Fascia-Central Console.

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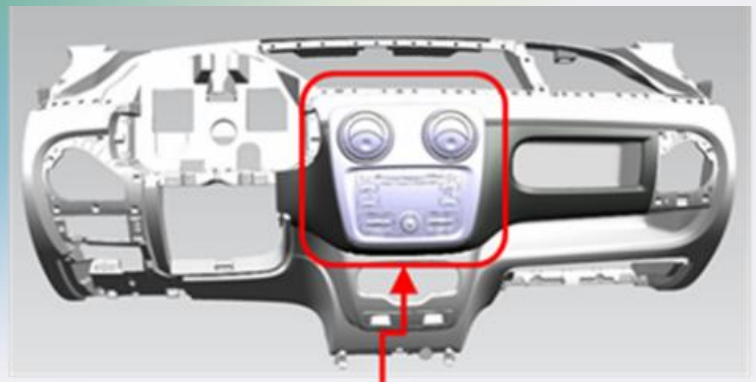
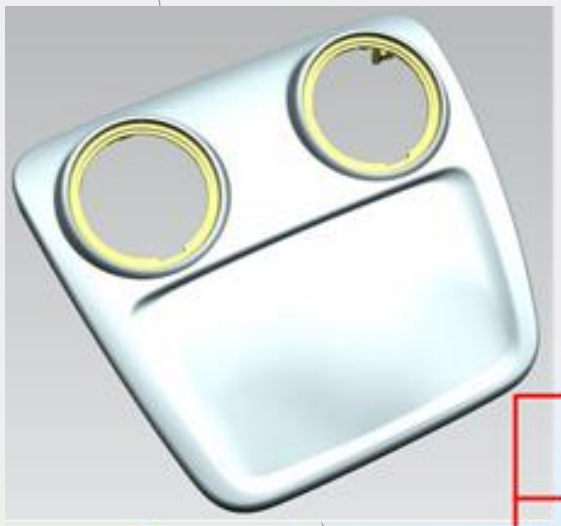
1. Description of the Fascia Central Console .

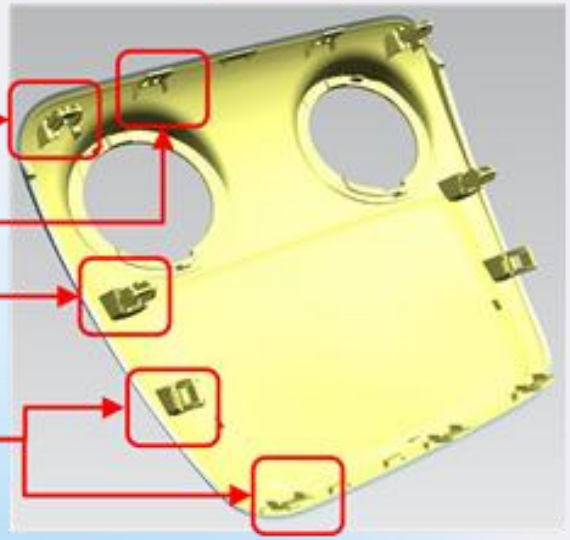


Component:	Fascia Central Console
Material:	PC+ABS Prime (Front Side)
	PC+ABS Recycled (Back Side)
Process:	2K Injection (Bi-material)
Finish:	Aesthetic (Mass coloured, Painted)
Assembly:	Dashboard, Airbag, Radio, Aerators



Fascia
Front Side
Aesthetic

Fascia
Back Side
Structural



Plastic
Clips

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2. Champion formulations.

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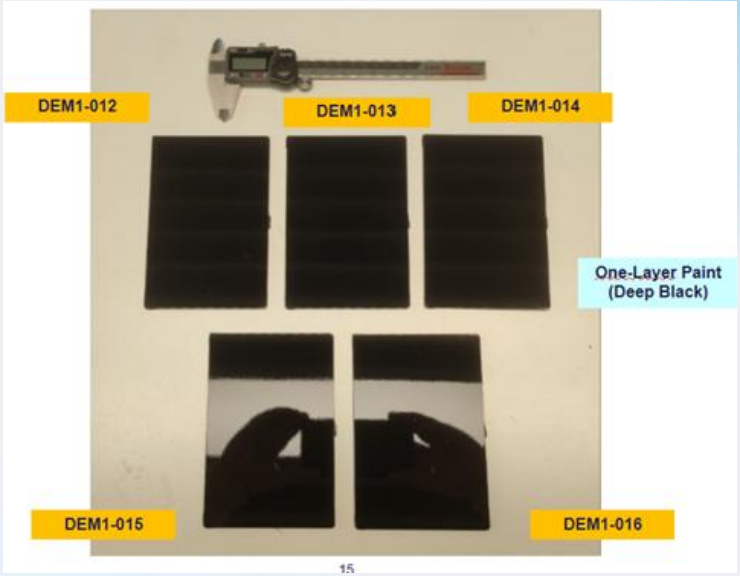
2. Champion formulations.

Samples of DEM1-012 to DEM1-016 PC+ABS Recycled materials

Type	Source	Code
PC + ABS	VTT Recycled	DEM1-012
PC + ABS	VTT Recycled	DEM1-013
PC + ABS	VTT Recycled	DEM1-014
PC + ABS	VTT Recycled	DEM1-015
PC + ABS	VTT Recycled	DEM1-016



Preparation of 2D sample plates

Surface energy (contact angle test) tested on 2D samples.

Formulation DM1-013 (MTC 612) has been selected for 3D injection molding.

50kgs produced and tested.

Variants	Results							
	Contact Angle				Total Surface tension			
	1	2	3	Av.	1	2	3	Av.
DM1-012-MTC 611	82,084	76,016	78,465	78,855	34,180	37,985	36,440	36,202
DM2-013-MTC 612	71,686	75,174	82,333	76,398	40,665	38,520	34,025	37,737
DM1-014-MTC 613	80,733	86,490	82,651	83,291	35,025	31,420	33,510	33,318
DM1-015-MTC 614	83,162	84,751	83,086	83,666	33,500	32,510	31,990	32,667
DM1-016-MTC 615	85,302	82,029	83,621	83,651	32,165	34,215	33,215	33,198

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3. Manufacturing of the demonstrators.

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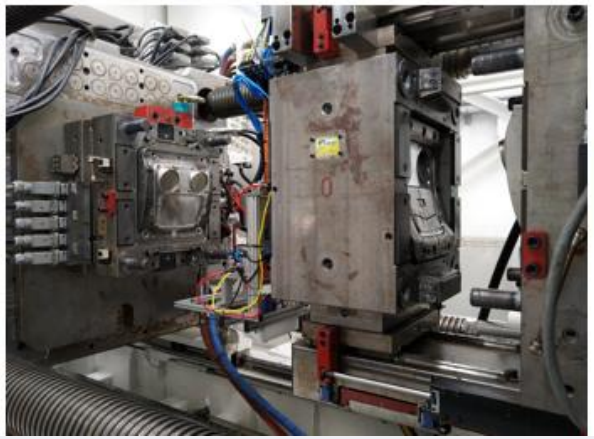
3. Manufacturing of the demonstrators.

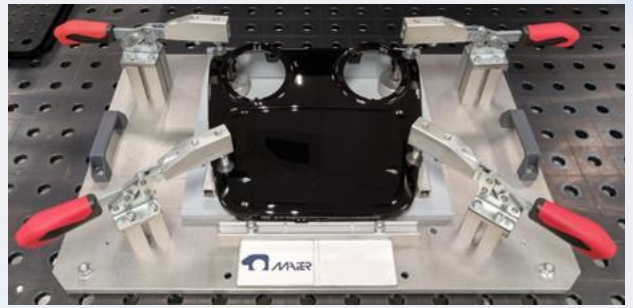
Injection



Moving Half (Left)
Rotating Half (Right)

Painting

Assembling



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3. Manufacturing of the demonstrators.

Trial			A (Prime + Prime)		B (Prime + Recycled)		C (Recycled + Recycled)	
Date			04-05-22		04-05-22		02-09-22	
Project			IDI0073		IDI0073		IDI0073	
Part	Code		7791U100		7791U100		7791U100	
	Name		15A1130 Fahada		15A1130 Fahada		15A1130 Fahada	
	Finishing		Pulido		Pulido		Pulido	
Material	Code		PLA00072	PLA00072	PLA00072	DEM1-013	DEM1-013	DEM1-013
	Type		PC+ABS	PC+ABS	PC+ABS	PC+ABS	PC+ABS	PC+ABS
	Name		BAYBLEND	BAYBLEND	BAYBLEND	Recycled	Recycled	Recycled
	Grade		T65XF	T65XF	T65XF	VTI	VTI	VTI
	Colour		BK 901510	BK 901510	BK 901510	BK	BK	BK
Pre-Drying	Equipment		Piovan HR200		Piovan HR200		Piovan HR200	
	Silo							
	Time	(h)	4	4	4	4	4	4
	Temperature	(ºC)	80	80	80	90	90	90
Injection Moulding Ma	Equipment		E700 Multitech		E700 Multitech		E700 Multitech	
	Code		I07077		I07077		I07077	
	Injection Unit		1	1	1	3	1	3
	Screw Diameter	(mm)	70	70	70	55	70	55
	L/D Ratio		22	22	22	20	22	20
	Max. Capacity	(cm^3)	1.500	1.500	1.500	511	1.500	511
Mould Temperature								
Fixed Half	Equipment		Frigel		Frigel		Frigel	
	Code		ATE0151		ATE0151		ATE0156	
			1		1		1	
	Set	(ºC)	80		80		70	
	Actual	(ºC)						
Rotating	Equipment			Frigel		Frigel		Frigel
	Code			ATE0151		ATE0156		ATE0156
				1		2		2
	Set	(ºC)		80		70		70
	Actual	(ºC)						
Moving Half	Equipment		Frigel		Frigel		Frigel	
	Code		ATE0156		ATE0156		ATE0156	
			2		2		2	
	Set	(ºC)	65		65		70	
	Actual	(ºC)						
Injection	Injection Unit		1	1	1	3	1	3
	Screw Rotation	(m/s)	0,25	0,25	0,25	0,25	0,25	0,25
	Backpressure	(bar)	20,00	20,00	20,00	20,00	20,00	20,00
	Stroke (Shot Size)	(cm^3)	270,00	270,00	270,00	270,00	270,00	270,00
	Dossing Delay	(s)	1,00	1,00	1,00	1,00	1,00	1,00
	Dossing Time	(s)	7,14	7,14	7,14			
	Switchover position	(cm^3)	50,00	50,00	50,00	70,00	70,00	70,00
	Cushion	(cm^3)	48,93	48,93	48,93			
	Injection Speed	(cm^3/s)	70,00	70,00	70,00	100,00	100,00	100,00
	Injection Pressure (Limit)	(bar)	1.500,00	1.500,00	1.500,00	1.900,00	1.900,00	1.900,00
	Injection Pressure (Max)	(bar)	971,00	971,00	971,00	1.460,00	1.460,00	1.460,00
	Injection Filling Time	(s)	3,45	3,45	2,09	2,09	2,09	2,09
	Holding Pressure	(bar)	400,00	400,00	400,00	400,00	400,00	400,00
	Holding Pressure Time	(s)	8,00	8,00	8,00	8,00	8,00	8,00
	Cooling Time	(s)	30,00	30,00	30,00	30,00	30,00	30,00
	Cycle Time	(s)						
Melt Temperature	Injection Unit		1	1	1	3	1	3
	Nozzle	(ºC)	260	260	260	270	270	270
	T1	(ºC)	250	260	260	270	270	270
	T2	(ºC)	250	250	250	260	260	260
	T3	(ºC)	250	250	250	260	260	260
	T4	(ºC)	240	240	240	250	250	250
	T5	(ºC)	240	240	240	250	250	250
	Hopper	(ºC)	70	70	70	50	70	50
Hot Runner	Injection Unit		1	1	1	3	1	3
	M1	(ºC)	260		260		270	
	M2	(ºC)	260		260		270	
	M3	(ºC)	260		260		270	
	M4	(ºC)	260		260		270	
	M5	(ºC)	260		260		270	
	M6	(ºC)	260		260		270	
	M7	(ºC)	260		260		270	
	M8	(ºC)	260		260		270	
	M9	(ºC)	260		260		270	
	M10	(ºC)	260		260		270	
	M11	(ºC)		260		270		270
	M12	(ºC)		260		270		270
	M13	(ºC)		260		270		270
	M14	(ºC)		260		270		270
	M15	(ºC)		260		270		270
	M16	(ºC)		260		270		270
	M17	(ºC)		260		270		270
	M18	(ºC)		260		270		270
	M19	(ºC)		260		270		270
	M20	(ºC)		260		270		270
	M21	(ºC)		260		270		270
	M22	(ºC)		260		270		270
	M23	(ºC)		260		270		270

Tri-Layer Paint (Satin Chrome)

	Code	Type	(%)
Primer	P00278	Primer	47.6
	P00350	Thinner	47.6
	P7421	Hardener	4.8
	Total		100.0
Colour		Paint	83.2
	P00052	Thinner	16.6
	P7421	Hardener	0.2
	Total		100.0
Coat		Coat	66.6
	P00350	Thinner	33.3
	P7421	Hardener	0.1
	Total		100.0

One-Layer Paint (Deep Black)

	Code	Type	(%)
Paint	P7433	Paint	71.4
	P7421	Hardener	14.3
	P00054	Thinner	14.3
	Total		100.0

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4. Validation of the parts.

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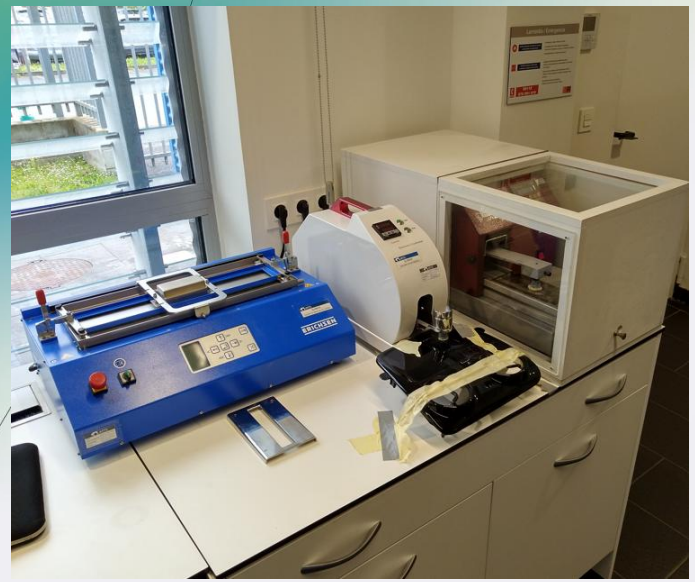
4. Validation of the parts.



Test	Standard		Code	A	B	C	A	B	C
				1 layer paint			3 layers paint		
Colour	D25 5479 / ASTM D2244		a	-1,12	-1,05	-0,07	-1,13	-1,04	-0,07
			b	-0,06	0,01	-0,25	-0,06	0,01	-0,20
Initial Adhesion	B72 0200 / D25 1075		a-b	OK	OK	OK	OK	OK	OK
Aesthetic (Visual)		Injection	0,0	0,0	0,0	0,0	0,0	0,0	0,0
		Painted	0,0	0,0	0,0	1,0	0,0	0,0	1,0
		Total	0,0	0,0	0,0	1,0	0,0	0,0	1,0
				OK	OK	OK	OK	OK	OK
Resistance to inmersion in water (Ford Tank)	B72 0200 / D27 1327	Blistering	0	0	0	0	0	0	0
				OK	OK	OK	OK	OK	OK
		Adhesion	a-b	a	a	a	a	a	a
				OK	OK	OK	OK	OK	OK
Resistance to washing with high pressure	B72 0200 / D25 5376		0,0	0,0	0,0	0,0	0,0	0,0	0,0
				OK	OK	OK	OK	OK	OK
Assessment - Overall Rating			OK	5	5	5	5	5	5
			NOK	1	0	2	1	0	2
			%	100	100	100	100	100	100

Validation tests results were improved from previous trials and it can be confirmed that recycled material versions give same results as prime material versions.

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4. Validation of the parts.

Nº	Test description	Method	Specification	A	B	C
2.2	Stiffness (5daN / 5 s / Ø14mm)	CAR03 0009	Deflection < 2 mm			
3.1	Heat ageing (22h/100ºC)	D45 1234	No change			
4.1	Impact resistance (B/1000/50/23ºC)	D42 1235	No break			
4.1	Impact resistance (B/1000/50/-30ºC)					
5.3	VOC	D45 1601	Report			
5.4	Flammability	D45 1333	<100 mm/min			
5.5	Fogging (1h / 110ºC)	D45 1727	85±5%			
	Fogging (24 h / 110ºC)					
5.6	Odour	D10 5517	Frequency of descriptor's presence <6/10			
5.7	Light resistance (WOM) (240 h)	D47 1431	≥4			
5.8	Colour fastness to rubbing (10 Cycles)	D45 1010				
	Dry		≥4/5			
	Sopay water		≥4/5			
	Technical Heptane		≥4/5			
	Essence F		≥4/5			
	Acid Perspiration		≥4/5			
	Basic Perspiration		≥4/5			
	Distilled water		≥4/5			
5.9.1	Wear by rubbing	D14 1055	≥4/5			
5.9.2	Dry abrasion	D42 1775	≥4/5			
5.10	Resistance to micro-organism in humid atmosphere (7days/40ºC/95%HR)	D47 1217				
	7 days		No Odour			
	24 h		No Micro-organism			
5.11.1	Accelerated ageing (72h/40ºC/>95%HR)	D47 1165				
		B15 5050				
5.11.2	Finished parts	B15 5050				
5.11.4	Colour fasteness to water, sea water and perspiration	D47 1020				
	Acid perspiration	B15 5050	5			
	Basic perspiration		5			
5.12	Chemical resistance (hand cream)	B62 0400				
	Nivea		≥4/5			
	La Roche-Posay		≥4/5			
5.13	Paint coatings and similar products staining	D27 5144	Colour change: 0			
	Initial adhesion	D27 1327	Adhesion: a/b			
	Adhesion after water inmersion (72h/40ºC)	B62 0400	No change			
6.3	Part fall test (1m)		No break			

Regarding functionality, there are some tests with a NOK result. Basically they are grouped in Colour fastness to rubbing and Chemical resistance (hand cream) tests. They have NOK results but for all the versions, included the prime + prime version.

This means that the result is not linked directly to the material. It seems that it is linked to a lack of maturation process that could be probably solved working on all the process (injection and specially painting & curing process).

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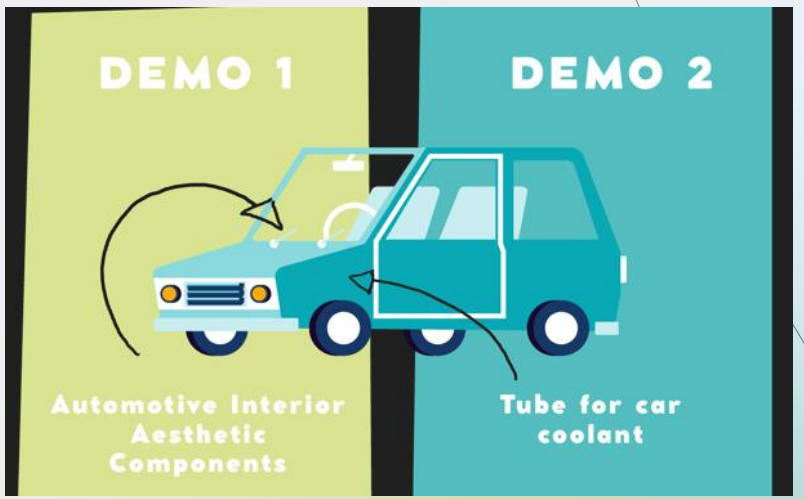
DEMO 2: Automotive cooling circuit and its elements



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RECYCLED MATERIALS FOR AUTOMOTIVE SECTOR

Automotive cooling circuit and its elements

CONTENTS

1. Components of the cooling circuit.
2. Conventional hoses and new trends.
3. Champion formulations.
4. Manufacturing of the demonstrators.
5. Validation of the parts.

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1. Components of the cooling circuit.

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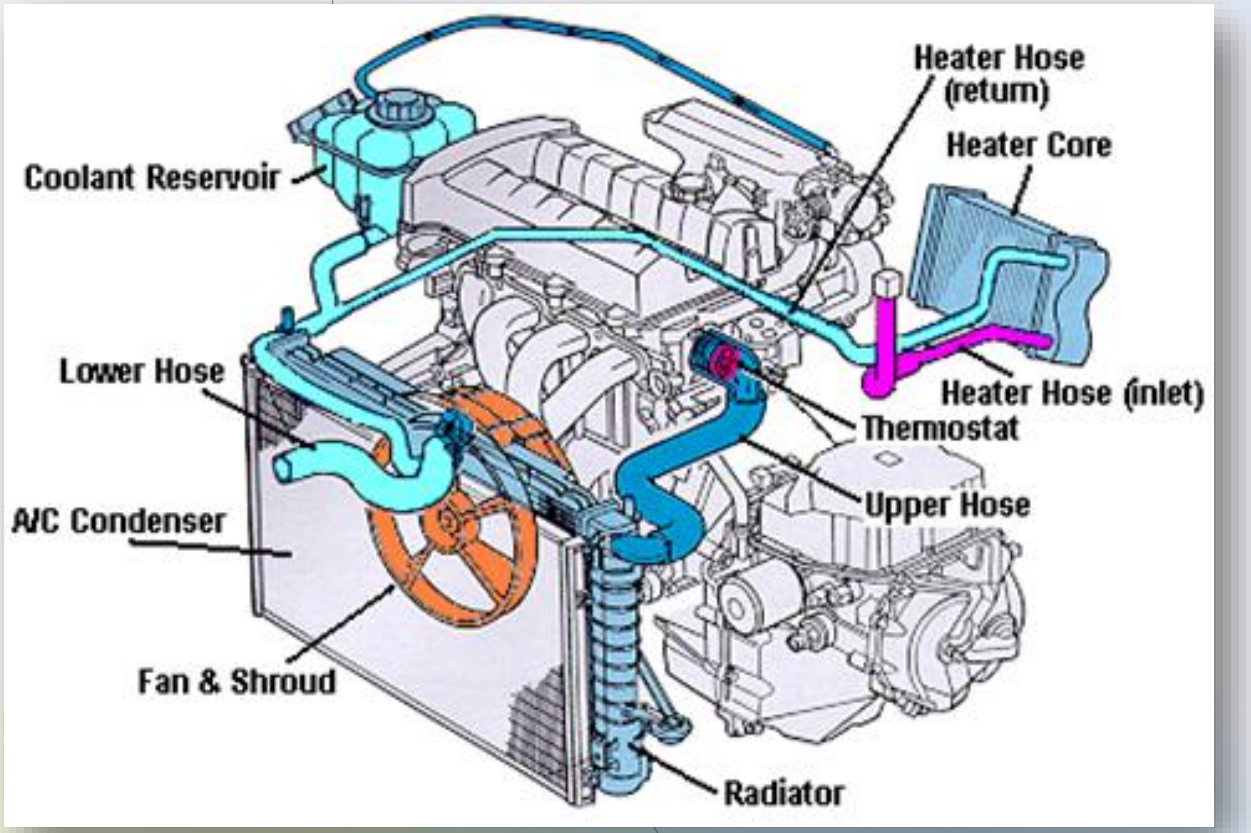
1. Components of the cooling circuit.

- Radiator.
- Water pump.
- Thermostat.
- Coolant.
- Expansion tank.
- Heater core.



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2. Conventional hoses and new trends.

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2. Conventional hoses and new trends.

Internal combustion engine (ICE).

Tmax = 135°C - 150°C

Pmax = 2.5 bar - 3.5 bar

Conventional hoses.

RUBBER / YARN / RUBBER

Electric vehicles (EV).

Tmax = 90°C - 110°C

Pmax = 1.5 bar - 2.0 bar

New trends.

THERMOPLASTIC or

THERMOPLASTIC ELASTOMERS

Advantages:

1.Recycclability

2. Weight reduction

3. Production times

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3. Champion formulations.

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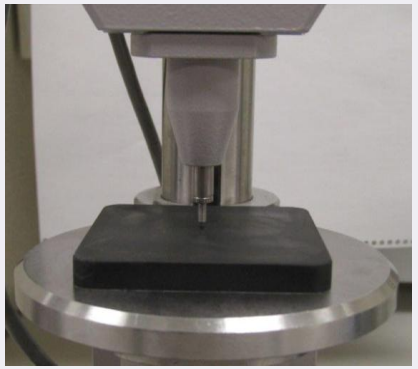
3. Champion formulations.

Formulation no.	Recycled content (%)	Hardness (ShD)	Tensile Strength (MPa)	Elongation at break (%)	MFI (g/10min)
		40 ± 5	>7	>400	1-9
DM2-008	**0**	41	13.7	440	2.4
DM2-012	**18**	38	14.7	496	10
DM2-011	**23**	38	14.0	422	14



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4. Manufacturing of the demonstrators.

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4. Manufacturing of the demonstrators.

Extrusion of pipes

Thermoforming

Assembling

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4. Manufacturing of the demonstrators.

DM2-008 (0% REC)

DM2-012 (18% REC)

DM2-011 (23% REC)

DM2- rTPV

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5. Validation of the parts.

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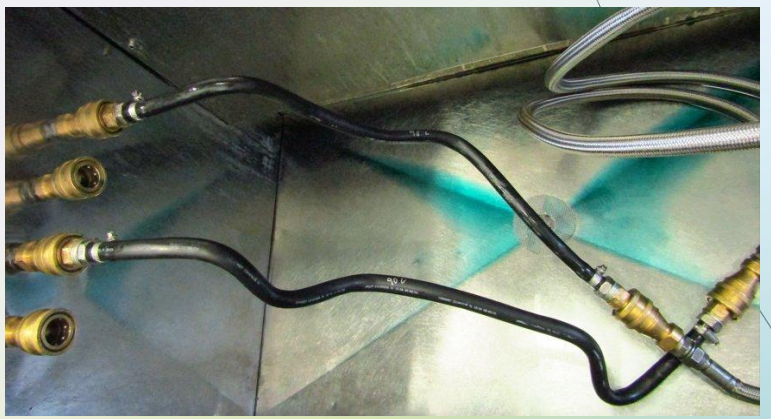
5. Validation of the parts.

BURST TEST

Formulation no.	Burst pressure at 23°C (bar)	Burst pressure at 90°C (bar)
	≥8.5	≥8.5
DM2-008	17	11
DM2-012	15	9
DM2-011	13	8.5
DM2-rTPV	16	9.5



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5. Validation of the parts.

FATIGUE TESTS

Temperature = 100°C

Pressure = 2.5 bar (100.000 cycles)

3 bar (100.000 cycles)

Duration = 5 days

Temperature = 100°C

Pressure = 1.5 bar

Duration = 2 months

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LUNCH TIME

ENJOY!

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AGENDA

MARCH 20 - BRUSSELS

	TECHNICAL ADVANCEMENTS	REGULATORY RECOMMENDATIONS	DIGITAL TOOLS AND STAKEHOLDERS´ RECOMMENDATIONS
11.30-12:00	**Recycled materials for automotive sector** Ainara Telleria, Cikautxo Beñat Madariaga, Maier	**PRE-1000 tool** Andromeda Scoppio, Plastics Recyclers Europe	**Sustainability Assessments & EcoProfiles** Julia Cilleruelo, GreenDelta
12:00-13:00	**Lunch Time**		
13:00-13:30	**Results from home appliances pilot: washing machine** Ainara Telleria, Cikautxo	**POPs Regulation** Ana Rita Neiva, Coolrec Mathilde Taveau, Plastics Recyclers Europe	**Digital Product Passport** Teresa Oberhauser, Circularise
13:30-14.00	**Coffee Break and Networking**		
14:00-14:30	**Food-contact solutions** Ana Rita Neiva, Coolrec.	**Food-contact Regulation for recycled plastics** Mathilde Taveau, Plastics Recyclers Europe	**Stakeolders´ engagement** Eve-Liis Roosmaa, Tallin university
14:30-15:00	**Recap for the parallel sessions and closing remarks**		
15:00-15:30	**Networking**		

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RESULTS FROM HOME APPLIANCES PILOT: WASHING MACHINE

DEMO 4: Washing machine seals

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RESULTS FROM HOME APPLIANCES PILOT: WASHING MACHINE

OBJECTIVE

Demonstrate the possibility to use recycled materials in home appliances pilot.

Feasibility of the manufacturing processes (injection moulding) using recycled materials.

Analyse the level of fulfillement of the technical specifications with demonstrators with different recycled material levels.

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Ainara Telleria Echaniz

PRIMUS project
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Material development for fluid handling division at

cikatek
R&D and Innovation Centre

PRIMUS WP4 leader is experienced in material development for automotive industry. After a Chemical Degree, she did her masters in Applied Chemistry and Polymeric Materials followed by the PhD in Inorganic Chemistry. She is working at CIKATEK R&D and Innovation Centre for the past 8 years, developing new materials for the automotive industry, focused on the automotive cooling system and its elements.

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Results from home appliances pilot: washing machine

CONTENTS

1. Components of the washing machine.
2. Rubber materials.
3. Champion formulations.
4. Manufacturing of the demonstrators.
5. Validation of the parts.

1. Components of the washing machine.

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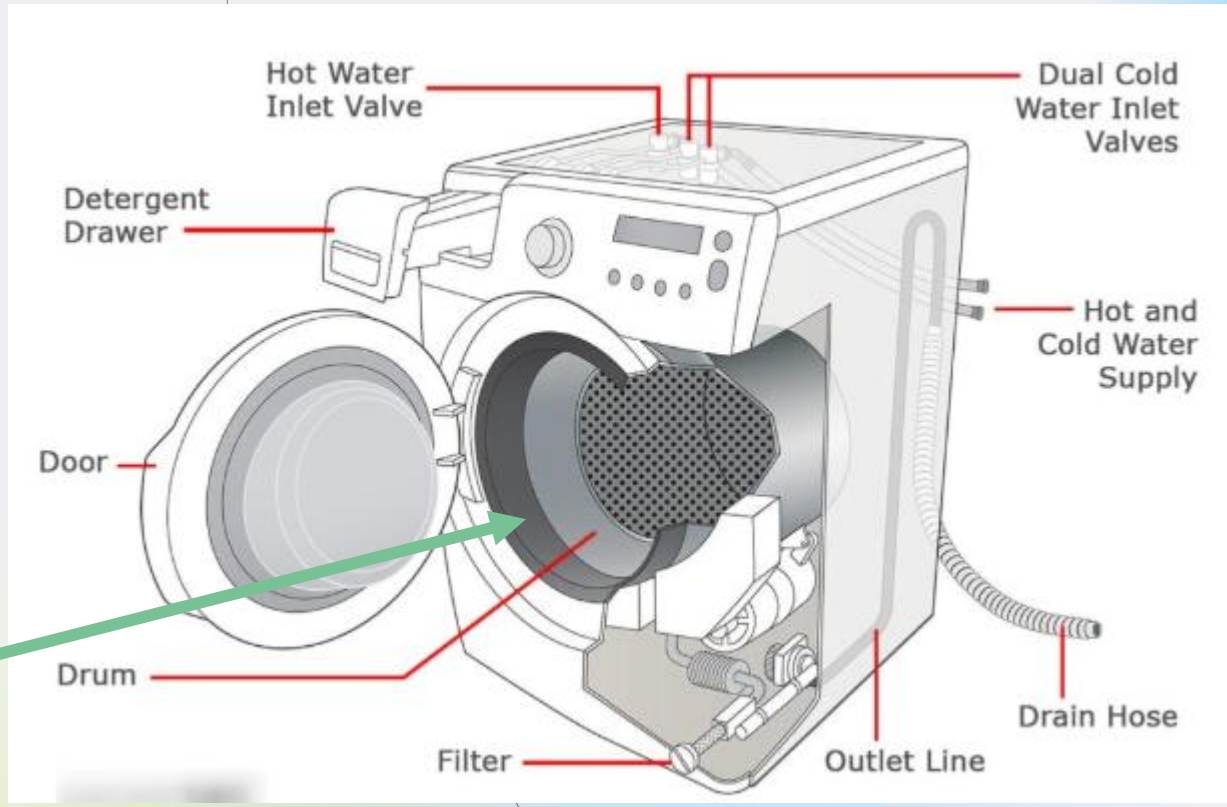
1. Components of the washing machine.

- Drum.
- Motor.
- Water pump.
- Control panel.
- Detergent dispenser.
- Drain hose.
- Door gasket.



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2. Rubber materials.

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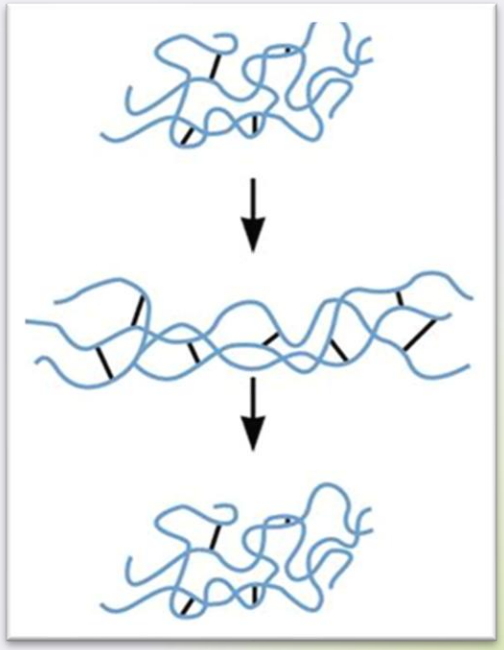
2. Rubber materials.

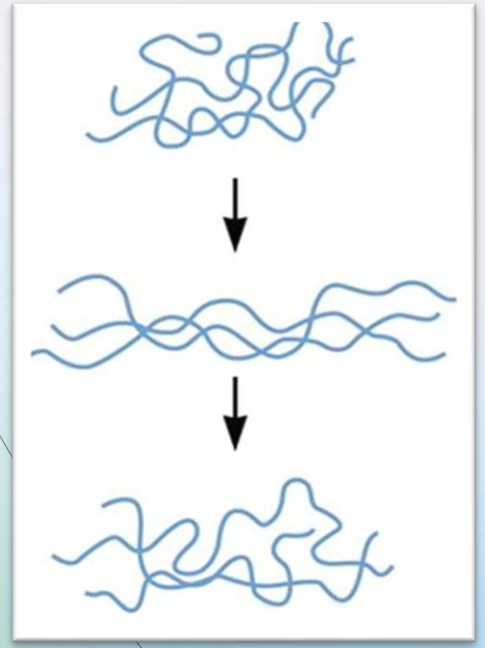
ELASTOMERS

- Crosslinked.
- Transformed into 3 dimensinal network.
- Do not flow.
- Do not have Tm.
- Elastic.



THERMOPLASTICS

- Uncrosslinked.
- Not a rigid network.
- Flow at high temperatures.
- Tm.



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3. Champion formulations.

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3. Champion formulations.

Collected end of life gaskets

Equipment used for chunking

Micronizing installation

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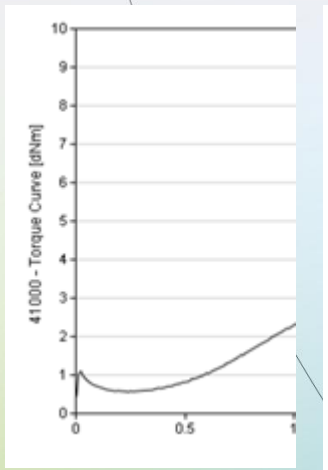
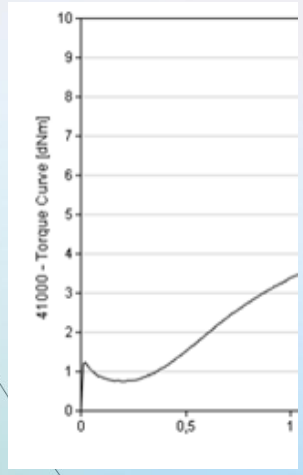
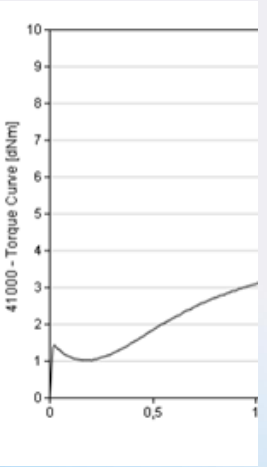
3. Champion formulations.

Formulation no.	Recycled content (%)	Hardness (ShA)	Tensile Strength (MPa)	Elongation at break (%)	ML, 1 min at 180°C
		38 ± 3	>8	>550	<1
DM4-013	**0**	37	10.3	835	0.56
DM4-010	**10**	37	9.4	754	0.75
DM4-012	**20**	38	8.2	705	1.02

Mixing instalation







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4. Manufacturing of the demonstrators.

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4. Manufacturing of the demonstrators.

Injection machine used for the production of the demonstrators

Mold used for the production of the demonstrators

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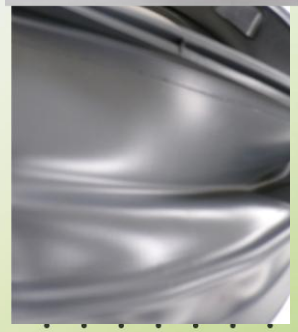
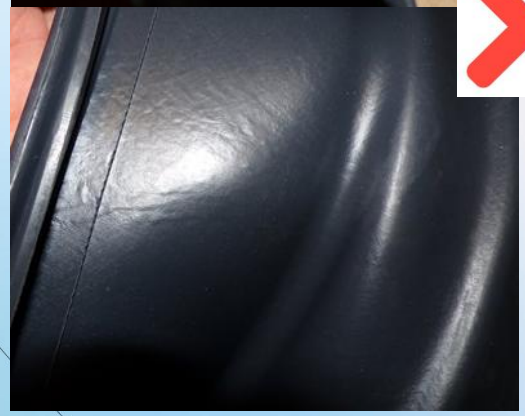
4. Manufacturing of the demonstrators.

DM4-013 (0% REC)

DM4-010 (10% REC)



DM4-012 (20% REC)



5. Validation of the parts.

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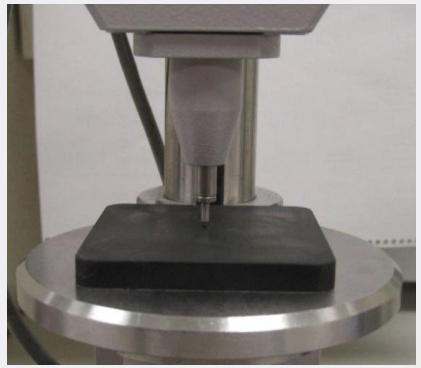
5. Validation of the parts.

MECHANICAL PROPERTIES

Formulation no.	Recycled content (%)	Hardness (ShA)	Tensile Strength (MPa)	Elongation at break (%)	Abrasion (mm^3)
		38 ± 3	>8	>550	<500
DM4-013	**0**	36	10.1	945	431
DM4-010	**10**	36	9.5	795	487
DM4-012	**20**	37	8.3	766	497



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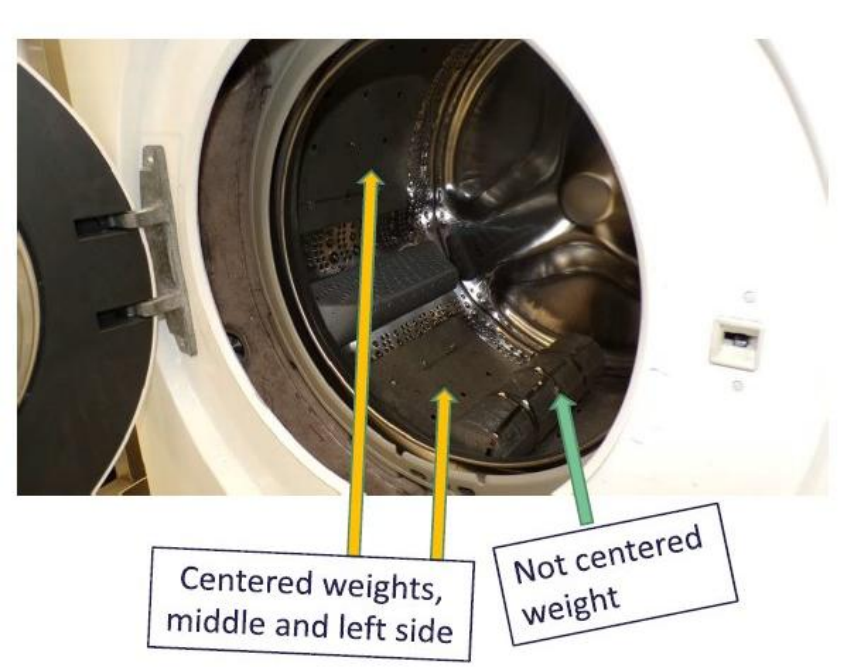
5. Validation of the parts.

DURABILITY TEST



Temperature = 23°C

Dry conditions

Speed = 240 rpm

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5. Validation of the parts.

DURABILITY TEST

Formulation no.	Recycled content (%)	Time until hole appears (h)	% of decrease
DM4-013	**0**	29	
DM4-010	**10**	27	-7
DM4-012	**20**	21	-28

Wear of the part after several hours of test but still the hole has not appeared

Hole produced as a consecuence of the durability test

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COFFEE BREAK

& NETWORKING

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Food-contact solutions

Ana Rita Neiva

Coolrec

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Ana Rita Neiva

PRIMUS project
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Plastics Engineer at

Coolrec
Part of Renewi

PRIMUS refrigerator-to-refrigerator pilot leader.
Ana holds a master's degree in Polymer Engineering and specializes in tailoring polymeric materials. During her academic research, she developed more sustainable products for food packaging and recycled plastics in automotive applications. With a career developed in the recycling sector, she currently works as a Plastics Engineer at Coolrec Plastics carrying out several innovation projects.

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FOOD-CONTACT SOLUTIONS

Break-out session

OBJECTIVE

The aim of this session is to provide a comprehensive overview of the **requirements to ensure the safety of using recycled high-impact polystyrene (rHIPS) in a new interior lining** of a refrigerator.

A case study is presented, in which **technical, food safety and migration** tests were performed. Key findings are highlighted to show future opportunities in the uptake of rHIPS from refrigerators to be used in refrigerators, contributing to a circular economy.

PRIMUS PROJECT

Work carried out

Regulatory background

Regulation (EU) No 1935/2004 sets requirements to all materials intended to come into contact with food and defines "food contact materials" (FCM).

Regulation (EU) No 10/2011 sets requirements on plastics materials in contact with food and comprises risk assessments.

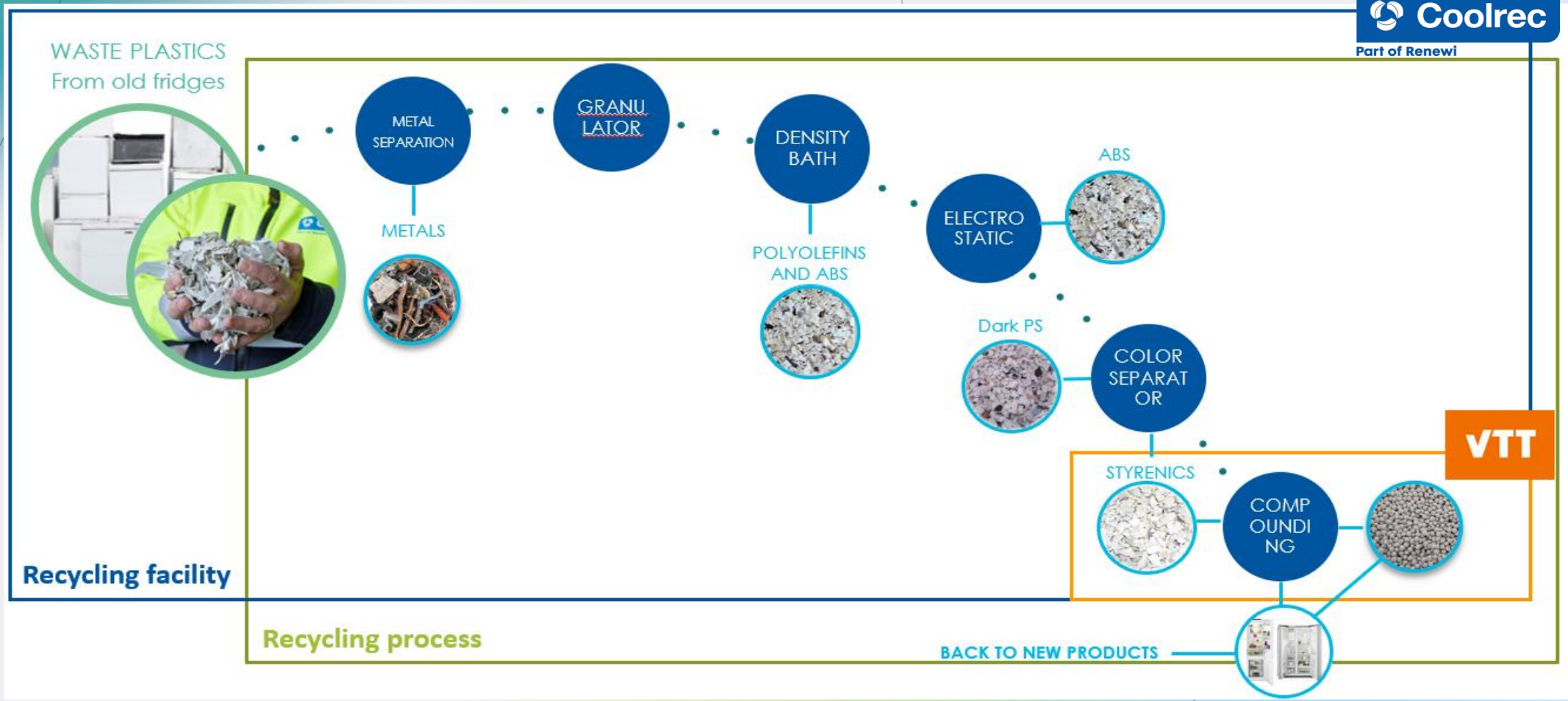
Regulation (EU) No 2022/1616 sets requirements on recycled plastics, mostly on the process itself for the control of contaminants.

Work on PRIMUS

- ❑ r-HIPS assessment and reformulation to be formed into suitable samples for food safety tests
- ❑ Upgrade material to match technical specifications
- ❑ Quantification of (Non) Intentional Added Substances (N)IAS on the input and output
- ❑ Migration testing and modelling tool (finished part – inner liner of a refrigerator)

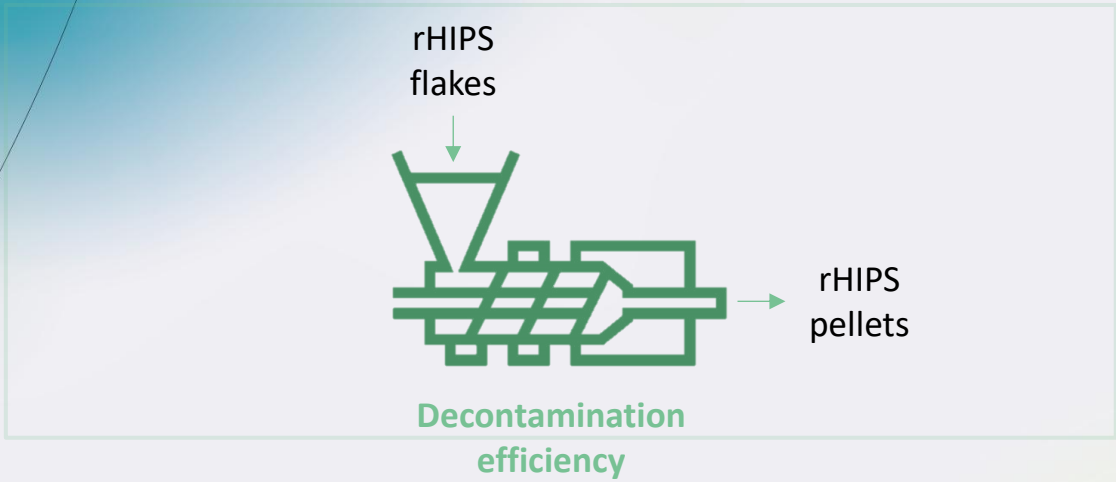
FROM OLD TO NEW REFRIGERATORS

Closing the loop



FIRST ASSESSMENT OF RHIPS FLAKES AND PELLETS

Novel technology assessment

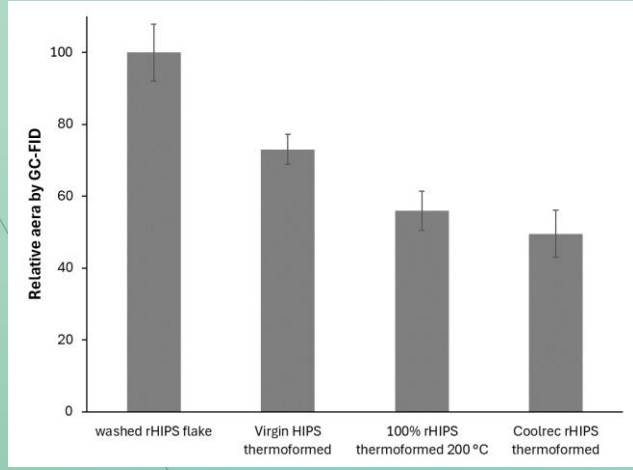


1. Sampling strategy applied (rHIPS flakes and pellets)
2. PRE-1000 methodology
3. Impact of the decontamination efficiency assessment

Key findings:

After assessing the decontamination efficiency, it was verified that thermoformed vHIPS sheets contain a higher concentration of PS oligomers than the ones made with rHIPS.

It is expected that PS oligomers are released during the long product lifetime.



MITIGATION MEASURES

Reduction of PS oligomers

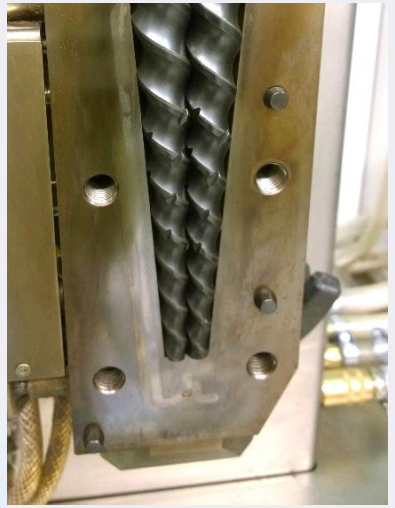
A **mitigation plan** was prepared in which different conditions could be assessed, such as:

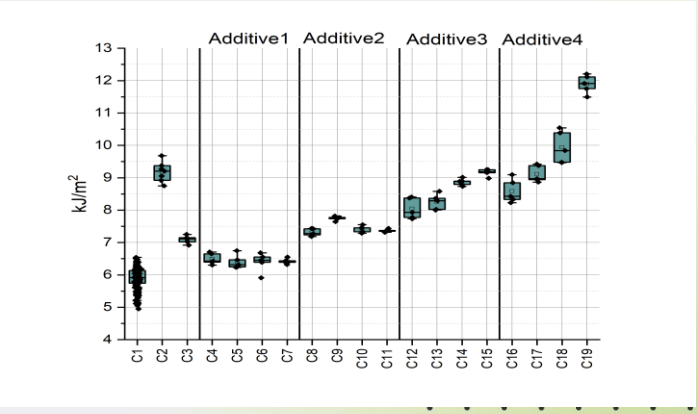
- The temperature settings and other parameters were adjusted such that the **compounding conditions were as mild as possible** to avoid thermo-mechanical degradation in the process (max 200 °C).
- **Use of antioxidants** in final formulation to reduce the amount of oligomers
- **'super cleaning' decontamination options** - Washing procedure applied to the flakes with pure water, in a high intensity mixer in room temperature, followed by incubation of the r-HIPS flakes at +100 °C/10h in an air circulation desiccant dryer. → Reduction of 70% PS trimers.
- **Vacuum degassing** of the Varex line (VTT) on the compounds.

RE-FORMULATION OF RHIPS RECIPE

Varex-line compounding

- Upgrade compounded recipes considering virgin HIPS properties
  - Washing, homogenization, compounding and mechanical characterization performed
  - Several recipes identified to boost rHIPS properties
    - Compounding with food grade TPEs to improve mechanical properties
    - Adding virgin HIPS and other additives to the compound





DEMONSTRATOR

Sheet extrusion and thermoforming

Recipes tested:

TRIAL	rHIPS	Impact modifier	vHIPS	Antioxidant	Processing T
VAREX 1	100%				220°C
VAREX 2	100%				200°C
VAREX 3	70%	12%	18%	0.1%	200°C
VAREX 4	50%	8%	42%	0.1%	200°C

→ **Recipe selected**

→ High amount of oligomers

Selection

12% food contact TPE added to reach an acceptable level of 10-15 kJ/m^2 Charpy N impact strength and increase the ESCR, **18% virgin HIPS** to boost melt viscosity, and **0.1% antioxidants** to reduce the concentration of PS oligomers generated during processing.

Pilot scale extrusion and thermoforming

After using the Varex line to produce the recipe number 3, the extruded sheets and the thermoformed samples were produced at VTT.

FOOD CONTACT SAFETY ASSESSMENT

(Non) Intentional added substances – (N)IAS

- Monitoring of (N)IAS on rHIPS flakes, rHIPS pellets and rHIPS thermoformed sheet.
- Assessment of Novel technology decontamination efficiency.
- Risk assessment through the development of a migration modelling tool. Use of several exposure scenarios for theoretical migration.
- Regulation (EU) 10/2011 and Cramer Classes are used for the toxicological evaluation of substances, allowing the establishment of limits.

Key findings:

Substances detected on the flakes were not detected on the thermoformed sheet, proving the efficiency of the decontamination technology.

Example: DEHP (phthalate)

Styrene dimers and trimers were detected in higher concentration on the thermoformed sheets than on flakes, due to degradation from thermal cycles.

The migration modelling tool showed a considerable safety margin when comparing the theoretical migrated substances with the Regulatory limits.

FOOD CONTACT SAFETY ASSESSMENT

Overall and specific migration

- Assessment of the overall migration on the rHIPS thermoformed sheet
  - Simulants A (ethanol 10%), B (acetic acid 3%) and D2 (oil) - which simulate all types of foodstuffs.

Test - simulant	Simulant	Unit	Result	Criteria	Compliance[1]
Overall migration - simulant A	10% ethanol	mg/dm^2	< 0.5 (< 0.5; < 0.5; < 0.5)	≤ 10	compliant
Overall migration - simulant B	3% acetic acid	mg/dm^2	3.0 (3.5; 3.5; 2.0)	≤ 10	compliant
Overall migration - simulant D2	Olive oil	mg/dm^2	5.5 (4.5; 6.0; 5.5)	≤ 10	compliant

[1] Commission Regulation (EU) 10/2011 on plastic materials and articles intended for contact with food, as amended (last update Regulation (EU) 2023/1627 of 10 August 2023).

- Assessment of the specific migration on the rHIPS thermoformed sheet*
  - For specific substances such as metals, intentional-added substances (*e.g.* impact modifiers, antioxidants), etc.

*Laboratory tests ongoing

Key findings:

The overall migration results were positive after assessing the three different simulants and proving the compliance required by Regulation (EU) 10/2011.

RECOMMENDATIONS

- Considerations should carefully be taken when assessing food contact safety, such as:
  - Efficiency of the decontamination technology;
    - Different reformulation options can be considered to form suitable samples – use of virgin materials as a functional barrier or mixture, antioxidants, stabilizers, etc;
    - Use of mild conditions during compounding, sheet extrusion and thermoforming;
    - Apply "super cleaning" decontamination to reduce PS trimers
    - Use melt filtration and an efficient vacuum degassing system;
  - Exposure scenarios of the final application – temperature, time, type of food in direct contact, *e.g.* fruits and vegetables, and indirect contact with material through packaging;
  - Contact area of the final application; volume of food and volume of polymer;
  - Choice of simulants;
    - Example: for migration, it is relevant to select a simulant that represents the food in direct contact (fruits and vegetables)

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THANK YOU!

ANY QUESTIONS?

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