Jindal
Nylon Films

SUSTAINABLE BOPA & CPA FILMS

- **Reducing** our carbon footprints
- **Reusing** efficiently the used nylon film
- **Partnering** for creating integrated eco-systems
- **Promote** the use of recycled and biobased plastics

WHERE WE ARE ...

Jindal Nylon Films

WATER
Since 2015
sub-irrigation permit

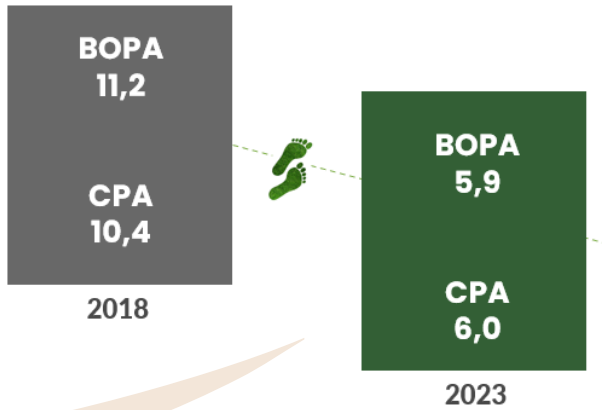
LCA study
NYLEEN™ Less is more

Since 2018

30% less of CO_2 emissions

ENERGY
Since 2020
100% renewable

PCF: kg CO_2-eq/kg film



WASTE reduction
Since 2014 BY-PRODUCT Certification

CSI PLASTIC BYPRODUCT UNI 10667-1:2017 Licence SPP140020

Since 2017
STAKEHOLDER
CEFLEX

Since 2018
Ecovadis
Assessment

OVERALL SCORE 71 / 100

GOLD 2023 ecovadis Sustainability Rating

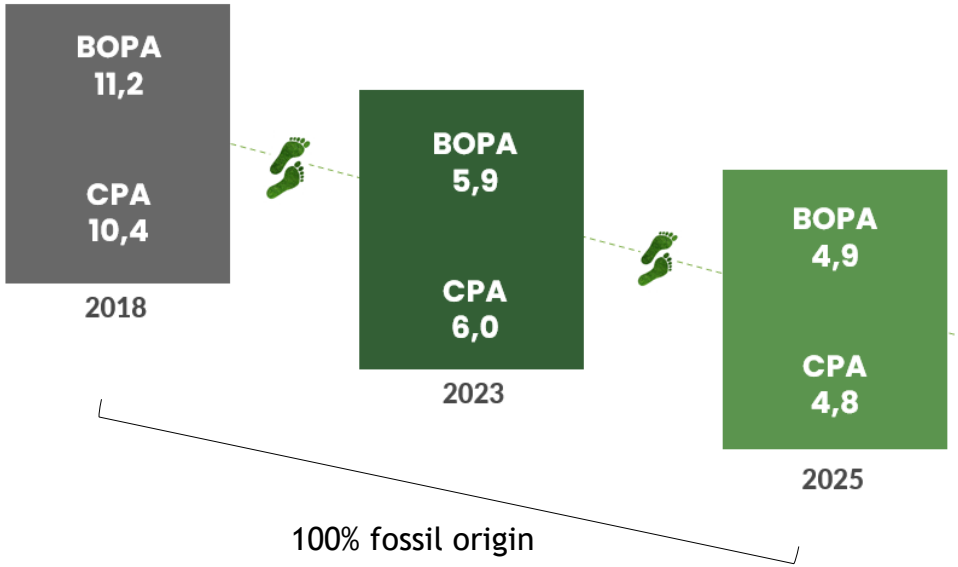
2024
ISCC PLUS
Certification

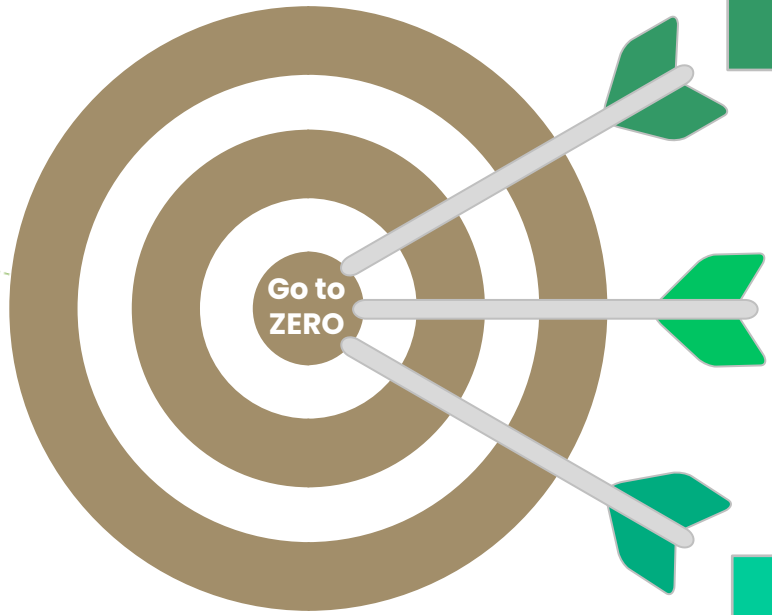
Engagement of our EU resin suppliers

Jindal Nylon Films

Product Carbon Footprint REDUCTION program

kg CO_2-eq/kg film





100% new sustainable origin

Biomass Balance*
BOPA 2,2 – 55%
CPA 2,2 – 54%

Chemical recycled*
BOPA 3,2 – 35%
CPA 3,2 – 33%

Low PCF*
BOPA 4,0 – 18%
CPA 4,1 – 14%

* ISCC PLUS Certified / Raw material data made according to ISO 14067:2008

… OUR KEY TARGETS

Jindal Nylon Films

- **RECYCLABILITY**:
  - **Recycled RM**: chemical and mechanical PIR/PCR
  - **Circularity** project: our waste to be regenerated into mechanical Recycled RM
  - Improved **FILM recyclability** through special resin grade's formulation (with compatibilizers)

- **BIO-SOLUTIONS**
  - **Bio-based** raw material
  - **Biomass Balance** solutions

- **MINIMIZATION – D4R**
  - Advanced packaging structures (New properties: High barriers, AF…)
  - Downgauging solutions

Packaging containing POLYAMIDE is RECYCLABLE

Jindal Nylon Films

COLLECTION & SORTING

Packaging containing PA can be collected and sorted as PE film

Multiple trials by the NTPC institute, to evaluate the **sorting** efficiency of the packaging, have demonstrated that the current industrial optical sorter can sort packaging **containing PA** similarly to PE

RECYCLING

Recyclability studies and Protocols

Numerous studies and certifications from **Cyclos HTP**, **APR, RecyClass** and **COTREP** have **scientifically confirmed** that PA layers in flexible multilayer packaging can be recycled

The tested PE/PA structures are compatible with the PE recycling stream having a neutral (or even beneficial) effect on the final recyclate product quality.

- All **coextruded films** (PE/PA as well as PE/PA/EVOH) with a tie layer ratio of > 0,5 g tie layer/g PA are **compatible** with **recycling** in the PE film waste stream.
- For **coextruded films**, the properties of the recyclates with higher PA concentrations can be further improved by adding a compatibilizer, enabling up to **100% recyclability**.
- **Laminated films** with PA and a PE-g-MAH compatibilizer can also be considered **recycling-compatible**, achieving 100% recyclability with specific percentages for PA content and adhesive.

BASF Chemical Recycling

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BASF's ChemCycling® business

In ChemCycling®, BASF uses **feedstock from chemical recycling of plastic waste** for its broad Ccycled® product portfolio. The recycled feedstock is attributed to the certified Ccycled® products **through a mass balance approach.**

BASF customers have successfully introduced Ccycled® products in various industries like food or medical packaging, sports and lifestyle as well as automotive. **They value the circularity contribution of chemical recycling.**

Is pyrolysis an energy-efficient technology?

Pyrolysis is a highly efficient thermochemical process carried out at temperatures between 300-700 °C.

75% **of the plastic waste can be converted into secondary raw materials.**

Source: LCA End of Life Tires by Fraunhofer UMSICHT for Pyrum

Through further processing, around 2 metric tons of plastic waste will yield 1 metric ton of new plastic.

Pyrolysis is also self-sufficient. How so?

The part of the waste that cannot be turned into oil is pyrolyzed into gas which is used to generate the energy required for the process.

Food Packaging

Südpack
Mozzarella and sausage packaging with Ultramid® Ccycled®

Vartdal / Ekornes
Fish box with Styropor® Ccycled®

STEPAC
Fresh produce packaging with Ultramid® Ccycled®

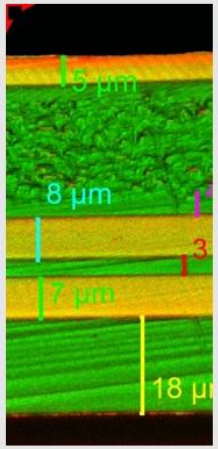
Imballagi Alimentari
Remaxigel ice-cream boxes made of Styropor® Ccycled®

SCIENCE-BASED STUDIES ON STANDARD FILMS IN THE MARKET

Jindal Nylon Films

Coextruded barrier packaging (with tie layer)

PE/tie/PA

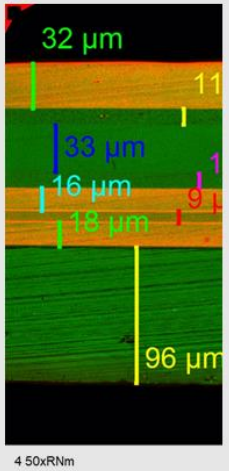


PA
Tie layer
PE
Tie layer
PA
Tie layer
PA
Tie layer
PE

Certified:
up to 30% PA6 / PA6/66 with PE-g-MAH:
recycling compatible
With additional PE-g-MAH (compatibilizer):
100% recyclable

Coextruded high barrier packaging (with tie layer)

PE/tie/PA/**EVOH**



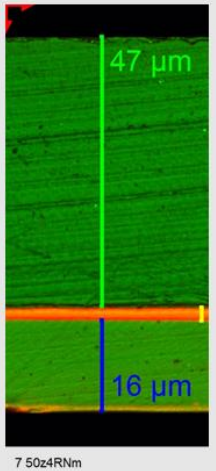
PA
Tie layer
PE
Tie layer
PA
PA
EvOH
Tie layer
PE

Certified:
up to 30% PA6 and 5% EVOH with PE-g-MAH:
recycling compatible
With additional PE-g-MAH (compatibilizer):
100%(-%EVOH) recyclable

Laminated barrier packaging with adhesives

BOPA//PE with PE-g-MAH

(BOPA = biaxially oriented PA laminated on PE Film)



PE –with PE-g-MAH
Adhesive
BOPA

Certified:
up to 23% PA6/2% adhesive/3,5% PE-g-MAH:
recycling compatible

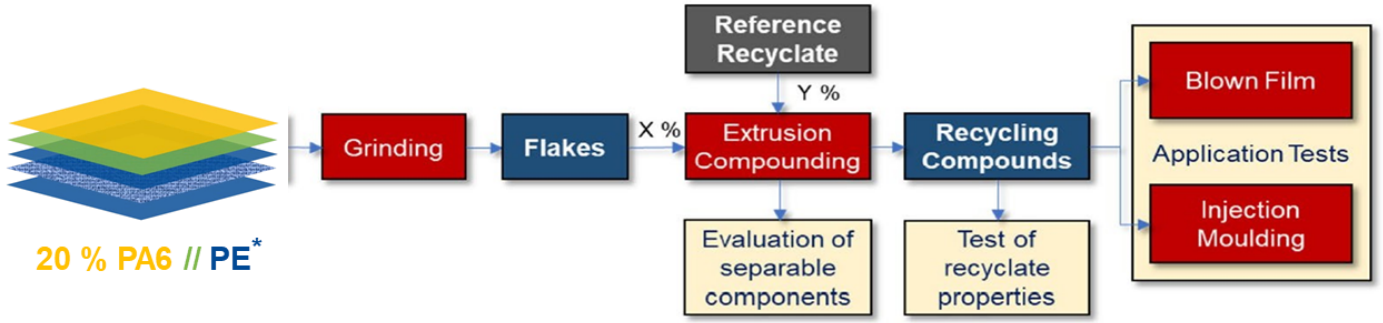
Color code of confocal microscopy: PE/tie layer/ unpolar polymere, PA (BOPA more greenish) / EVOH

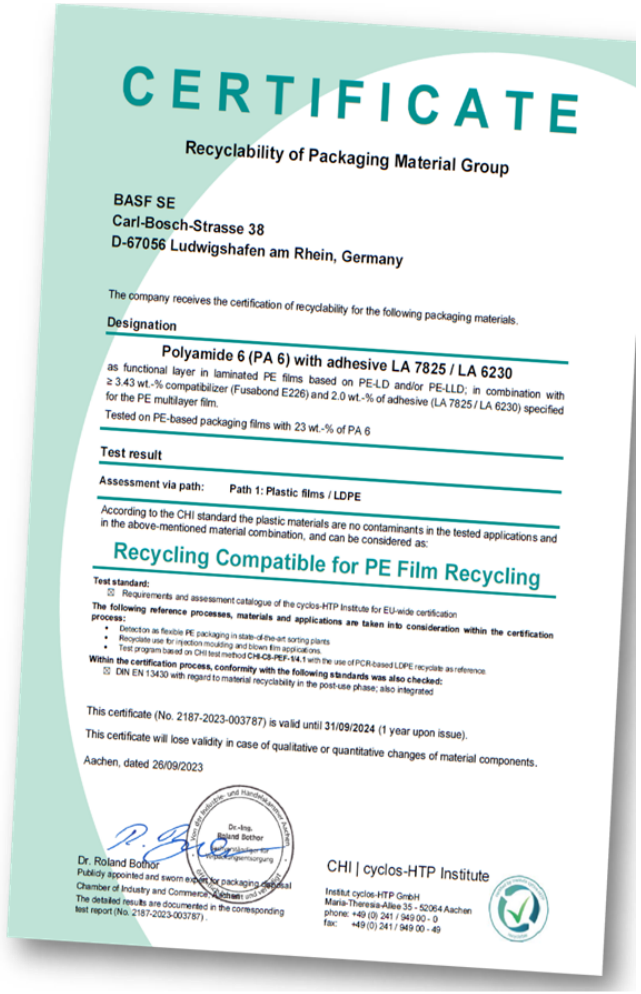
Already accepted in German minimum standard on recyclability

BASF We create chemistry

SCIENCE-BASED STUDIES ON STANDARD FILMS IN THE MARKET

Laminated PE//PA Film Recyclability





CERTIFICATE

Recyclability of Packaging Material Group

BASF SE
Carl-Bosch-Strasse 38
D-67056 Ludwigshafen am Rhein, Germany

The company receives the certification of recyclability for the following packaging materials.

Designation

Polyamide 6 (PA 6) with adhesive LA 7825 / LA 6230

as functional layer in laminated PE films based on PE-LD and/or PE-LLD; in combination with ≥ 3.43 wt.-% compatibilizer (Fusabond E226) and 2.0 wt.-% of adhesive (LA 7825 / LA 6230) specified for the PE multilayer film.

Tested on PE-based packaging films with 23 wt.-% of PA 6

Test result

Assessment via path: Path 1: Plastic films / LDPE

According to the CHI standard the plastic materials are no contaminants in the tested applications and in the above-mentioned material combination, and can be considered as:

Recycling Compatible for PE Film Recycling

Test standard:
☒ Requirements and assessment catalogue of the cyclos-HTP Institute for EU-wide certification

The following reference processes, materials and applications are taken into consideration within the certification process:
- Detection as flexible PE packaging in state-of-the-art sorting plants
- Recyclate use for injection moulding and blown film applications
- Test program based on CHI test method **CHI-CS-PEF-14.1** with the use of PCR-based LDPE recyclate as reference

Within the certification process, conformity with the following standards was also checked:
☒ DIN EN 13430 with regard to material recyclability in the post-use phase; also integrated

This certificate (No. 2187-2023-003787) is valid until **31/09/2024** (1 year upon issue).

This certificate will lose validity in case of qualitative or quantitative changes of material components.

Aachen, dated 26/09/2023

Dr. Roland Bothor
Publicly appointed and sworn expert for packaging disposal
Chamber of Industry and Commerce Aachen
The detailed results are documented in the corresponding test report (No. 2187-2023-003787).

CHI | cyclos-HTP Institute
Institut cyclos-HTP GmbH
Maria-Theresia-Allee 35 - 52064 Aachen
phone: +49 (0) 241 / 949 00 - 0
fax: +49 (0) 241 / 949 00 - 49

Results

CHI 5: all properties (mechanical, optical, processing) above or not significantly below recyclable reference:
The components PA can be considered as **Compatible for Recycling**
It requires the presence of at least 3.43% compatibilizer.

CHI30: all properties (mechanical, optical, processing) below recyclable reference :
The tested film structures without compatibilizer cannot be considered as recyclable.
The addition of compatibilizer (≥ 3.43%) into the structure has a positive effect on the compatibility of PA, especially in injection moulding → **Recyclability up to 23 % PA**

* 1 – laminated with PU adhesive
2 – laminated with PU adhesive with 0.15 g PE g MAH/ gr film

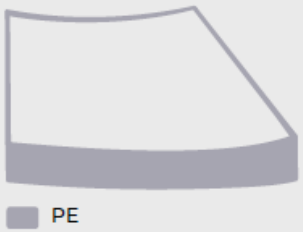
BASF We create chemistry

UBE high performance films with SUSTAINABILITY

Jindal Nylon Films

01 PACKAGING *MINIMISATION*

FROZEN SALMON

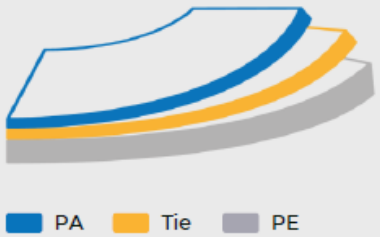


▶ CURRENT STRUCTURE
45 µm of PE

- HFFS Vacuum pack
- Attractive product due to transparent and bright film.
- Main functionality is a prevention of contamination.

▶ PROBLEMS TO SOLVE

- Reduce brakeage ratio
- Direct printing to avoid label



UBE Corporation Europe

▶ PROPOSAL
25 µm PERFORMANCE SC15

PROPERTY	METHOD	REFERENCE	PERFORMANCE SC15
THICKNESS (mm)	-	45	25
MAXIMUM LOAD (N)	ISO 527-3	9	9
PUNCTURE ENERGY (mJ)	UNE-EN 14477	3,78	5,8
SPENCER ENERGY (mJ)	ASTM D3420	270	1000

▶ BENEFITS

- 44% Thickness reduction
- Improved sealing
- 53% Increased puncture resistance
- 270% Increased Spencer energy
- Satisfactory direct printing result
- Structure approved by APR and Recyclass

UBE high performance films with SUSTAINABILITY

Jindal Nylon Films

PET PE

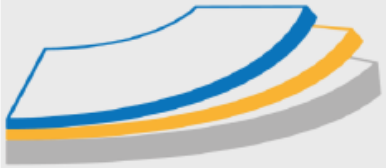
CURRENT STRUCTURE

12 µm of BOPET laminated with 90 µm of PE

- Vertical flow pack
- Printable surface
- Main functionality is a prevention of contamination

PROBLEMS TO SOLVE

- Reduce complexity
- Recyclability



PA Tie PE

UBE Corporation Europe

PROPOSAL

50 µm PERFORMANCE SC15

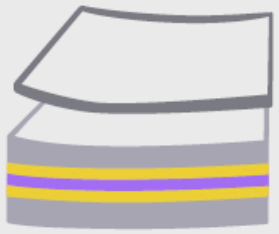
PROPERTY	METHOD	REFERENCE	PERFORMANCE SC15
THICKNESS (mm)		102	50
STRENGTH AT BREAK (MPa)	ISO 527-3	32	36
PUNCTURE ENERGY (mJ)	UNE-EN 14477	4,5	5,2
OTR (cc/m2*day)	ASTM D3985	120	200

BENEFITS

- 16% Increase strength at break
- 13% Increased puncture resistance
- 53% Thickness reduction
- Structure approved by APR and Recyclass

UBE high performance films with SUSTAINABILITY

Jindal Nylon Films



PET PE EVOH TIE

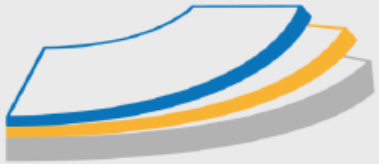
CURRENT STRUCTURE

12 µm of BOPET laminated with 90 µm of PE/EVOH

- Vertical flow pack
- Printable surface
- Main functionality is barrier to moisture and oxygen

PROBLEMS TO SOLVE

- Reduce complexity
- Recyclability



PA Tie PE

UBE Corporation Europe

PROPOSAL

75 µm MDO-PERFORMANCE SC15

PROPERTY	METHOD	REFERENCE	PERFORMANCE MDO SC15
THICKNESS (mm)		102	75
STRENGTH AT BREAK (MPa)	ISO 527-3	35/38	120/30
PUNCTURE ENERGY (mJ)	UNE-EN 14477	7	8
OTR (cc/m2*day)	ASTM D3985	40	60

BENEFITS

- 230% Increase strength at break in MD
- 14% Increased puncture resistance
- 26% Thickness reduction
- Structure approved by APR and Recyclass

THANK YOU FOR YOUR ATTENTION

Alberto Manservigi

Sustainability & NBD Direction mgr

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CERTIFIED MANAGEMENT SYSTEM
ISO 9001 - ISO 14001
ISO 45001