Latest innovations in PHA-based materials for food packaging applications such as thermoformed trays or plastic cups

ITENE RESEARCH CENTER

Hendrik Roch, María José Jiménez Pardo, Mª Amparo Verdú Solís, Miriam Gallur Blanca
hendrik.roch@itene.com

Instituto Tecnológico del Embalaje, Transporte y Logística - ITENE
C/ Albert Einstein 1, Parque Tecnológico, 46980 Paterna, Valencia, España

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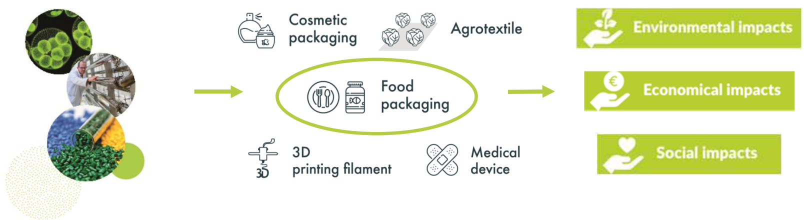
nenu2PHAr

Research objectives



Formulate and functionalise eco-designed PHA-biobased compounds for **high volume consumer** products.

Identify **processes for PHA-materials** to reach defined functional properties better than fossil-fuel counterparts.

Demonstrate the **circular economy and sustanability** of the nenu2pHAr **value chain**.

Biopolymer formulation & processing

Developments within the nenu2PHAr project will contribute, among others, to:

1 Optimisation of material properties:

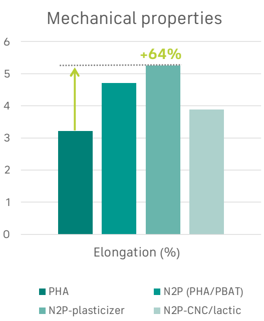
- Evaluation of **biodegradable** polymer blends and extruded sheets.
- Adjusting of mechanical material properties by **polymer blending** or use of **additives**.
- Increase in barrier properties by adding **functionalized nanofillers**.

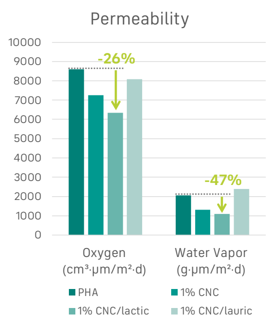
2 Validation of thermoforming process:

PHA-based materials suitable for a prototype production. Target applications are **rigid food packaging trays** or **plastic cups**.

Experimental procedure

Adjustments of material properties





Formulations & compounding

- High amount of PHA, up to 70%.
- Increase flexibility by adding bioplasticizer or blends with biodegradable polyesters.
- Low content of mineral fillers (MF) to increase stiffness.
- Modification of cellulose (CNC) or starch nanocrystals (SNC) to increase functionality.

- Cast sheet extrusion at width up to 300 mm.
- Thickness of monolayer sheets from 300 to 600 µm.

Thermoforming of rigid plastic trays & cups

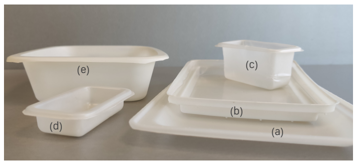


Figure 1: Variety in shapes of prototypes.

(a) Flat food tray 165mm x 125mm x 10mm,
(b) Two-tier tray 140mm x 100mm x 12mm,
(c) Portion cup 60mm x 30mm x 32mm,
(d) Portion cup 60mm x 30mm x 12mm,
(e) Food tray 150mm x 115mm x 35mm.

Results

1 Material properties of trays based on nenu2PHAr blends

Product	Young´s Modulus (GPa)	Tensile strength (MPa)	Elongation at yield (%)	OTR* ($cm^3 µm/m^2 d$)	WVTR* ($cm^3 µm/m^2 d$)
Benchmark	2,1	58	4,3	104 3.657**	379 64**
PHA/PBSA	0,5	19	9,4	28.000	5.200
PHA/PBS	1,4	31	5,9	4.680 2.276**	2.696 465**
PHA/PBS/MF1	1,6	25	2,9	3.747	2.443
PHA/PBS/MF2	1,6	32	3,9	5.414	3.263

Chart 1: Mechanical and barrier properties of nenu2PHAr products.

* 23°C/HR50%
** 15°C/HR85%

Mechanical and barrier properties of the thermoformed trays had been analyzed and benchmarked with conventional products based on petrochemical multilayer films.
Further developments are in progress to increase barrier and shelf life of products by multi-layer extrusion and coatings with CNC or SNC.

2 Thermoformed sheets based on nenu2PHAr blends

The extrusion and thermoforming of bioplastic sheets containing PHA material was **successfully evaluated**. The process had been **verified at TRL 5**.

Best products were achieved by thermoforming conditions of
Pre-heating: <20 seconds
Vacuum: 7 to 9 seconds
Cooling time: 15 seconds

The obtained results and conclusions can be transferred to follow-up trials **at industrial scale** by project partners BEL and DANONE.

Figure 2: Samples produced with developed nenu2PHAr formulations.

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nenu2phar.eu
@nenu2phar

Consortium

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