I'PAC : a new packaging bio-sourced, biodegradable, intelligent and protective

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Abstract

Customers' expectations in packaging are growing faster than they are ever done. Here is the aim of the student contest suggested by ActinPak, to make a food packaging with a **sustainable development approach** and able to detect bacteria. I'PAC is a revolutionary packaging, it is the first partially **bio-sourced** and fully **biodegradable** packaging. It is an **intelligent packaging** which **informs the customer** on food quality thanks to a special **ink able to detect meat decay**. It also has **high barrier properties** thanks to the use of **Micro fibrillated Cellulose (MFC)**.

Production of the container

Extrusion step :

This step is made in order to produce the copolymer composed of PLA, PBAT, and MFC.

Figure 1: Extrusion machine

→ The different composites are heated by a particular temperature profile and go throw special screws composed of several modules

Module	1	2	3	4	5	6	7	8	9	10
T (°C)	190	185	180	175	170	165	160	155	155	155

Table 1: Ramp temperature of the screw (10 correspond to the extrusion die)

→ A double extrusion is necessary to obtain optimal properties :
→ 1st Master batch extrusion : 59.5% PBAT / 25.5% PLA /15% MFC are melt
→ 2nd extrusion : 49% PLA and 51% of Master batch are melt
The final formulation: 62.5% PLA / 30% PBAT / 7.5% of MFC

Thermoforming step :

Once the bio composite has been obtained thanks to the extrusion, it had to be hot pressed to obtain the desired shape. Optimal parameters of hot pressing had to be found thanks to a design of experiment (Table 2)

Figure 2: Thermoforming machine

Temperature (°C)	Pressure (MPa)	Preparation time (min)	Thermoforming time (min)	Container mass (g)
170	5	5	5	35
185	5.5	10	10	37.5
200	6	15	15	40

Table 2: Field of experiment

The control of the temperature is a key step of the process. So is the mass of the container and the time of thermoforming. An optimal combination has been found : for 170°C for the heating, 10 minutes of preparation time, 5 minutes of hot pressing time and and 40 g per container to ensure it a marketable physical aspect.

BIO-SOURCED & BIODEGRADABLE

→ Container made of biopolymers and MFC
1) PLA : Biodegradable and bio based
2) PBAT : Biodegradable
3) MFC : Biodegradable and bio based

Thanks to those raw materials, the container is manly bio-based and biodegradable. The biodegradability is increase thanks to the use of MFC

→ PLA film previously coated with MFC is used to close the container

→ Biodegradability determination

Part of the NF EN 13432 norm : Disintegration aspect

- **Test duration :** 12 weeks
- **Target to validate biodegradability:** 90% (in mass) of the biopolymers particules must have a diameter under 2mm

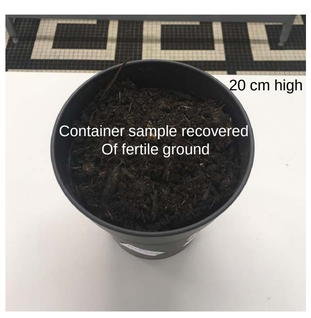

Figure 3: Disintegration test

INTELLIGENT

→ The ink used is intelligent and totally innovative (compared to the existing intelligent ink) . It reacts with H_2S released by salmonella (Patent in progress)

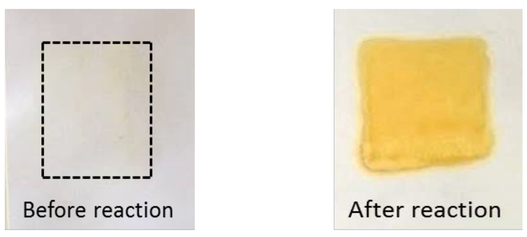

Figure 4 & 5: Visual reaction of the intelligent ink

→ Transparent ink : no degradation of the meat

→ Yellow/orange ink : detection of H_2S : rotten meat

PROTECTIVE

→ O_2 and water vapor are responsible of the meat degradation

→ Use of MFC increase the shelf of life of the meat because of its barrier properties towards 0_2 . Thanks to their crystallinity, MFC are able to form a really dense network, hard to break through for the 0_2 particules.

→ Absorption of water vapors by MFC

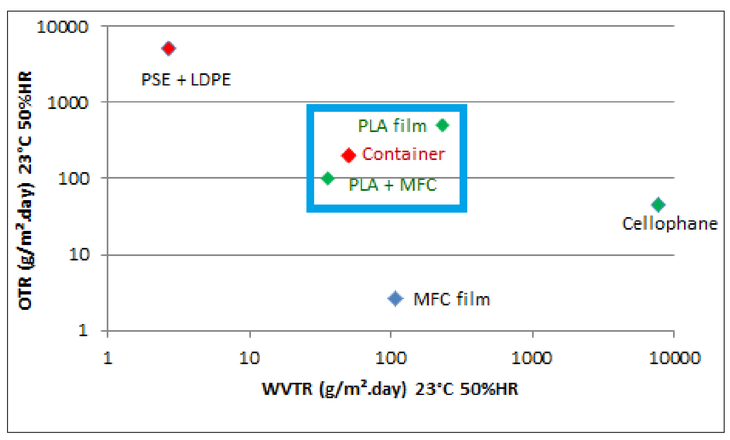

Figure 6: *OTR and WVTR for I'pac materials, and for usual materials of the food industry*

New design

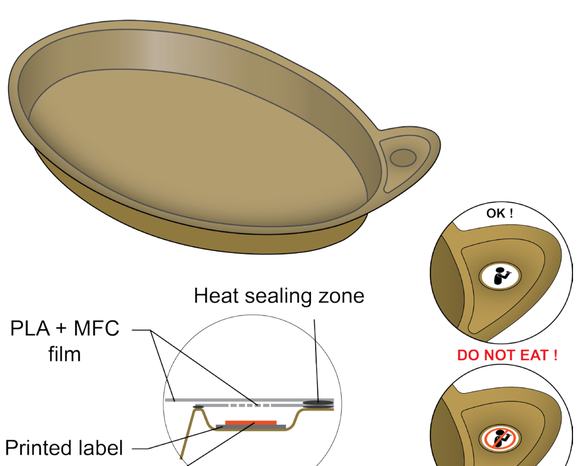

Figure 6: View of the new design

→ **Innovative** design compared to traditional ones used in food industry

→ Separated compartment to demarcate ink/meat

→ Logo (safe food) is crossed by the **intelligent ink** (unsafe food) to **alert** the consumer

(OK !) (**DO NOT EAT !**)

Conclusion

→ **An innovative packaging…**

The I'pac container presents as main interests to respect environment, as well as the consumer : the **good barrier properties** ensure a higher time for the decaying of meat; the label **avoid any risks of contamination** by Salmonella bacteria, meanwhile the biodegradability aspect is a **guarantee of respect of the environment** : there is currently no existing container including these three added values.

→ **… but hard to be processed !**

There is some improvement in the field of the ink which is not able to be used in a commercial context, as well as for the container which could present some inhomogeneity, and micro-cracks that lower the barrier properties.