Trioworld Whitepaper

Creating a PCR Food Contact Material that meets European regulations

Trioworld
Re-thinking plastic

Abstract

This whitepaper describes our journey with the ambitious goal to use recycled LDPE for food applications. After several positive results and chemical evaluations at the Landskrona site (Sweden), Trioworld decided to fully commit to designing an FCM (Food Contact Material) containing PCR (Post-Consumer Recycled) material.

In order to achieve this "closing loop" three different but equally important criteria are set;
1. To create a stable and high-quality PCR
2. To create a recyclable multi-layered film
3. To make sure the structure was fully tested for safe use in combination with food products

Together with the expertise of other industry leaders across the entire value chain, we overcame some of the tough decisions that come with an ambitious project like this. PCR is made from LDPE that's been collected for recycling.

After being recycled this is turned into a re-usable material, which is why PCR fits us so well as LDPE innovators at Trioworld.

Choosing to make Food Grade compliant PCR packaging is one thing: making it actually work is another. The third chapter covers the final 5-layer ~70 um concept that made the magic happen, and the combination of material (PE/PCR) within it. Probably the most challenging phase is ensuring that the packaging contains recycled material and is still safe for consumer usage.

We cover the extensive amount of testing that's done per batch needed both before and after production. And just as importantly an in-depth analysis of the test results. Creating a Food Grade recycled concept that passes our own and the EU's safety criteria has however made this hard work all worth it!

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Circularity has a new name: looking back at Trioworld's journey and sharing our recent breakthrough.

At Trioworld we've been a big proponent of Post-Consumer Recycled packaging (also known as "PCR packaging").

European regulations prevented recycled material from being used in food packaging applications. If we consider that estimations give food & beverage packaging a 69% share of all European's packaging waste (82.5 million metric tons per year as reported in Eurostat, 2017[1]), that still leaves a large quantity of packaging incompatible with PCR.

This is why we're so immensely proud of- and happy with, our most recent breakthrough. A food-grade PCR concept that has been judged Food Contact Material (FCM) compliant and found to be in accordance with the required EU regulations (EU 10/2011 articles).

How we made this project happen? What this breakthrough means for food packaging? How you can use this new concept to revolutionize your food packaging's sustainability? We'll be answering all these questions and more in the next few pages of this whitepaper.

An ambitious journey

Our journey started with an ambitious goal: to re-use recycled LDPE for food applications. After several positive results made by Trioworld in Landskrona (Sweden) in their chemical evaluations, Trioworld decided to fully commit to designing a FCM (Food Contact Material) containing recycled material (PCR).

This is truly breaking new ground, as using recycled material within EU regulations compliant packaging has been called “impossible” by many. Luckily, Trioworld is not a part of these many. Embracing the difficult challenge we started our ambitious journey on the creation of this new multi-layer “Loop” concept.

The loop of course signifying our true ambition: creating a sustainable packaging concept that can be continually used, recycled, and re-used. Often referred to as “closing the loop”. In order to achieve this we set apart three different but equally important criteria;

1. **To create a stable and thus recycle proof material**
   In layman’s terms, this means the material has to be solid and stable enough to survive the stress that comes with repeated use and recycling. The recycling process specifically puts a very high demand on a material’s toughness, as weaker materials risk degrading too strongly from recycling cycles. The more cycles the material is planning to be used, the higher the stress and thus requirements.

2. **To create a recyclable multi-layered film**
   When we decided to create a FCM that contains recycled material, we knew one thing was certain from the start: the concept would have to contain multiple layers. As EU regulations do not allow recycled material to come into direct contact with food, we had to create a structure that closes off the PCR layer.

   And for our material to be truly effective at closing the loop, it had to be fully recyclable. In order to reach this goal we knew the packaging concept could only contain one type of material. As a global specialist in Polyethylene the family of choice was never in doubt. But finding out which particular combination of virgin PE and PCR layers, which content % of PCR, and which thickness would work best, still left us with plenty of challenges.

3. **To make sure the structure was fully tested for safe use in food products**
   While we are firm believers in pushing the envelope when it comes to packaging sustainability, it shouldn’t come at the expense of safety. This is why our third criteria is specifically aimed at guaranteeing product safety and matching the EU’s high test standards.

   This means the recycled granules have to meet EU’s REACH regulation, and the finished packaging has to pass migration tests that are **specifically tailored in accordance with the chosen food application.**

Trials and tribulations: the timeline behind the creation of a stable recyclable proof material

The original goal behind our multi-layer Loop project was simple: Trioworld wanted to give European plastic waste a new life. But achieving this plastic rebirth was more easily said than done. We started this project together with a specific customer and an independent research institute, RISE[2](Research Institute of Sweden) in a joint initiative/ project. RISE is well known for adding their expertise to "kick-start" sustainability initiatives within Sweden and the EU.

This start was the ideal thinktank for our multi-layer Loop project: combining our practical know-how of an experienced manufacturer, the unique perspective of an ambitious customer, and the added expertise and laboratory evaluations from a research institute. And the lessons that this joint initiative gave us ended up being incredibly important for the Trioworld multi-layer Loop project that followed in its wake.

> "The joint inititative gave us very important insights and tools that stayed with us for the entire project, and will likely help shape our sustainable projects for years to come. This was truly a successful partnership that spanned the entire valuechain."
>
> **– Charlotte Fröhberg, Development Engineer at Trioworld.**

A jack of all trades is a master of none
The application that would use our sustainable concept was one aspect that was remarkedly different in the new Trioworld multi-layer Loop project. While the joint initiative project was looking for a "one-size fits all solution", we focused our internal project on a sustainability product that was specialized for a certain market or application. Due to our (and PE's) natural affinity for the frozen food market we logically focused our Trioworld multi-layer Loop concept on this market as well.

It wasn't until much later in the project, during the testing, that we really realized how much this decision had made a difference in the feasibility of our multi-layer Loop project.

Focusing on our strengths
A second aspect of our own specialization was functionality. While other stakeholders from the joint initiative originally thought an improved PET functionality and the use of EVOH solutions was the future, our internal project chose a different path: focusing on PE-solutions and emphasizing recyclability.

This choice wasn't just because we were "familiar" with PE. In previous projects we had already tested and evaluated batches of PCR. These evaluations, spanning for many batches and over a long-time span (~18 months), surprisingly found that PCR material could actually be very clean. These excellent results planted a seed at Trioworld: the idea of using PCR in Food Contact Material.

Starting small
Our first step of the journey was only small in a figurative sense: despite their tiny size the granules for our material-to be of great importance. To ensure we got this right we decided to only consider European suppliers. Partly because of their regional benefits, partly because of the high general standard of quality, and partly because this was more in spirit with the European REACH regulations.

It also felt compatible with our goals: if we truly wanted to close the loop on European plastic waste, surely it would be best to source our recycled material from within Europe! Within this initial selection we underwent a further investigation to find a supplier that passed our expectations on:

- Density criteria
- MFI criteria
- Color criteria
- EU Cert Plast Certified

Lastly, the supplier had to have Proper Quality Systems in place to ensure traceability.

Starting with a couple of suppliers we further narrowed down our scope to a selected number of suppliers. Of course these suppliers passed our high quality- and stability criteria regarding food applications. They are supplying our PCR granules for food applications to this day!

From granules to additives
Armed with the right granules to create a stable base material, we focused our attention on additives. We specifically searched to create a material with barrier properties. And with the PE and a high-density polymer our innovative design functions somewhat like a carbon-based web that captures and slows down the migration. To slow down or completely stop the migration we also continued our search for additives that affected the polymer structure. Combining these developments gave us some very promising results.

Of course none of the steps above were undertaken without significant testing. Continually analyzing the changes and additives was important to evaluate our barrier. If any of additives, or a combination of certain additives, would affect the polymer we had no choice but to eliminate them as an option.

Multi-layer PCR:
The challenges in creating a multi-layered film with recycled content

After the many tests and eliminated options that spanned the process of the previous chapter, our journey resulted in promising concepts that towered above the competition. We started with different layer concepts with PCR and learned that the 5-layer concept gave great results.

These PE films are produced in a Trioworld extrusion machine, are 50-70 µm and specifically designed to be used for frozen (food) applications. With our goal in mind (creating a recyclable film) we have always used PE layers or some kind of PE variant in our testing. This made the project much more challenging: many of the known shortcuts within the industry (f.e. PVDC) wouldn't work as the concept would not be recyclable anymore.

"Finding a packaging concept that could remain fully recyclable while being food grade compliant, and without compromising on our customers regular needs (barriers, production parameters) was quite possibly the most demanding project I've experienced yet.

I'm proudest of myself, my coworkers, and Trioworld for realizing a PE-only concept that could match all these demands. It would've been so much easier to simply add a secondary different material and launch a new product that would only be recyclable to the uninformed. Sticking to our original vision makes the result that much more satisfying. "

– Charlotte Fröhberg, Development Engineer at Trioworld.

Thanks to this stubbornness our multi-layer Loop concept can now however be defined as an all PE-film and is thus fully recyclable! The concept being finalized as a 5-layer concept is a second result of our persistence in finding the right solution. The 5-layer version ended up to be the best robust and solid solution.

Safety first:
Creating a PCR Food Contact Material that meets European regulations

"Migration" is a very well-known concept within the (food) packaging industry. Specific types of food have the annoying tendency to contain oils, and packaging history has had its cases of these oils making their way through a packaging concept. And while this can be annoying when your store-bought liquorish bag leaves you with fatty hands, this gets much more important when preventing contents from PCR material from migrating outside on inside the PCR layer.

A different but equally important concept within the packaging industry is a "Declaration of Compliance and material safety". This declaration is generally given to us by our suppliers, to attest their use of proper and safe materials. Because PCR material is made from post-consumer recycled waste, the specific structure of each batch can differ quite strongly, which in turn makes it impossible for our suppliers to share a declaration of compliance (DoC) with us.

Meeting the challenge
This created quite a challenge on an operation level for us: as we cannot get a DoC from our supplier directly, we were required to do extensive testing both before and after our production. To still get the required results we set up several different types of tests to meet the EU 10/2011 articles:

- Simulant tests
  Simulants are a material representing food in test studies. In our case we needed to make sure our packaging material was compatible with Frozen Food, and thus we have to meet the high demands from Simulants that represent frozen food.

  Depending on the application this might for example be a simulant that represents frozen products with a high-water content, like vegetables. For a different customer and project this might however change into a different representing frozen dry food that contain lots of flour, like frozen bread.

- Overall migration limit tests
  These tests look at the combined migration of all substances within the packaging concept. This total cannot exceed a certain guideline if the packaging still wants to possess EU's regulations.

- Specific migration limit tests
  While the overall migration tests are great at giving a "migration high-over", they are expanded on with specific migration limit tests. These tests are used to test specific substances from the packaging concept, and their migration. This could for example be done because the substance in question is extra dangerous or can have effects at different doses compared to the other substances.

  This extra, specific testing is also added for extra precaution. Since the previous "life" of recycled material can be so varied and complex, we can't always know which specific substance we're looking for. In order to guarantee a safe product we must do an extra screening on absence of harmful substances.

Perfect is the enemy of Good
While we consider Trioloop multi-layer Loop project very successful, it wasn't perfect. After many tries and tests, we had to conclude that fatty foods, and the simulant that comes with them, just weren't compatible with our PE/PCR concept.

But instead of simply cancelling the entire project we kept experimenting until we found a combination of frozen products and a PE/PCR Food Contact Material that worked. At Trioworld we believe that using properly chosen materials per use-case is still better then saying it can't be done and simply giving up our sustainable dreams.

Closing thoughts

With this whitepaper we illustrate that the Trioworld multi-layer Loop project was not without its challenges or setbacks. But we've now reached a point where we're incredibly proud of the results and will soon be launching the first consumer facing Trioworld multi-layer Loop projects into the wild: as our concept will be used for frozen bakery products by a large European customer.

Secondly this project has also taught us the importance of guiding our customers in this process. They depend and trust on the expertise that we (and our suppliers) have gathered during this project. And it is by guiding these bold and educated customers that dare to make the switch, that we aim to change the packaging world one project at a time.

The Holy Grail in Sustainable Packaging

"Answering the questions and matching the ambitions from our customers regarding sustainable packaging has been our most important priority at Trioworld. We've been a strong believer in PCR for a while now, and being able to apply PCR in a packaging concept for Food has truly been the holy grail of sustainable packaging innovation.

We're incredibly proud of the progress this new milestone represents, and are extremely excited that our most progressive customers are starting to roll out the use of this innovative new material. "

– Johan Schouwstra, Business Director Consumer Packaging Division.

Re-thinking Plastic

By trying, testing, and validating tons of different combinations we've found the concept that is most suitable for our current goals. But like always you can expect us to continue experimenting, to continue finding new and responsible uses for our materials in the future.

One thing is however certain: with this project we have taken the lead in the development of sustainable applications for the frozen food market!

Appendix/ sources

1. https://www.sciencedirect.com/science/article/pii/S0959652618313325#bib76
2. https://www.ri.se/en

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