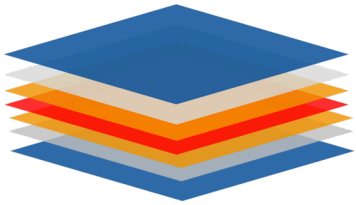
Position Paper

Polyamide: an important and sustainable raw material in advanced flexible packaging

Why is polyamide used in advanced flexible packaging?

Advanced flexible packaging is called as such due to its unique characteristic of being able to provide the highest level of protection possible to the goods while using the least amount of material. Hence, this type of packaging is generally used for valuable goods which also tend to be carbon intensive. This is all the more reason for these goods, such as perishables, to be provided the highest protection feasible. However, in order to progress towards a genuine waste hierarchy, the amount of packaging material used should be reduced.

Compared to regular packaging, advanced flexible packaging containing polyamide (PA) combines the properties of various materials while enabling very little material use. This simultaneously protects the valuable packed goods, shielding them from mechanical and chemical influences (such as oxygen coming in/aromas or other components diffusing through the packaging) while diminishing the amount of material used. In most commercial applications PA is combined with polyolefins and a tie; in high barrier packaging, additionally with polyethylvinylalcohol copolymers (EVOH), producing multilayer structure where every layer fulfills an essential function.



Component	Typical Thickness	Function
PE/PP	30-50 µm	High water barrier, shrinkage, sealability
Tie	< 10µm	Interlayer compatibility
PA	~ 15 µm	Puncture resistance, barrier, thermal resistance, better processability
EVOH	~ 10µm	High O_2 barrier

Valuable perishables currently benefit from advanced flexible packaging containing PA include meat, cheese, fish, bakery products and processed foods. The unique characteristics of such packaging ensure:

1. **Mechanical Performance:**
    a. Strength, stiffness & toughness
    b. High puncture and impact resistance
2. **Product and Packagaing Processing**
    a. Excellent thermoformability also for high drawing depths
    b. Heat resistance (sterilizable packaging, enabler for (fast) sealing)
3. **Barrier**
    a. High resistance and barrier to chemicals
    b. Good aroma and mineral oil barrier
    c. Medium oxygen barrier
4. **Others**
    a. Compliance with food contact regulations
    b. Easy processing in conventional equipment (state of the art)

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In combining the critical properties above, PA therefore contributes to:

- **Reducing packaging waste:** high protection level while using lower film thickness
- **Enabling the most economical packaging solutions:** fast processability, lower cost, best performance
- **Preventing food loss and increased shelf life:** through better food protection while providing customer convenience as well as optimized logistics

Using and recycling polyamide

Marrying such critical properties while using as thin as possible material layers is only achieved with advanced flexible multi-layer packaging. In this PA is only used for usually perishable goods, which require such stringent characteristics. In fact, using monomaterials would require fundamental structural changes to the advanced packaging value chain. This would be a significant burden in terms of costs for new equipment, but for lower throughput solutions. Hence, due not only to the material reduction but also its vital benefits, PA is used sparingly. As such, the overall quantity of PA found in packaging is around 0,3% of the overall material used in packaging application.[1]

When it comes to dealing with the PE flexible packaging waste stream, around 1% of PA can be expected as not much is placed on the market to begin with.[1] This quantity does not harm the quality of the waste stream, as a robust selection of studies[2] shows that this is neither detrimental to the sorting process nor the quality of the recyclate itself. In effect, a well-homogenized PA content improves various crucial mechanical properties of polyethylene (PE) recyclate films such as tensile strength or dart drop impact.

Furthermore, PA recyclable: There are several claims and guidelines describing PA as potentially impeding polyolefin recycling. However, this is in direct contradiction with much of the recent, scientific, and independent data. PA does not negatively impact PE recycling[3], and various independent test protocols have validated PE/PA recyclability in the PE waste stream including:

- **Cyclos HTP**: CHI-C8-PEF-1: Recycling Application Compatibility Test for PE-based Flexible Packaging
- **Association of Plastic Recyclers (APR)**: Critical Guidance Protocol for PE Film and Flexible Packaging
- **RecyClass:** Recyclability Evaluation Protocol for PE Films

In fact, PE/PA recycling has long been established as state-of-the-art for years in the industry, given that the barrier film producers can regrind their PE/PA film waste and feed this regranulate back into their primary films without curtailing mechanical or optical properties. This helps pave the way towards a genuine circular economy.

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[1] *Plastics – the Facts 2022, Plastics Europe,* Slide 37, Estimated Market Demand 2021 for the EU27 plus UK, CH, and NO in kt: Plastics in Packaging(best expert estimation based on external sources, studies, publications): 19670 kt in total, 5860 kt PE-LD, LLD, 60 kt PA (PA6, PA 6/66, PA 66), Source: Plastics Europe Market Research Group

[2] e.g. cyclos HTP studies requested by BASF SE, RecyClass and APR studies requested by UBE, (20+ studies and experience statements were submitted to CEN/TC261/SC4/WG10 - Design for recycling for plastic packaging products - SG6 - PE/PP flexible packaging)

[3] in presence of maleic acid anhydride grafted polyethylene (PE-g-MAH) as tie layer or compatibilizer

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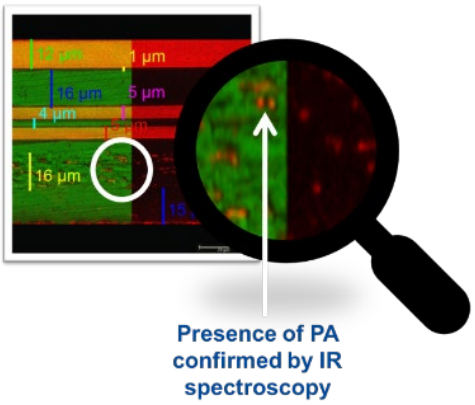

Examples from a sausage packaging from a German supermarket (2023) showing PE/PA recyclate in a PE layer (red dots in green PE is recycled PE/PA))(orange/red: PA, green/black: PE)

Even where non-food applications are concerned, such as engineering plastics and textiles, where PA is used, it helps close the circular economy loop. This is due to its chemistry, which enables PA to be easily depolymerized into its monomer caprolactam. This means it can be reused again thereby making it an innately circular material. PA can also be made of non-fossil raw materials (biomass/pyrolysis oils) meaning that it can in actuality conjoin this circularity with net zero objectives.

Our position

1. PA is a crucial raw material for advanced packaging, and inherently respects the waste hierarchy. It enables the **highest performance for a package with the least amount of material**. This in fact provides the best protection and safety for valuable goods at the best economic rate.

2. The protection that advanced packaging including PA offers valuable perishables helps **reduce food waste**.

3. Advanced packaging including polyamide is recyclable in the PE waste stream. **Independent and scientifically-sound test protocols validate PE/PA recyclability in the PE waste stream.**

Conclusive outcome

Currently, when it comes to the recyclability, Design for Recycling guidelines are being devised per material per packaging. We believe that, in the case of PA, these must follow the concept of **material neutrality** and acknowledge scientifically-sound and proven **state-of-the-art** materials which are compatible with the recycling of alternative materials, and that **improve the environmental footprint along the entire product lifecycle.**