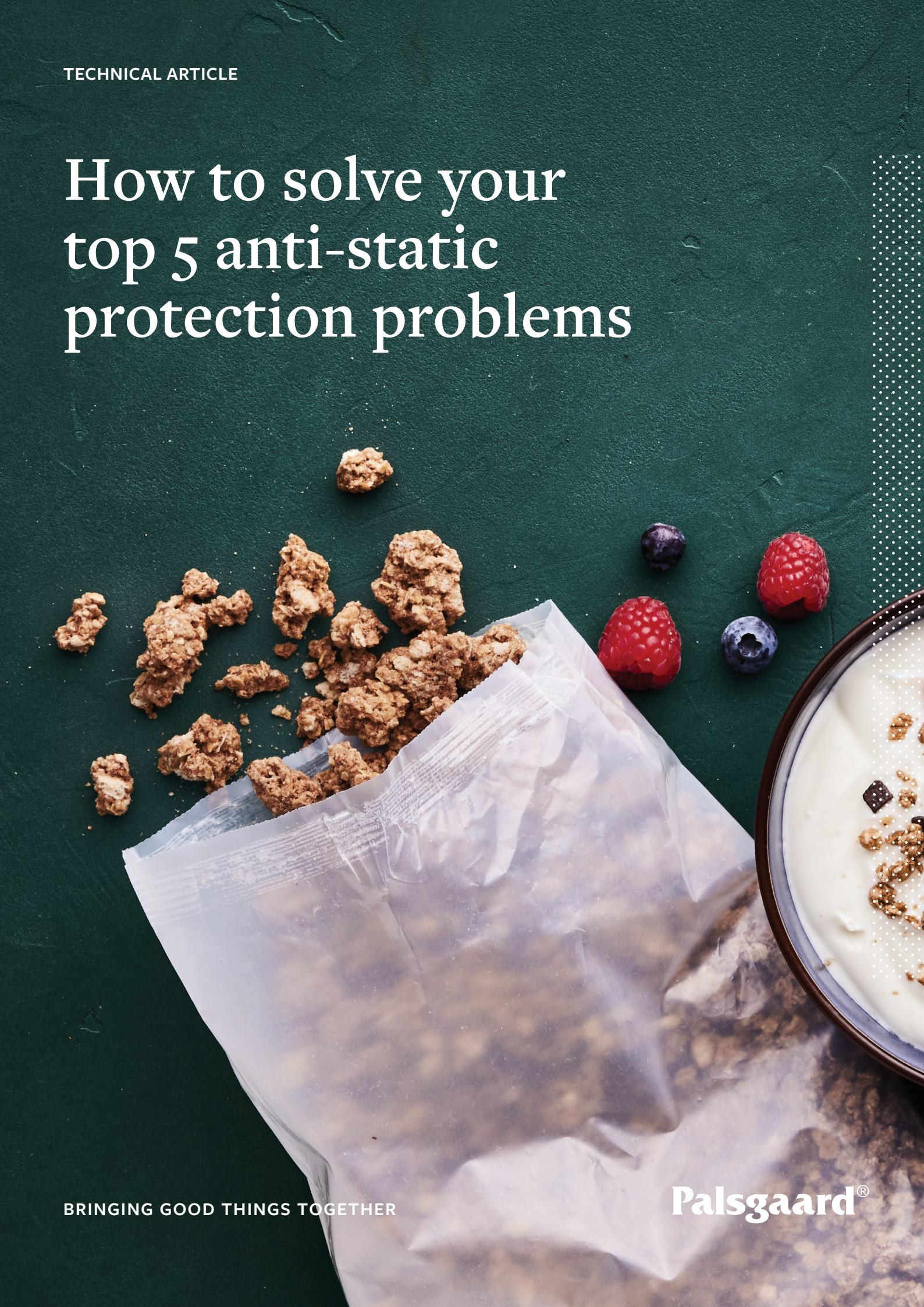
TECHNICAL ARTICLE

How to solve your top 5 anti-static protection problems



BRINGING GOOD THINGS TOGETHER

Palsgaard®

In the ever-evolving landscape of the plastics industry, rapid changes are reshaping traditional approaches. Palsgaard, a leading additives producer, has emerged as a catalyst for transformation, particularly in addressing the challenges faced by customers seeking effective, cost-efficient and sustainable anti-static performance.

Based on our work in the field and through extensive research conducted at our Polymer Application Centre, Palsgaard has identified five critical pain points where conventional additive solutions often fall short. In response, Palsgaard's **Einar®** plant-based anti-stats have proven to be a superior, safe and sustainable alternative, offering exceptional solutions to enhance application success.

In this article, Bjarne Nielsen, Business Development Manager for Polymer Additives at Palsgaard, discusses some of today's major challenges when it comes to aligning anti-static needs with important trends in the plastics industry, and explains the key benefits of **Einar®** plant-based anti-stats in meeting them.

1. Better Recyclability of Packaging

The plastics industry has made strides towards achieving circularity, but there are still unresolved issues, especially in the realm of flexible packaging, particularly polyethylene (PE). Consumers and regulatory bodies are pressuring brand owners and manufacturers to enhance the recyclability of their packaging products.

ELIMINATE MIXED-MATERIAL STRUCTURES

One way to address this challenge is by transitioning from complex multi-material solutions to simpler mono-material alternatives. The trend towards mono-material packaging offers substantial environmental benefits. By adopting mono-material solutions, manufacturers can improve sustainability within the fast-moving consumer goods (FMCG) industries. These packaging designs simplify the recycling process by utilising a single type of material, making it easier to separate and reprocess at the end of its product life-cycle. Mono-material packaging reduces the reliance on complex and mixed materials that are challenging to recycle, thereby minimising waste and enhancing resource efficiency. For instance, PE coffee bags typically employ a traditional aluminium coating for anti-static performance and barrier properties. However, the combination of plastic film and aluminium in these bags renders them difficult, if not impossible, to recycle, resulting in a potential loss of valuable material.

REPLACE ALUMINIUM

To overcome this issue, the aluminium coating can be eliminated, but this would entail losing efficient anti-static performance. An effective solution partly lies in replacing the aluminium coating with a high-performance anti-static additive incorporated into the PE film formulation. Among the available options, **Einar® 601** stands out as the most promising choice for achieving efficient anti-static protection in mono-layer PE film at low concentrations.

MAINTAIN POLYMER INTEGRITY

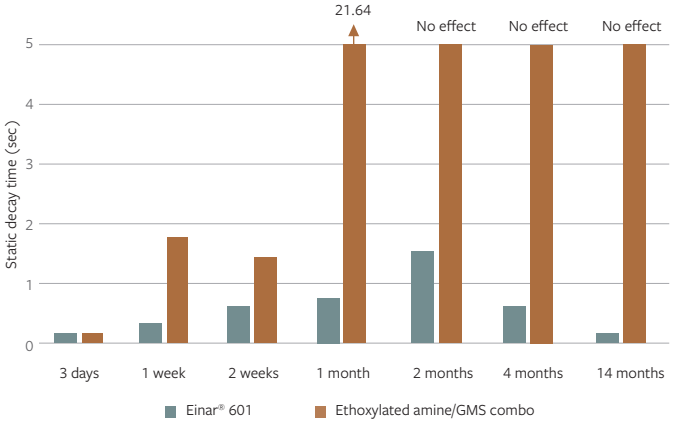
The addition of **Einar®** plant-based anti-static agents has no adverse effects on the recyclability of the packaging polymer or on the properties of the recycled material. **Einar® 601**, for instance, is a polyglycerol ester made exclusively from fatty acids of vegetable origin. Supplied in off-white paste form, it is typically applied in low loading levels of only 0.1% to 0.6% and is fully compatible with existing PE recycling streams.

FOOD SAFETY AND ENHANCED SUSTAINABILITY

By employing this plant-based additive, not only does the packaging become more recyclable, but it also attains worldwide food-contact approval. Moreover, anti-static flexible packaging created with **Einar® 601** significantly reduces the carbon footprint compared to aluminium-coated structures.

Compared to traditional anti-static additives like ethoxylated amines, **Einar® 601** demonstrates excellent performance in terms of static decay time (SDT) when incorporated into LDPE. SDT measures the rate at which a charged surface of 5000V dissipates to 500V, with a shorter SDT indicating better performance. **Einar® 601** exhibits an SDT of less than 2 seconds, which is considered outstanding performance, and one that is by no means matched by conventional ethoxylated amine solutions.

ANTI-STAT PERFORMANCE IN LDPE BLOWN FILM
Additive concentration is 0.1%, measured at 50% RH.



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2. Thinner Co-Extruded and Laminated Structures

When utilising co-extruded and laminated PE film in a packaging solution, the anti-static agent is often included in the sealing layer. However, as manufacturers aim to minimise plastic usage and decrease the thickness of the layers, there is limited material available for the additive to effectively migrate to the packaging surface. This migration is crucial for ensuring efficient anti-static protection. Therefore, using thinner co-extruded and laminated structures for sustainability purposes can impact the effectiveness of migratory anti-static additives. These additives are typically integrated into a specific layer of the packaging material and gradually migrate to the surface over time to deliver anti-static properties.

Driven by their hydrophilic ends, the additive molecules in the polymer matrix migrate towards the polymer surfaces to act as surfactants e.g. against fogging and static build-up. The performance of migratory anti-static additives may be influenced by the reduced thickness of the packaging structure in several ways:

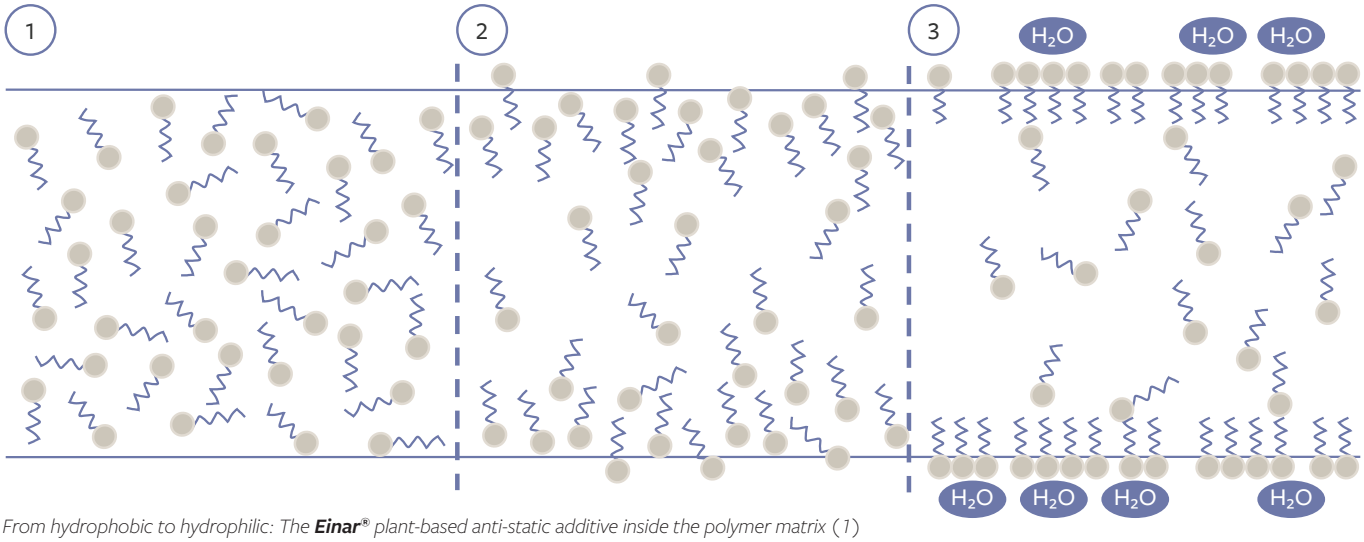
SURFACE CONCENTRATION

The reduced thickness of the packaging material may result in lower concentrations of the migratory anti-static additives on the surface. As the additives migrate, they accumulate on the surface, forming a layer that provides anti-static properties. Thinner structures may have lower overall additive concentration leading to a lower surface concentration, which could potentially impact the effectiveness of static dissipation.

ANTI-STATIC PERFORMANCE AND MIGRATION RATE

The overall anti-static performance of the packaging material may be affected due to the reduced availability of anti-static additives. The anti-static properties are directly related to the concentration and distribution of the additive on the surface.

To mitigate these effects, it becomes crucial to carefully optimise the formulation and concentration of the anti-static additive for thinner layers. Manufacturers can select additives with higher migration rates or improved surface concentration characteristics to compensate for the limited amount available.



*From hydrophobic to hydrophilic: The **Einar®** plant-based anti-static additive inside the polymer matrix (1) migrates to the surface (2) where its hydrophilic surfactant nature increase the surface energy of the polymer by reacting with ambient moisture (3), thus preventing static build-up and dust attraction.*

They may also explore alternative anti-static technologies that can provide effective anti-static properties with lower additive concentrations, such as inherent static-dissipative materials or coatings.

Einar® 601 offers several advantages in the context of thin PE films:

EFFICIENT MIGRATION

Einar® 601 exhibits improved migration efficiency, allowing it to migrate readily through the thickness of the PE film, even in lower quantities. This efficient migration ensures that the additive can effectively reach the film's surface, despite the reduced thickness of the layers. It helps achieve the desired anti-static properties at low concentrations and in a shorter timeframe.

LOWER DOSAGE

Einar® 601 demonstrates excellent performance at lower dosage levels. It can provide effective anti-static properties even when used in reduced concentrations, which is advantageous when incorporating limited amounts of the additive into thinner PE film layers. The lower dosage requirement helps minimise costs and potential negative effects on other material properties.

COMPATIBILITY

Einar® 601 is specifically designed for compatibility with PE films. It integrates well with polyethylene and its various copolymers commonly used in co-extrusion and lamination processes. The additive's compatibility ensures ease of formulation and integration into existing manufacturing processes without significant adjustments or adverse effects on the overall film performance.

By utilising **Einar® 601** as an anti-static additive in thin PE films, manufacturers can overcome the limitations associated with thinner co-extruded and laminated structures while maintaining effective anti-static properties and static control. Its efficient migration, highly potent anti-stat chemistry, lower dosage requirement and compatibility with PE films contribute to reliable anti-static performance in the new innovative and less resource-intensive packaging solutions of the modern world.

Einar® 601 also has an excellent performance in LLDPE films and is the ideal anti-stat in an LLDPE metallocene sealing layer.

3. Thin-Wall Injection Moulding

Manufacturers of thin-walled injection-moulded packaging made from impact copolymer polypropylene (PP) also face several challenges when trying to reduce raw material consumption to make their products more sustainable. These challenges include:

MAINTAINING STRUCTURAL INTEGRITY

Thin-walled packaging requires a delicate balance between reducing material usage and maintaining sufficient strength and structural integrity. Reducing the material thickness too much can lead to issues such as inadequate product protection, increased risk of breakage, or compromised stacking and transportation capabilities. Manufacturers need to find solutions that allow them to reduce material consumption without sacrificing the packaging's performance.

WARPAGE AND DISTORTION

Thin-walled parts are more prone to warpage and distortion during the moulding process. As material consumption is reduced, the parts become more susceptible to variations in cooling and solidification rates, resulting in dimensional inaccuracies and potential quality issues. Maintaining dimensional stability while reducing raw material consumption is crucial for producing high-quality packaging.

STATIC ELECTRICITY BUILD-UP

Static electricity can be a significant concern during the production, handling and use of thin-walled PP packaging. As the material thickness decreases, the surface area-to-volume ratio increases, leading to an increased demand for highly efficient anti-stat solutions. Static electricity can cause issues such as dust attraction, product sticking and handling difficulties, negatively impacting the overall quality and user experience of the packaging.

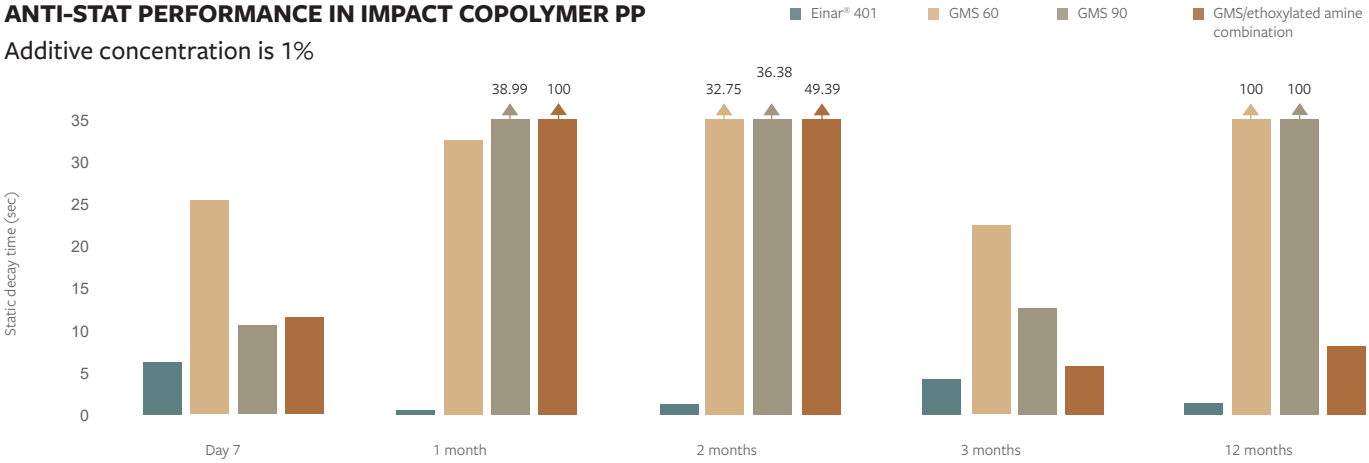
Efficient anti-static additives, such as **Einar® 401**, can help overcome these challenges and enable manufacturers to reduce raw material consumption while maintaining product quality and sustainability. Here's how they can help:

DUST AND CONTAMINATION CONTROL

Anti-static additives help mitigate the attraction of dust and other particulate matter to the surface of the packaging. By reducing static charge build-up, these additives minimise the risk of product contamination and maintain the cleanliness and aesthetic appeal of the packaging. This is particularly important for applications where hygiene and cleanliness are critical, such as food packaging.

ANTI-STAT PERFORMANCE IN IMPACT COPOLYMER PP

Additive concentration is 1%



Anti-stat performance in impact copolymer PP · Additive concentration is 1%

Superior immediate and long-term anti-static coverage: Static decay testing shows that **Einar® 401** *anti-static additive is able to outperform traditional less safe additive offerings, such as GMS combinations with ethoxylated amine.*

ENHANCED HANDLING AND USER EXPERIENCE

Anti-static additives improve the surface characteristics of the packaging, reducing the likelihood of products sticking together or clinging to surfaces. This makes the packaging easier to handle, stack and transport, enhancing the overall user experience.

Additional bonus effects of adding efficient additives like **Einar® 401** also include:

IMPROVED PROCESSING EFFICIENCY

Anti-static additives can enhance the flow properties of PP, allowing for smoother and more efficient processing. They can help minimise issues like melt fracture, flow marks and surface defects, leading to improved productivity and reduced scrap rates. This improved processing efficiency enables manufacturers to achieve material savings without compromising the packaging's structural integrity.

By incorporating an efficient plant-based anti-static additive like **Einar® 401** into their thin-walled impact copolymer PP packaging formulations, manufacturers can address the challenges of reducing raw material consumption while ensuring product quality, performance and sustainability. In particular, **Einar® 401** provides:

SAFE CHEMISTRY

As an optimised blend of mono- and diglycerides with selected fatty acid profiles from vegetable oils, **Einar® 401** alleviates consumer concerns over food safety with worldwide regulatory approvals for food contact.

UNMATCHED ANTI-STAT PERFORMANCE

In impact PP copolymers, **Einar® 401** outperforms any alternatives, including traditional glycerol monostearate (GMS) and/or ethoxylated amine (EA) solutions as well as competitive plant-based anti-static agents. It was developed specifically to work under challenging conditions, such as low temperatures and low humidity. The anti-static effect will reliably exceed one year.

EASE OF USE AND CLEAN DOSAGE

Einar® 401 can easily be adjusted to specific PP grades and concentration needs without any adverse effects on mechanical, optical or barrier properties. Supplied in pellet form, it is ideal for dust-free mixing with the polymer as well as for incorporating the anti-static in PP-based masterbatches.

This property profile makes **Einar® 401** the perfect solution for adding long-lasting, safe and sustainable anti-static performance across a broad range of applications, from thin-walled containers for yoghurt and margarine to small or large buckets in both food and non-food storage.

Einar® polymer additives are made from carefully selected plant oils, including RSPO-certified sustainable palm oil, rapeseed, sunflower and castor oil. The same raw materials used in Palsgaard's food emulsifiers and personal care ingredients.

4. Safer Alternatives to Ethoxylated Amines

Traditionally, ethoxylated amines (EA) have been utilised as anti-static additives in plastics due to their ability to reduce static charge build-up on the surface of the material. However, there are a few reasons why manufacturers may need to seek alternative solutions:

ENVIRONMENTAL AND HEALTH CONCERNS

EAs are known to be potentially harmful to the environment and human health. They can persist in the environment, accumulate in living organisms and have the potential to disrupt aquatic ecosystems. Additionally, some ethoxylated amines have been associated with skin irritation and allergic reactions in humans. These concerns have led to increased scrutiny and regulations regarding the use of ethoxylated amines.

REGULATORY RESTRICTIONS

Many countries and regions have implemented regulations based on standards and recommendations such as those set forth by the European Union for Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) and implemented by the European Chemicals Agency (ECHA). One particular concern under this regime is the potentially high environmental and health impact of certain EAs in sensitive applications. Manufacturers need to comply with these restrictions to avoid legal consequences and maintain their reputation as responsible and compliant entities.

CONSUMER DEMAND FOR SAFER PRODUCTS

In recent years, there has been a growing demand from consumers for safer and more environmentally friendly products. As a result, manufacturers are under pressure to find alternative anti-static additives that meet these expectations and align with their sustainability goals.

PRODUCT PERFORMANCE AND QUALITY

Ethoxylated amines may not always provide the desired level of anti-static properties or long-term effectiveness. Manufacturers may need to explore alternative additives that offer superior performance, ensuring their products meet the required quality standards.

Palsgaard's **Einar®** anti-static additives are fully REACH-compatible and have been shown to outperform EA particularly when it comes to efficiency and safety considerations. Their benefits as non-hazardous plant-based amine alternatives extend across

the entire portfolio, including **Einar® 201** in powder or pellet form for PP injection moulding; **Einar® 401** in pellet form for impact PP copolymers; **Einar® 411** in pellet form for PP films, PP injection moulding and PP foams; and **Einar® 601** in paste form for all PE grades, including LDPE, LLDPE and HDPE in film, foam and injection moulding applications. While **Einar® 601** is widely considered the safest and most efficient anti-static agent vs. EA in PE films, the clear superior choice for impact PP copolymers is **Einar® 401**.

NON-TOXIC AND SAFE

Einar® additives are specifically designed to prioritise safety for both human health and the environment. They are non-toxic and do not pose a risk of skin sensitisation or allergic reactions. Manufacturers can confidently use these additives without compromising the well-being of workers or consumers.

REDUCED ENVIRONMENTAL IMPACT

Einar® additives are produced using sustainable and renewable raw materials, such as vegetable oils. The manufacturing process is designed to minimise environmental impact, ensuring that the additives are environmentally friendly throughout their lifecycle. By choosing **Einar®** additives, manufacturers can contribute to a greener and more sustainable plastic industry.

REGULATORY COMPLIANCE

Einar® additives comply with relevant regulations and standards. They undergo thorough testing to meet regulatory requirements, providing manufacturers with peace of mind and avoiding potential legal issues associated with non-compliant substances.

ELIMINATION OF HARMFUL SUBSTANCES

Unlike ethoxylated amines, **Einar®** additives do not contain substances that are known to be harmful to human health or the environment. By utilising **Einar®** additives, manufacturers can eliminate the risks associated with the use of potentially hazardous chemicals, safeguarding their employees and consumers.

EXPERT SUPPORT

Palsgaard offers technical support and expertise to assist manufacturers in the proper utilisation of **Einar®** additives. This guidance ensures that manufacturers can effectively incorporate the additives into their production processes while maximising safety and performance.

5. Stability at Low Humidity and Reduced Oiliness

When looking for efficient anti-stats for electronic packaging applications, it's a requirement that they function well at low humidity conditions and that they cause no negative effects such as stress-cracking of polycarbonate and that they cause no oily residue on the packaging surface.

Conventional anti-stats such as ethoxylated amines and diethanolamide are known to cause stress-cracking and in the case of amides lead to excessive migration resulting in the development of an oily residue on the packaging film.

By switching to **Einar® 601**, a plant-based anti-static additive, manufacturers of polyethylene electronics packaging can overcome these challenges and benefit in several ways:

ENHANCED PERFORMANCE IN LOW HUMIDITY

Einar® 601 is specifically formulated to maintain its effectiveness in low humidity conditions. It provides consistent static control, reducing the risks of electrostatic discharge damage to sensitive electronic components.

PREVENTION OF POLYCARBONATE STRESS-CRACKING

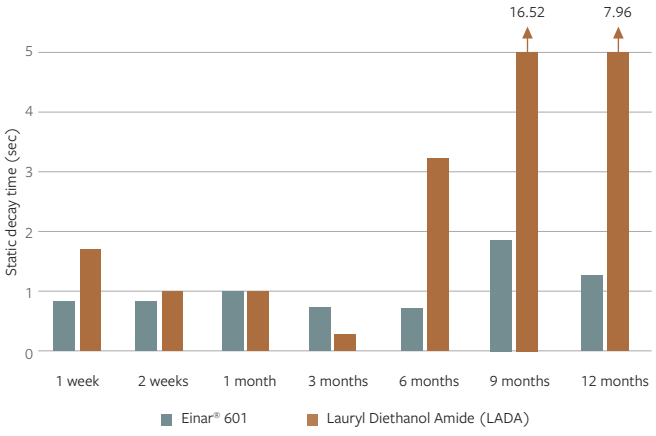
PC is a popular material for electronic components due to its mechanical strength and dimensional stability. However, using traditional additives can lead to stress-cracking in PC, compromising safety and functionality of the finished product. **Einar® 601** offers excellent compatibility with PC, ensuring that stress-cracking risks are minimised.

REDUCED OILINESS OF PACKAGING FILM

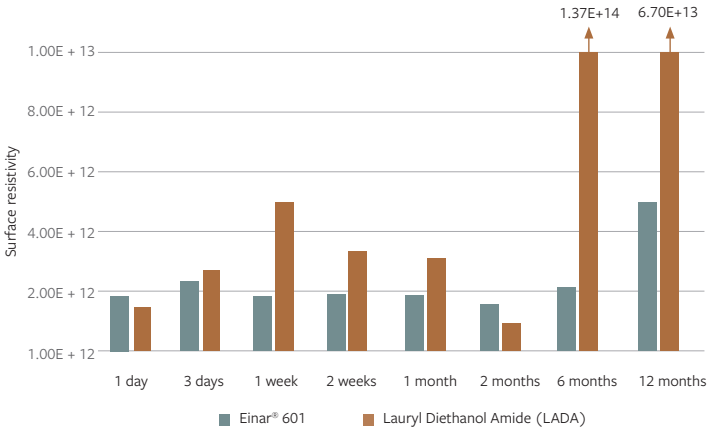
Traditional anti-static additives may leave an oily residue on the packaging film, making it difficult to handle and potentially contaminating the electronic components. **Einar® 601**, in contrast, produces less oiliness even at the same typical dosage, improving manufacturing efficiency and product quality by keeping the film clean and easy to handle.

By making the switch to **Einar® 601**, manufacturers can achieve improved performance, prevent stress-cracking, minimise oiliness and reduce costs in their electronics packaging, particularly in low-humidity conditions.

ANTI-STAT PERFORMANCE IN LDPE BLOWN FILM
Additive concentration is 0.3%, measured at 12% RH.



SURFACE RESISTIVITY IN LDPE BLOWN FILM
Additive concentration is 0.3%, measured at 12% RH.



Anti-stat application support

Palsgaard has acquired extensive expertise in plant-based anti-static polymer additives. Continuous research, development and sampling at our Polymer Application Centre make sure that customers stay in the lead of the most effective and cost-efficient anti-stat technology for their particular needs, resulting in end products with enhanced sustainability and safety at no compromises in quality or performance.

The Centre is fully equipped for flexible and precise testing to support new application developments or assist customers in evaluating and comparing the performance of **Einar®** anti-static solutions vs. their current additives. Capacities include injection moulding, blown and cast film production equipment as well as comprehensive testing facilities for material characterisation and additive performance, such as static decay time and surface resistivity at both ambient and low humidity. For colour masterbatches, specialised filter pressure, particle count and colour strength measuring solutions have been developed to help optimise pigment dispersion.

This allows customers to convince themselves of the benefits derived from **Einar®** plant-based additives for the quality and sustainability of their products by means of conclusive sampling and optimization trials at the source.

ABOUT BJARNE NIELSEN

Bjarne Nielsen is Business Development Manager for Polymer Additives at Palsgaard. In this role since 2016, he is responsible for the business development of glycerol esters and food-grade additives for use in applications outside the food industry in polymers and personal care products.

Bjarne brings close to 30 years of experience in the development of new products and applications in this field. He has a successful track record of working closely with many different customers to understand and develop new opportunities, resulting in several patented products, successful innovations and commercial applications.

Prior to joining Palsgaard, Bjarne has been working in product development as well as delivering development and technology services to customers around the globe for approximately 23 years at Danisco/DuPont.

Bjarne has a background in Chemical Engineering and holds a Master's degree from Danish Technical University (DTU) in Lyngby, Denmark.

To learn more about Palsgaard's plant-based, food-grade polymer additives, please visit **www.palsgaard.com** or contact us directly here:

CONTACT US