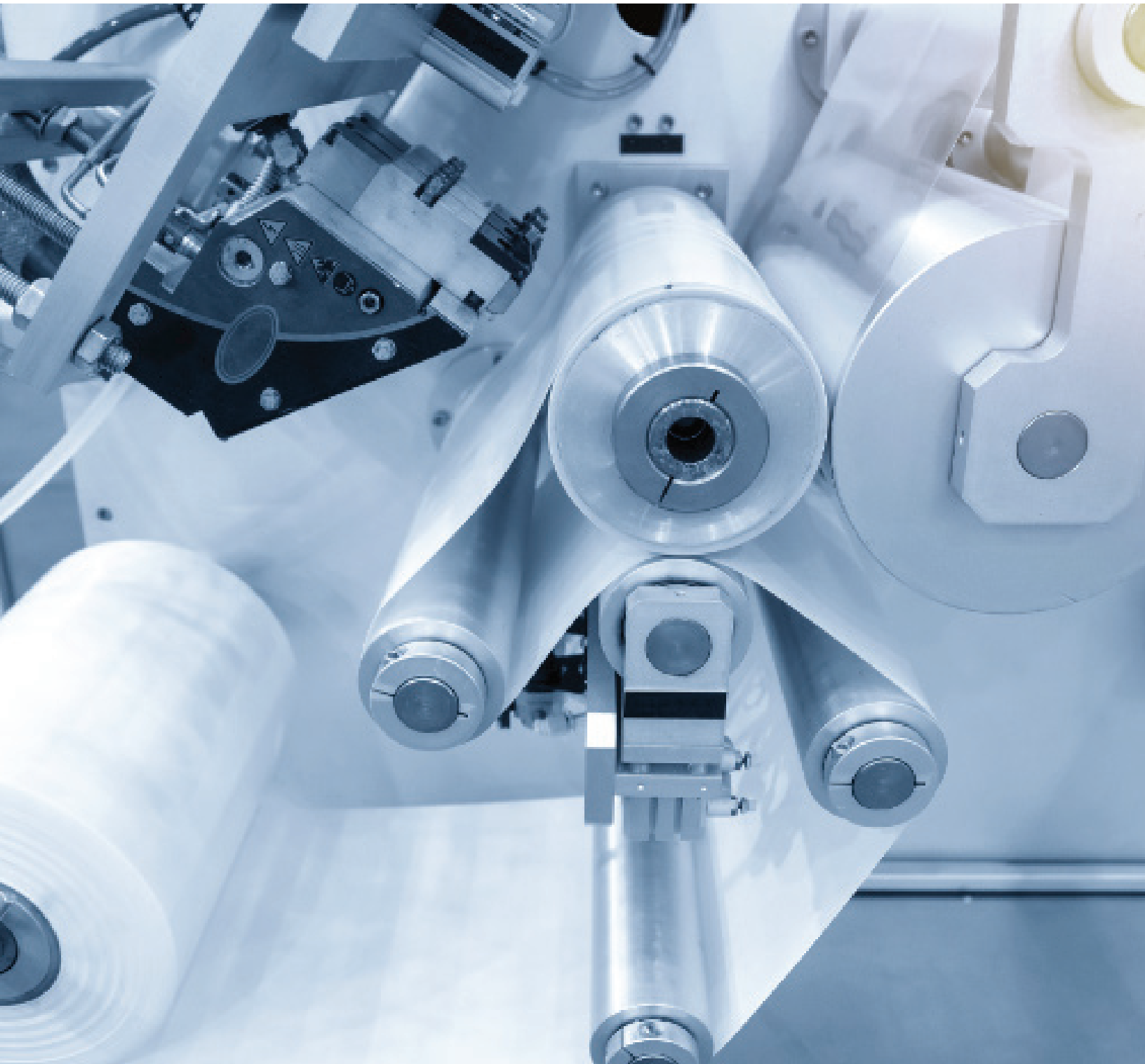
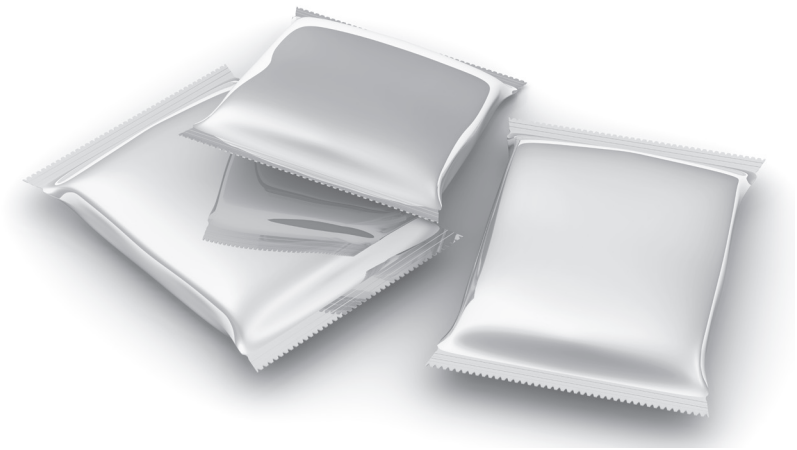
DuPont permanent slip solutions for flexible packaging



Transforming industries and improving lives through material science.

The foundation of everything we do at DuPont centers around what our customers need. It's not just about the solutions we innovate, but also how we work with our customers.

Through our worldwide network of innovation and technical centers, our leading researchers work in close collaboration with customers, from concept to commercialization, using a wide range of processing, prototyping technologies and testing expertise.



DuPont is proud to be a reliable partner to the films and packaging industries.

MULTIBASE™ thermoplastics additives contain high or ultra-high molecular weight siloxane, pre-dispersed and/or reacted in a range of polymer-carriers and specially engineered to deliver multiple benefits for greater design freedom and production efficiencies.

These easy-to-use pellets enable processing improvements for both the compound manufacturer and processor. They can also extend the material properties of both thermoplastic compounds and finished components, depending on the masterbatch additive formulation and application requirements.

We offer the most innovative range of high-performance additives for packaging manufacturers, converters and packaged goods OEMs, and we continue to drive material innovation to solve evolving challenges in the industries we serve.

Market trends and challenges

As the population becomes increasingly clustered in cities and away from agricultural settings, global urbanization and the growth of the middle class have led to a rise in the demand for packaged food.

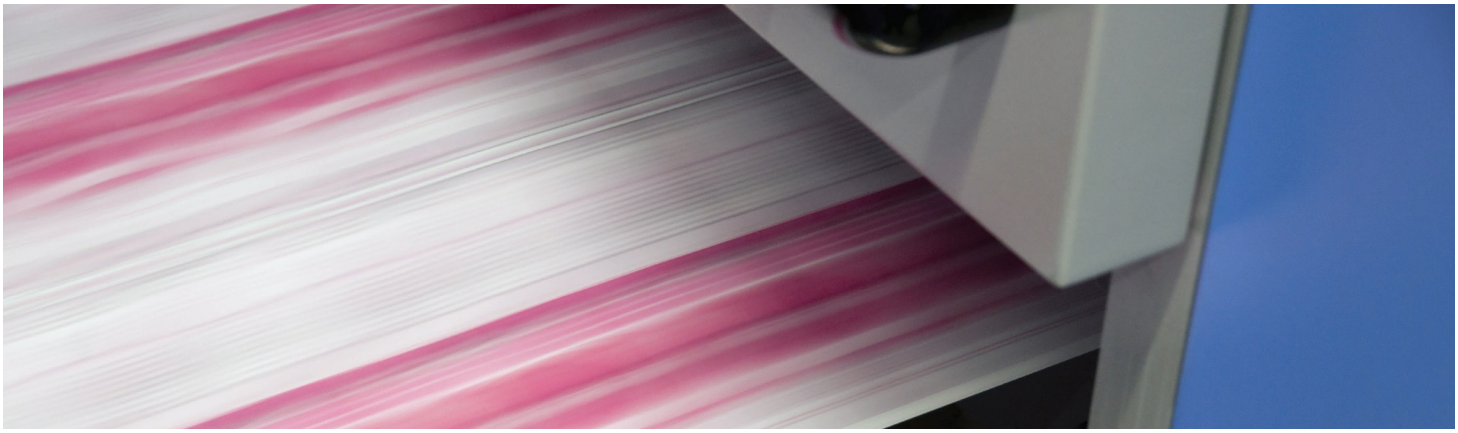
Consumers are more concerned about health and wellness and have preferred packaged foods with extended lifespans. Busy and time-constrained lifestyles have pushed consumers to choose products that offer convenience and portability. These trends, combined with the continued rise of e-commerce, have over the last decade contributed to the growing popularity of flexible packaging over rigid packaging. Key benefits include improved economics and reduced pack weights, with lower transport costs and a reduced footprint. As efforts to limit food waste along the global supply chain and the need for portion packaging have increased, pouches have seen particular traction within the flexible packaging market.

Challenges

A major challenge in transitioning from rigid to flexible formats is the fill line speeds. New generations of form-fill-seal machines (VFFS, etc.) have set new standards in production speeds and sealing techniques and are prompting plastic film processors, pack fillers and packaging manufacturers to seek new ways to optimize production efficiency, control costs, and simplify supply chain management to meet tighter delivery schedules. Stable, long-lasting slip additives are critical for reducing stress on Low-density Polyethylene (LDPE)-blown films and Biaxially Oriented Polypropylene (BOPP) films used in high volume for high-speed form-fill-seal (FSS) packaging operations. Lowering Coefficient of Friction (CoF) on film surfaces can boost productivity and ensure consistent film quality and uninterrupted throughput.

Organic slip additives or migratory slip additives have been the traditional choice. But their efficiency can be compromised over time or when heat is applied. Also, because they migrate, some molecules can transfer and impact printability or other post-process operations on the opposite layer.

DuPont's AMB-12235, MB25-235 and HMB-6301 additives have been engineered to address the complex challenges posed by the packaging industry. These permanent slip additives provide exceptional permanent low Coefficient of friction effect against metal to enable higher throughput and productivity in polyolefin film processing (e.g., FFS process)



Prioritizing sustainability

DuPont makes it easy for customers to pursue both their short- and long-term sustainability goals, as our innovation culture embraces green chemistry principles.

The entire packaging value chain is responding to the needs of the planet, whether this means using more energy-efficient processes, designing durable, multi-use products, taking a designed-to-recycle approach or setting up a circular economy.

These objectives align with a commitment to sustainability, as modified polymers can support initiatives such as reducing waste, lowering energy consumption and increasing the durability of final products.

MULTIBASE™ additives support extended lifespans for end applications, enable more effective manufacturing to reduce energy consumption and scrap, and often permit lower-complexity formulations in support of recyclability.

The United Nations' 17 Sustainable Development Goals served as guiding principles for DuPont's nine ambitious and measurable sustainability goals, to be achieved by 2030. Our annual sustainability report details our progress: dupont.com/sustainability.

The DuPont solution: Non-migrating slip and slip anti-block additives

As non-migrating agents, MULTIBASE™ additives deliver consistent performance over time and in high-temperature conditions, thus maintaining a low CoF from film production to bag formation.

MULTIBASE™ additives also offer several cost advantages. They are effective at low loadings and need to be incorporated only in the outer (skin) layer of multi-layer films, thus reducing the amount required.

DuPont additive solutions enable easier formulation steps. The additive level remains the same to reach the right CoF regardless of skin layer thickness. Processing advantages include smooth feeding of the non-sticky masterbatch pellets into the extruder. The formulation also prevents die build-up and gel formation.

Multilayer film type	Resin in skin layer of the film	Recommended grade	Usage recommendation
LDPE blown films	VLPE – Density 0.9-0.902	AMB-12235*	4-6%
	LDPE/LLDPE Density> 0.91	MB25-235	2-4%
BOPP films	Polypropylene Terpolymer	HMB-6301	3-4%

***contains anti-block**

Features & Benefits

- Stable, long-lasting slip performance even in high-temperature environments
- Non-migration across film layers and intra layer
- No transfer to the opposite layer
- Limited to no increase in haze that could affect film clarity
- Maintenance of key mechanical properties

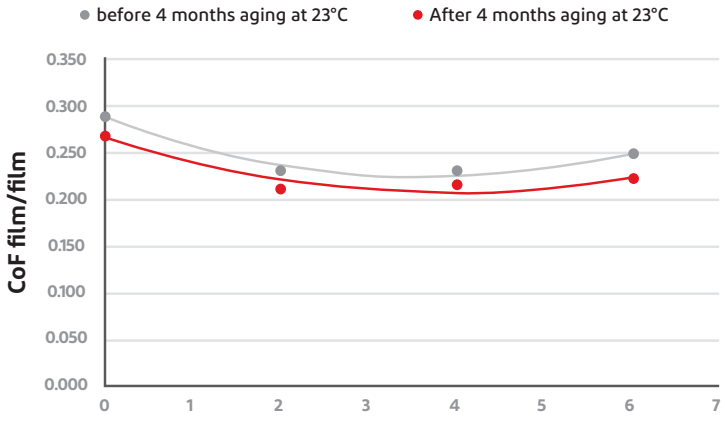
Applications

- Multilayer Polyethylene blown films and BOPP films for use in bags, wrappers, packages and pouches
- Compatible and efficient in LDPE, LDPE/LLDPE blends, VLDPE resins, Polypropylene Terpolymers

Solutions for multilayer polyethylene blown films

For Low-density Polyethylene (LDPE, LLDPE or blends) MULTIBASE™ MB25-235 permanent slip additives offer a low and very stable CoF performance over time and temperature.

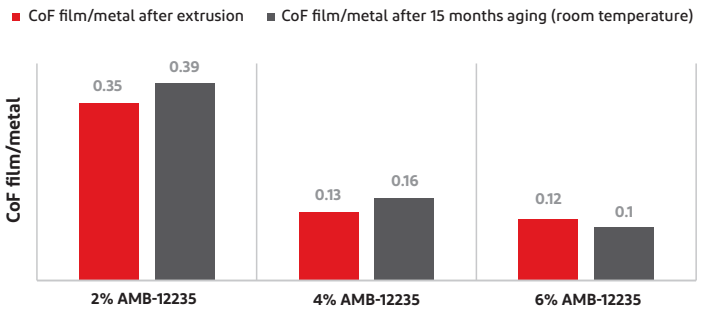
Dynamic CoF film/film **BEFORE AND AFTER AGING** as a function of MULTIBASE™ MB25-235 Masterbatch content (+3000ppm AB = Talc)



Low sealing ignition temperature Very Low Density Polyethylene (VLDPE) resins

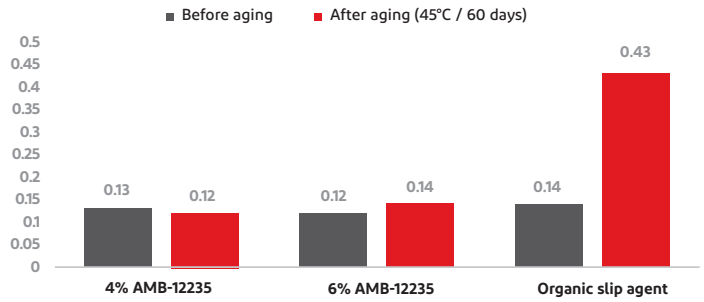
MULTIBASE™ AMB-12235 permanent slip anti-block additive responds to the new level of complexity to reach high slip effect in very tacky resins (VLDPE, densities~ 0.902g/cm^3) used in sealing layers of multilayer Polyethylene blown films.

Influence of time on the slip efficiency



Dynamic CoF film/metal of a VLDPE-based skin layer after 15 months storage at room temperature

Influence of temperature on the slip efficiency

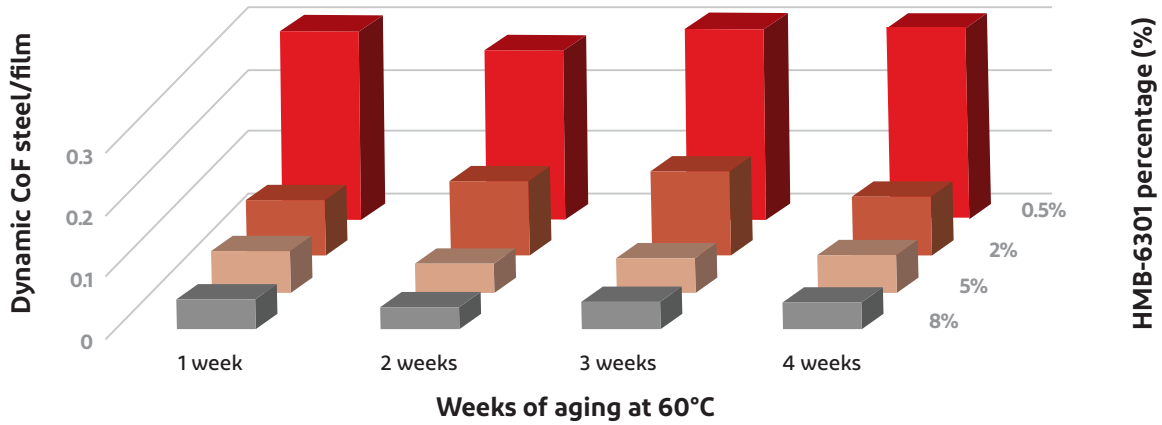


Dynamic CoF film/metal of a VLDPE-based skin layer before and after aging (45°C/60 days) depending on slip additive type and concentration

Solutions for Bi-oriented Polypropylene Films (BOPP)

MULTIBASE™ HMB-6301 is a unique slip additive technology that delivers stable, long-term slip performance without migration to facilitate packaging production processing of BOPP films.

Dynamic CoF film/steel of Low SIT skin layer of BOPP film versus amount of MULTIBASE™ HMB-6301 over time at 60°c



Extend properties, enhance processing, reinforce materials.

Combining an industry-leading portfolio of silicone-based additives and masterbatches—plus deep experience in serving the industries that use them—we can help you capture greater efficiencies in production while delivering more performance, durability and quality to your end users.

To learn more about our wide range of plastics, please visit dupont.com/multibase and contact us if you have any questions.

Mobility & Materials

DuPont Mobility & Materials (M&M) delivers a broad range of technology-based products and solutions to the consumer goods, industrial, transportation, electronics and healthcare markets. M&M partners with customers to drive innovation by utilizing its expertise and knowledge in polymer and materials science. M&M works with customers throughout the value chain to enable material systems solutions for demanding applications and environments. For additional information about DuPont Mobility & Materials, visit dupont.com.

Global capability. Local solutions.

Innovation Centers

Mainland China
Japan
Russia
Switzerland
Taiwan
Turkey
United States
- Arburn Hills, MI
- Silicon Valley, CA
- Wilmington, DE

Major R&D Centers

Canada
France
Mainland China
Japan
Korea
Switzerland
Taiwan
United States
- Wilmington, DE
- Marlborough, MA
- Midland, MI
- Silicon Valley, CA

No. 001-20540-AVI0321