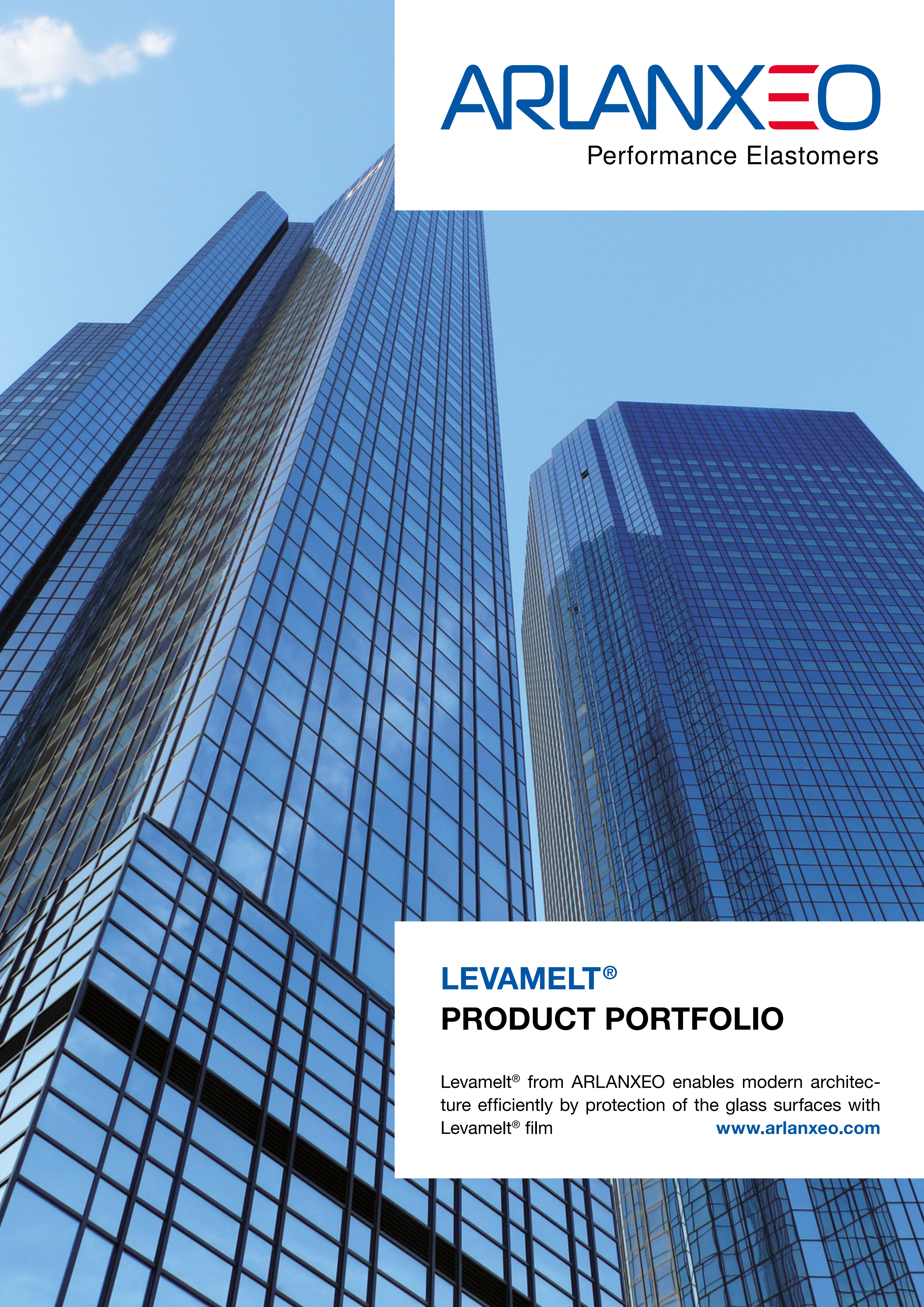


ARLANXEO
Performance Elastomers

LEVAMELT®
PRODUCT PORTFOLIO

Levamelt® from ARLANXEO enables modern architecture efficiently by protection of the glass surfaces with Levamelt® film

www.arlanxeo.com

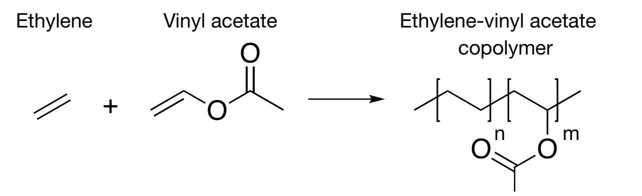
LEVAMELT®
PRODUCT PROPERTIES

Levamelt®

Polymer properties

Levamelt® is formed by copolymerization of ethylene and vinyl acetate (VA). In principle Levamelt® consists of methylene units forming a saturated polymer backbone with pendant acetate groups. These polymers are designated ethylene-vinyl acetate copolymers (EVM)[1] according to ISO 1629 : 2015 (E) nomenclature. The presence of a fully saturated main chain already indicates that Levamelt® is a particular stable polymer. Degradation generally only occurs at very high temperatures and even then very slowly.
These polymers are used as synthetic rubbers, as adhesive raw materials or as modifiers in thermoplastics, in particular in polyvinyl chloride (PVC). The adhesive raw materials and plastic modifiers are sold under the brand name Levamelt®.

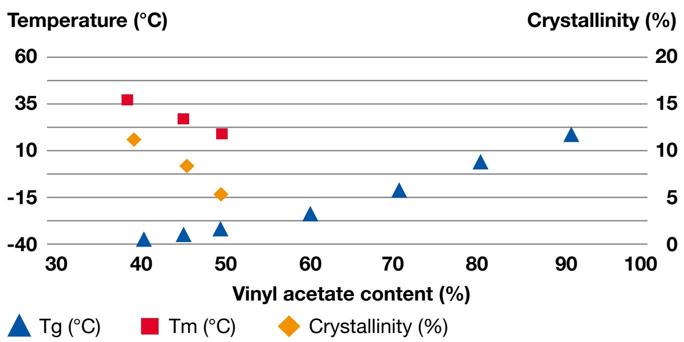
Radical polymerization – chemical structure of Levamelt®



Influence of the VA-content on morphology

The higher the proportion of vinyl acetate in the copolymer, the stronger the regularity of the ethylene chain is interrupted. Crystallization is reduced and becoming entirely absent at a vinyl acetate content of approx. 60 wt.%. Hence copolymers with a high vinyl acetate content are amorphous.

Influence of the VA-content on morphology



Tg = Glass transition temp   Tm = Melting temp

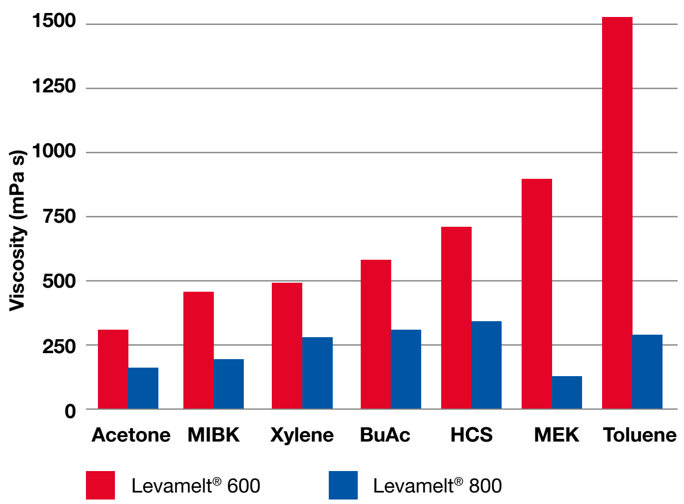
[1] In accordance with ISO 1043-1:2016, the abbreviation EVAC is to be used for thermoplastics. The abbreviation EVA is also frequently found.

Levamelt® in solution

Levamelt® can be used in solvent-borne adhesive applications. Solvents for various Levamelt® grades can be aromatic and chlorinated hydrocarbons, as well as cyclic ethers. Alcohols do not dissolve Levamelt® copolymers, while esters, ketones, and aliphatic hydrocarbons have a strong swelling effect.

Storing Levamelt® solutions at low temperatures will cause gelation which, however, is reversible upon mild heating and agitation without any adverse effect.

Viscosity of 15 % Levamelt® solutions



MIBK = Methyl Isobutyl Ketone   BuAc = Butyl Acetate
HCS = Solvesso 100   MEK = Methyl Ethyl Ketone

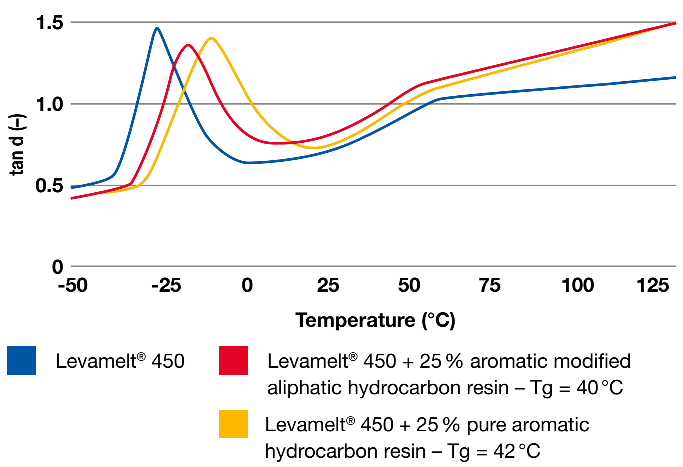
Levamelt® for hot-melt applications

Compared to EVA copolymers with lower vinyl acetate contents, Levamelt® grades provide improved adhesion characteristics, better low-temperature adhesion, and are particularly useful in the formulation of pressure sensitive hot-melt adhesives. Levamelt® 456, having the highest melt flow index / lowest molecular weight, is the preferred polymer in case low melt viscosities are required. Levamelt® 450 and 452 are utilized, either alone, or in a blend with Levamelt® 456 resulting in enhanced heat strength.

Since Levamelt® copolymers have very little inherent tack and comparatively high melt viscosities, further compounding with other resins is necessary in order to render them useful for adhesive applications. The type and level of resin varies widely with the properties required and the intended end-use. Typical resins include modified and unmodified wood rosins and wood rosin esters, respectively.

The compatibility of Levamelt® with different tackifier resins has been verified by dynamic mechanical analysis (DMA). The next graph shows a good compatibility of different tackifiers with Levamelt® 450.

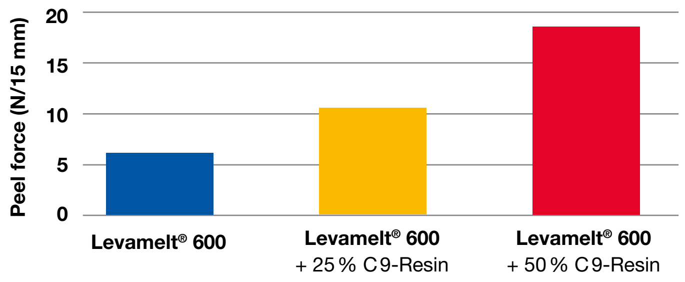
Compatibility of Levamelt® with tackifiers



Influence of tackifier on Levamelt®

Further the influence of the amount of tackifier (C9 hydrocarbon resin) was evaluated: the tackifier (C9 hydrocarbon resin) was increased from zero up to 50 % in Levamelt® 600 and the peel force on steel was measured.

Influence of tackifier on peel force



LEVAMELT®
ADHESIVE FILMS

Levamelt® in adhesive films

Levamelt® is particularly suitable for the production of adhesive films for a wide range of applications in various industries.

Depending on the grade that is used and the surface such films are applied to, low up to semi-permanent adhesion can be achieved. Despite Levamelt® being an inherent sticky material, its supply form are yet free-flowing pellets, facilitating the production of adhesive films via co-extrusion without the need of processing additives.

The adhesion properties of Levamelt® can be adjusted by blending with polyethylene, resins or waxes.

Production of adhesive films

A classical approach to manufacture adhesive films is the lamination of a film that has been produced in a separate extrusion process with a solvent-borne or dispersion adhesive.

Prior to the application of the adhesive e.g. by means of roller coating, two additional steps are needed. First the adhesive solution or dispersion must be prepared in a complex process. Secondly the conditioning of the film surface e.g. via a corona pretreatment is needed to reach a sufficient bonding of the adhesive layer to the plastic. The last step is commonly integrated either within the extrusion or the coating stage. The use of solvent-borne or dispersion adhesives requires the extraction of volatile matters. This downstream drying stage represents a very energy-consuming sub-process.

In contrast, Levamelt® provides the option to produce an adhesive film by means of co-extrusion, thus reducing overall process steps. In short: all raw materials needed can be processed within the same stage, with no requirement for time and energy consuming pre- and post-processing.

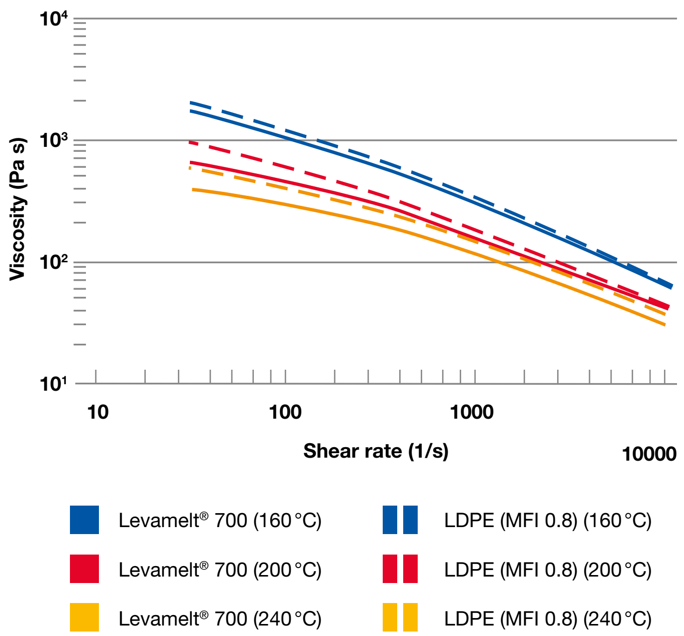
Co-extrusion of Levamelt® with polyolefines

Two materials are co-extrudable if they display a similar viscosity at process conditions. Commonly, polyolefines are used as backing material e.g. for protective or lamination films. The melt flow index (MFI) of low density polyethylene (LDPE) ranges typically between 0.5 and 3 g/10 min depending on blow or cast film grade, whereas the MFI of most of the Levamelt® grades lies in the range of 5 g/10 min.

This – at first sight – suggests, that co-extrusion with polyethylene is not possible. However the viscosity of a polymer varies with shear rate and temperature. The MFI measurement is a single-point method and provides only information on a given temperature and a given shear rate that are not necessarily representative for real-life-processing conditions. Thus, high pressure capillary viscosimetry represents a more suitable method for the coextrusion process.

The diagram shows that the curves of Levamelt® match those of LDPE very closely particularly at low processing temperatures (~160 °C) and increasing shear rates. Hence – as proven in practical trials – both materials can in fact be co-extruded.

Viscosity of Levamelt® and low density polyethylene (LDPE)



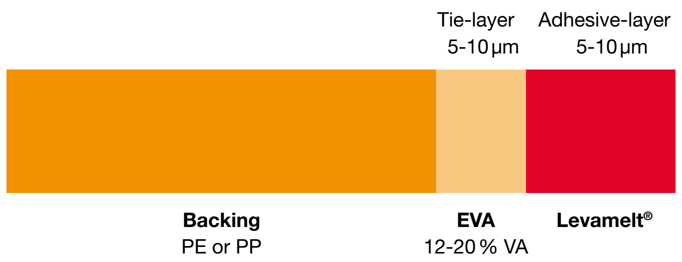
General considerations on layer construction

To ensure a good bonding of the adhesive Levamelt® layer to the polyolefinic backing (such as LDPE or LLDPE) an EVA-based tie-layer should be used. This means that at least a three layer construction of the film is necessary (see picture below). The tie-layer material has a good adhesion to both the Levamelt® and the polyolefine. It acts as compatibilizer between the two materials as a result of its intermediate VA content. In fact the adhesion of the tie-layer interface is even higher than the adhesion of the Levamelt® to typical surfaces such as metal, glass, different plastics or varnishes and lacquer. This is important particularly for protective films in order to ensure smooth removal without residues.

The higher the VA content of the Levamelt® is, the higher the VA content of the tie layer material should be. The EVA should have a minimum VA content of 12 wt.% – or even better 15 wt.% – and maximum VA content of about 18 wt.% to 20 wt.%. This kind of layer construction has the advantage of a very low backing adhesion, thus the film roll can be uncoiled easily.

The choice of the backing material is mainly based on the required mechanical properties of the film such as stretch properties, puncture resistance and required flexibility. The addition of processing agents such as anti-block packages (i. e. silica) provides an uncritical micro-rough surface, thus preventing the inner layer of the folded film from sticking. In contrast to this the use of erucamide slipping agent might cause a slight reduction of the interface adhesion. Furthermore the bulk layer can comprise various layers to allow further design options, e. g. using an outer layer with additives to allow printability. Such a film construction can

Layer construction with Levamelt®



Extrusion of Levamelt®

Considering rheological aspects, both blown film and cast film extrusion represent suitable processing technologies for Levamelt®. Levamelt® can be processed undiluted or blended to adjust the stickiness of the adhesive layer. Blending of different Levamelt® grades also with polyethylene is possible. For this purpose a low viscous LDPE grade without any slipping agent should be applied. Test with a LDPE containing erucamide showed that the adhesion decreases significantly even if only some weight-percents are used. As to the temperature setting of the extruder only the feeding zone might be a critical factor. Levamelt® is a material with an inherent high cold flow. Thus cooling down the feed is essential to avoid clogging, especially if a grooved barrel extruder is used. In this case a temperature of 80 °C should not be exceeded. Apart from this a constant increase along the flow path of the melt up to die temperature is acceptable.

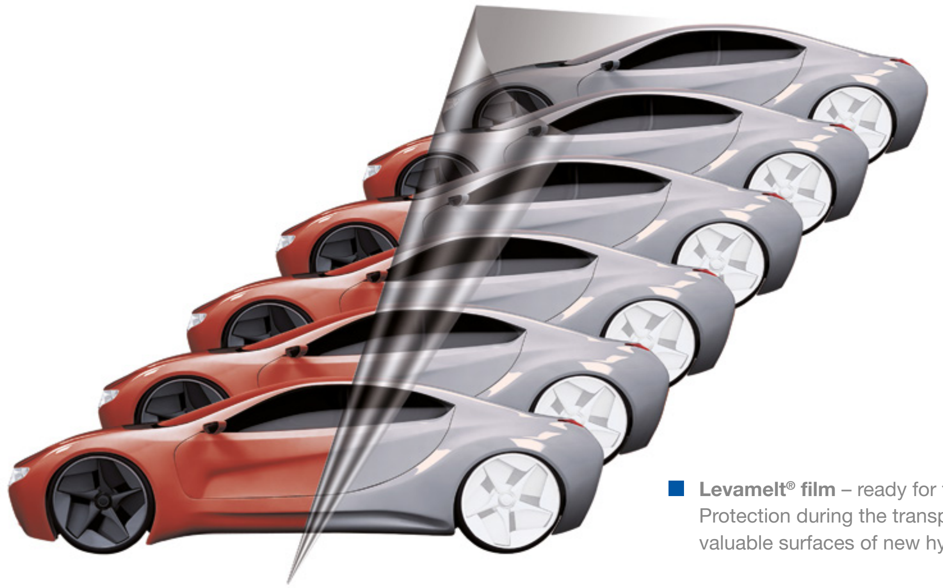
For the extrusion of Levamelt®, material considerations similar to those given for thermoplastic EVA grades need to be obeyed. Degradation of the polymer melt can occur due to excessive temperature stress. Therefore components that are in contact with the melt such as extruder, adaptor and die components should be constructed from corrosion resistant alloys or surfaced with durable chrome plating. Nevertheless Levamelt® is a relatively temperature-resistant material. Concerning the screw design no special recommendation can be given. Tests have shown that screws designed for the processing of polyolefinic materials are suitable.

Levamelt® adhesive film properties

In order to determine the adhesive properties of Levamelt® on different surfaces, a 30 µm Levamelt® layer was applied to a 100 µm plastic backing film by extrusion coating processes. Subsequently film samples were punched and laminated to various substrates at room temperature. Following over night storage the peel force was determined in a 180° angle peeling test using standard tensile test equipment. The next chart shows the peel force of different Levamelt® grades on stainless steel and polycarbonate (representing metal and polymeric surfaces).

Within the semi-crystalline Levamelt® grades the adhesion to both stainless steel and polycarbonate rises with increasing VA content. This effect can be traced back to the growing polarity of the material. For the amorphous grades counteracting effects dominate. As already discussed at the beginning the glass transition temperature increases progressively depending on the VA content. This implies that the difference between application and glass transition temperature becomes significantly smaller and the mechanical bonding to the surface decreases. This effect is not observed at higher application temperatures.

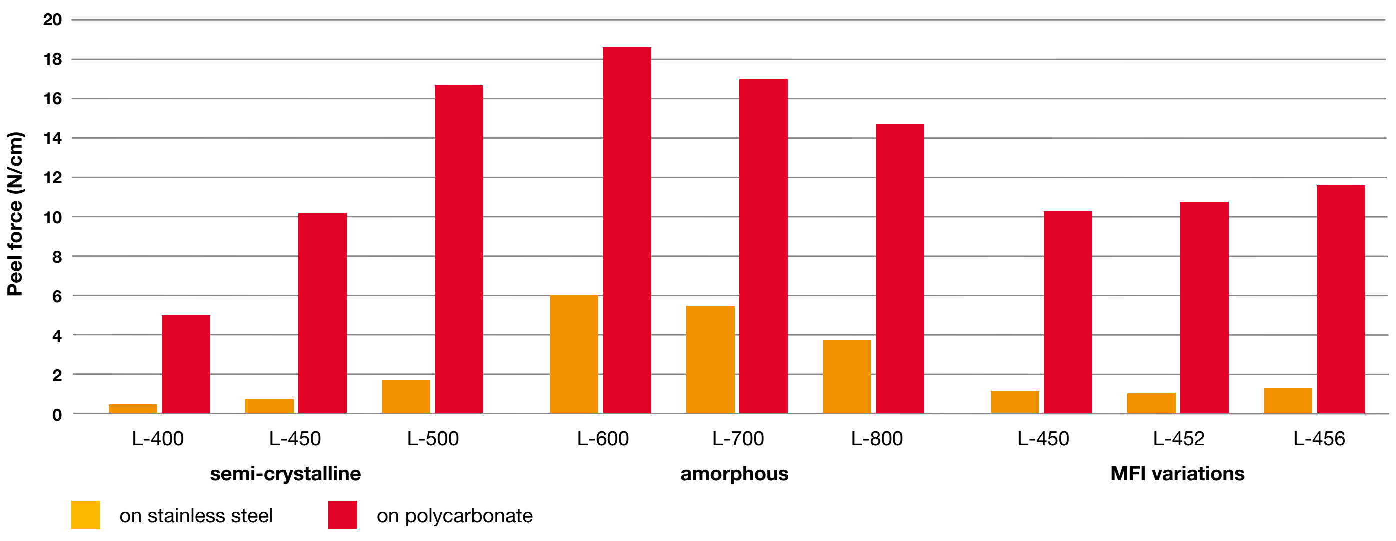
With decreasing viscosity a better wetting of the surface and thus increasing peel forces can be expected, which can be observed in the case of polycarbonate and stainless steel.



Levamelt® film – ready for the future: Protection during the transport for the valuable surfaces of new hybrid sports-cars

Levamelt®

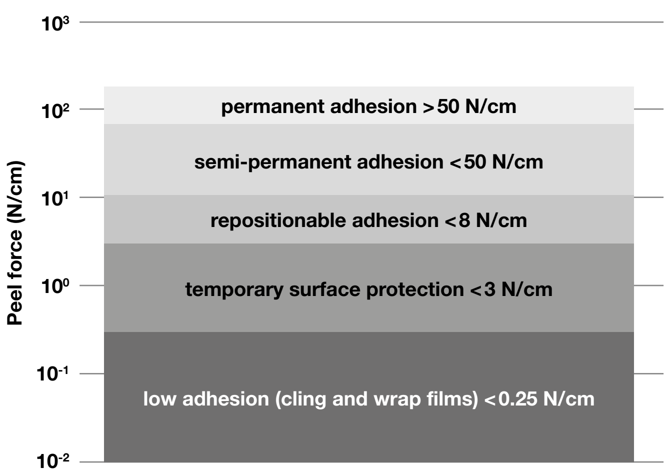
Peel forces of different Levamelt® grades



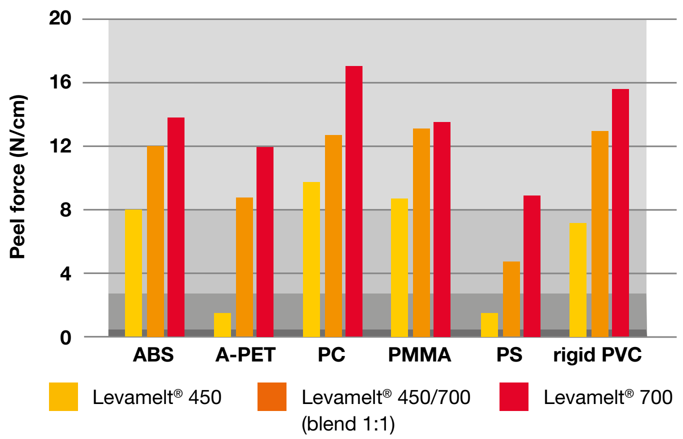
Depending on the Levamelt® grade used and the surface the adhesive film is applied to, Levamelt® covers the applications of temporary surface protection, repositionable adhesive tapes and is even useful for semi-permanent adhesion (as can be seen in respective charts).

In both diagrams another option of Levamelt® is shown: Individual peel forces to the requirements of different applications can be matched by blending two or more grades. Beyond the presented values it is possible to achieve lower peel forces even on high adhesion substrates by diluting Levamelt® with different kinds of polyethylene such as m-PE or LDPE.

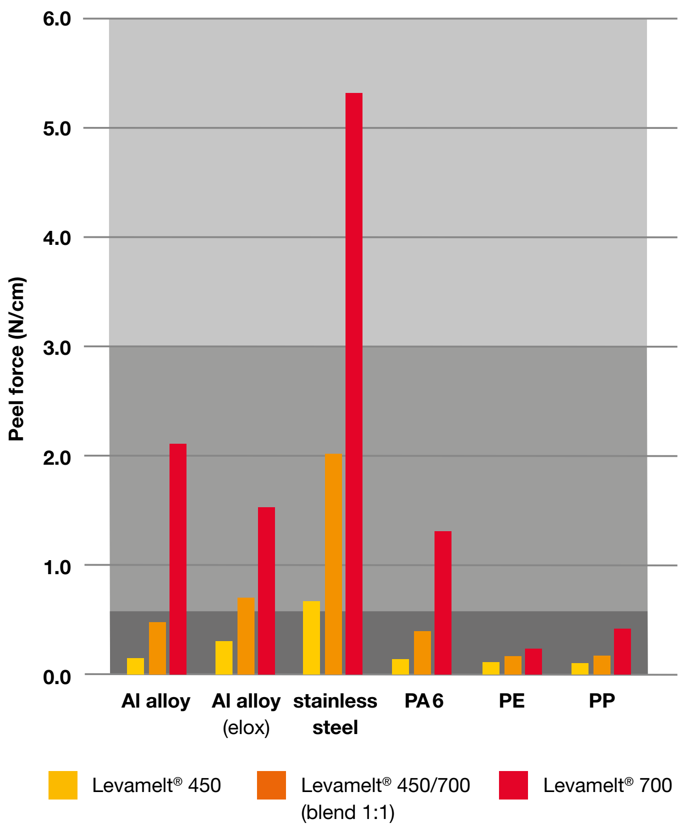
Overview about the customary peel force required for different applications



Semi-permanent adhesion to temporary surface protection



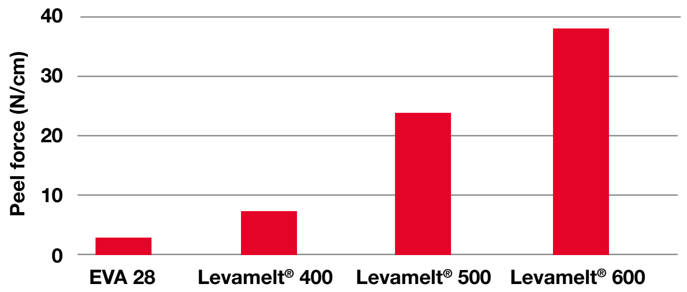
Repositionable to low adhesion



Hot lamination with Levamelt®

Beside the adhesion of cold laminated films, hot application is interesting, in particular in the area of food packaging. To enhance the sealing properties, PVC trays often are laminated with a polyolefine film. As lamination layer thermoplastic EVAs are commonly used – however with limitations with regards to achievable peel forces. The next chart shows a comparison of an EVA with approx. 28 wt.% VA content versus various Levamelt® grades. EVA and the Levamelt® samples were laminated on PVC at 80 °C. The subsequent peel test resulted in up to eight times higher adhesion values for Levamelt® compared to the thermoplastic EVA.

Comparison of EVA to various Levamelt® grades



Levamelt® range and supply form

	VA content (wt.%)	Melt flow index[1] (g/10 min.)	Density (g/cm³)	Supply form	Packaging
Levamelt® 400	40 ± 1.5	3 ± 2	approx. 0.98	granules, almost colorless	25 kg bags[3] on pallet, 1000 kg net
Levamelt® 450	45 ± 1.5	3 ± 2	approx. 0.99		
Levamelt® 452	45 ± 1.5	10 ± 5	approx. 0.99	granules, almost colorless	25 kg bags[3] in cardboard boxes on pallet, 1000 kg net
Levamelt® 456	45 ± 1.5	25 ± 10	approx. 0.99		
Levamelt® 500	50 ± 1.5	2.75 ± 1.25	approx. 1.00		
Levamelt® 600	60 ± 1.5	2.75 ± 1.25	approx. 1.04		
Levamelt® 650 VP[2]	65 ± 2.0	4 ± 2	approx. 1.05		
Levamelt® 686	68 ± 2.0	25 ± 10	approx. 1.06		
Levamelt® 700	70 ± 1.5	4 ± 2	approx. 1.07		
Levamelt® 800	80 ± 2.0	4 ± 2	approx. 1.11		
Levamelt® 900	90 ± 2.0	4 ± 3	approx. 1.15		

[1] 190°C/2.16kg, MFI and MFR (Melt flow rate) are similar.
[2] VP = Versuchsprodukt = trial product
[3] Material of the bags is based on EVA-copolymer resin, melting point 93 °C, film thickness 0.13 mm. Bags should always be removed if the compounding temperature does not significantly exceed the softening point.

Under suitable conditions Levamelt® can be stored for 36 months from the date of production. High temperatures or pressure may cause the granules to agglomerate, so that free-flowing properties cannot be guaranteed (detailed storage conditions are to be found in the product data sheets).

Trial product:
(VP = Versuchsprodukt = trial product). The information contained herein is merely preliminary. Testing as to properties and applications is not final. Further information, including data which could change or add hazards with use, may be developed by the manufacturer, the user or a third-party institute. Such information may be needed to properly evaluate or use this product. Use is undertaken at the sole risk of the user.

Quality & Environmental Management:
Levapren® is produced under strict control regarding safety, environmental protection and quality. The whole supply chain, from production to customer service, is covered by ISO 9001 and ISO 14001 certification.

Product Safety:
Relevant safety data and references as well as the possibly necessary hazard warning labels can be found in the Material Safety Data Sheets.

Health and Safety Information:
Appropriate literature has been assembled which provides information concerning the health and safety precautions that must be observed when handling the ARLANXEO products mentioned in this publication. For materials mentioned which are not ARLANXEO products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be followed. Before working with any of these products, you must read and become familiar with the available information on their hazards, proper use and handling. This cannot be overemphasized. Information is available in several forms, e.g., material safety data sheets and product labels. Consult us through your ARLANXEO representative or the Health, Safety, Environment and Quality Department (HSEQ) of ARLANXEO.

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