M⁘COM

Alfater XL®
Processing Guide
2K Molding with Polyamide

Alfater XL® is a thermoplastic vulcanizate elastomer (TPV) based on PP and cross-linked EPDM.

The Alfater XL® 4PA series is optimized for adhesion to PA6 and PA6.6. This series is therefore very suitable for multi-component injection molding such as 2K molding or (cold) insert molding (often also called overmolding). Typical 2K applications include soft-touch handles or seals, e.g., for housings.

Processing of TPV is generally different from conventional thermoplastics. The following processing guide aims to provide a first support, especially for customers with less experience in TPV processing.

Pre-drying

Pre-drying of Alfater XL® 4PA for 2 - 4 hours at 70 - 80 °C in dry-air (desiccant) dryers is needed. Open bags should not be stored over a long period of time. Pre-drying of polyamide is essential for good adhesion. The residual moisture content of PA should be < 0.1 %, following the individual manufacturers' instructions or using the pre-drying conditions given in the technical data sheet of the PA.

Flowability and shrinkage

Alfater XL® 4PA are easy flow grades. Shrinkage of the Alfater XL® 4PA grades is anisotropic and comparable to conventional TPV. Softer Alfater XL® 4PA grades tend to shrink more than harder grades. Shrinkage depends strongly on the injection molding conditions and part design.

The shrinkage values for the Alfater XL® 4PA grades given below in the table have been measured on standard sample plates and are therefore only a guideline. Depending on the injection molding process, the processing conditions and the part design, these values can vary.

Alfater XL® 4PA	Guideline values for shrinkage (ISO 294-4, after 24 h)	
	Parallel to flow	Transverse to flow
Alfater XL® A55I 4PA0010 (Hardness: Shore A55)	1.7 - 2.7 %	1.5 - 2.0 %
Alfater XL® A70I 4PA0010 (Hardness: Shore A70)	1.3 - 2.2 %	1.2 - 1.7 %
Alfater XL® A85I 4PA0010 (Hardness: Shore A85)	1.2 - 2.0 %	1.1 - 1.6 %

In principle, the shrinkage behavior of Alfater XL® 4PA can be optimized or minimized to a certain degree by adjusting the injection molding conditions. Important parameters here include the selection of the injection speed, the cooling time and the holding pressure level as well as the holding time. Further information on this topic can be found in our separate shrinkage guideline.

Machinery

Three-zone polyolefin screws are recommended. The L/D ratio of the screw should be ≥ 20:1, preferably 24:1. The compression ratio df/dm of the screw should be between 2:1 and 3:1. Furthermore, the screw design should allow adequate shearing of the Alfater XL® 4PA. Specific mixing elements at the screw tip can improve homogeneity of the Alfater XL® 4PA melt. Very short and / or low shear screws, such as those used for PVC processing, are not recommended.

The clamping force of the machine should be higher than the separating force caused by the injection process otherwise quality problems can occur, e.g., flashing.

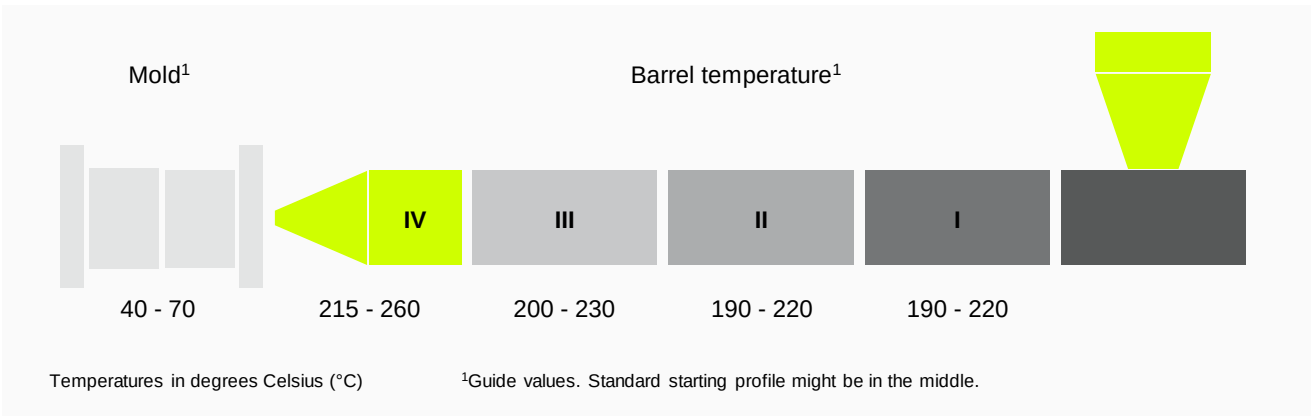
Injection or overmolding temperature

A gradually increasing temperature profile is recommended. The temperature profile below is a guideline and a starting point for process optimization.

Temperature adjustments can be necessary depending on the multi-component injection molding process applied, the part design, and the hardness of the Alfater XL® 4PA.

In order to achieve good adhesion of Alfater XL® 4PA to polyamide, a high interfacial temperature between the hard and the soft component is essential. Consequently, a high injection or overmolding temperature of Alfater XL® 4PA favors a high interfacial temperature and is therefore highly recommended for good adhesion.

The effect of the overmolding temperature on the adhesion is schematically shown on the following page in Figure 1. Ideally, the overmolding temperature for Alfater XL® 4PA should range from 230 - 260 °C. Temperatures considerably higher than 260 °C are not recommended, especially in conjunction with long residence times, because this can cause thermal degradation of Alfater XL® 4PA and / or evaporation of additives.



Temperatures in degrees Celsius (°C)

[1]Guide values. Standard starting profile might be in the middle.

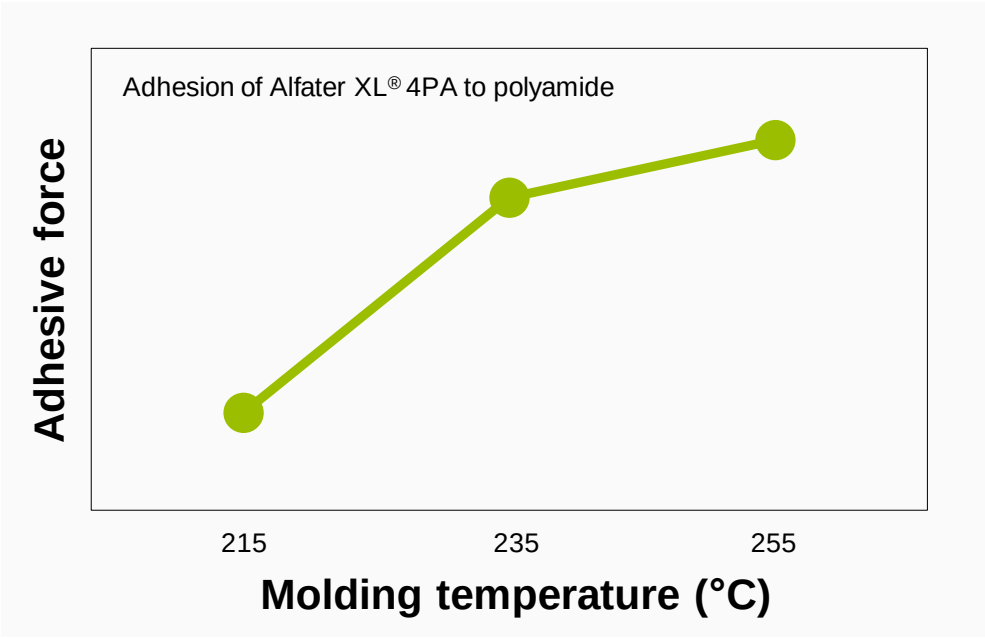


Figure 1: Influence of injection molding temperature of Alfater XL® 4PA on the adhesion to PA.

Delay time

The delay time is the time between the molding of the PA component and the following injection or overmolding with the Alfater XL® 4PA layer as the soft component.

Normally, an increasing delay time tends to have a negative effect on adhesion, as the interfacial temperature between the hard and soft components decreases significantly with increasing delay time. Figure 2 shows schematically this influence on the adhesion.

As a result, 2K molding processes with zero delay time between the molding of the PA substrate and the injection of the soft Alfater XL® 4PA layer are preferred instead of (cold) insert molding process (overmolding).

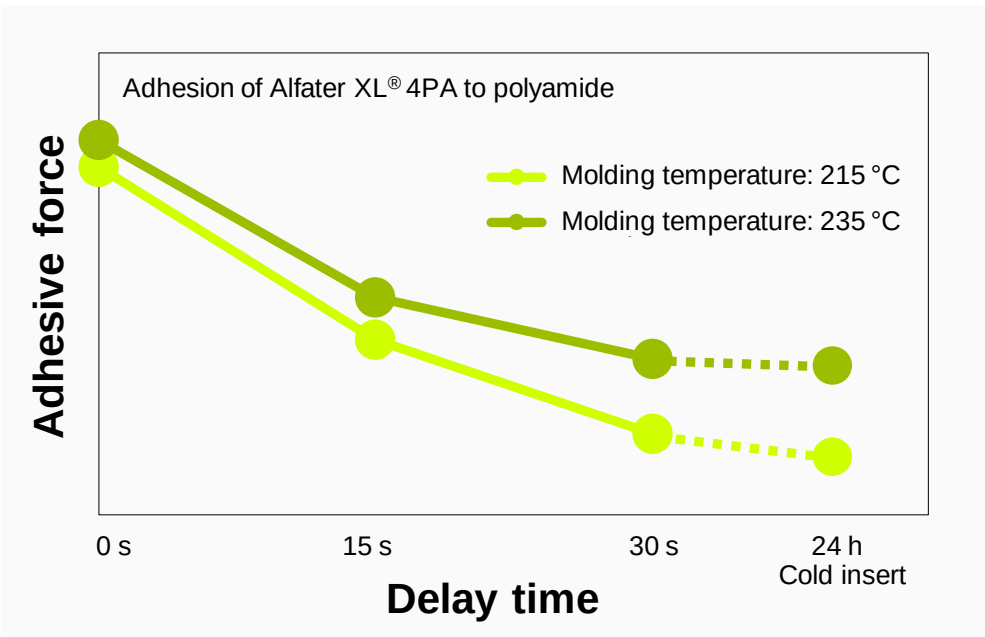


Figure 2: Influence of delay time (time before molding) of Alfater XL® 4PA on the adhesion to PA.

Injection speed

The viscosity of Alfater XL® 4PA is more sensitive to shear than to heat. For sufficient flow, mold filling and surface wetting of the PA substrate it is recommended to use rather high injection speed and fast mold filling of Alfater XL® 4PA. For this reason, a high injection speed of Alfater XL® 4PA favors good adhesion to the PA substrate. This effect is shown schematically in Figure 3. However, the part and gate design must be explicitly considered in order to avoid potential quality problems, such as jetting around the gate area.

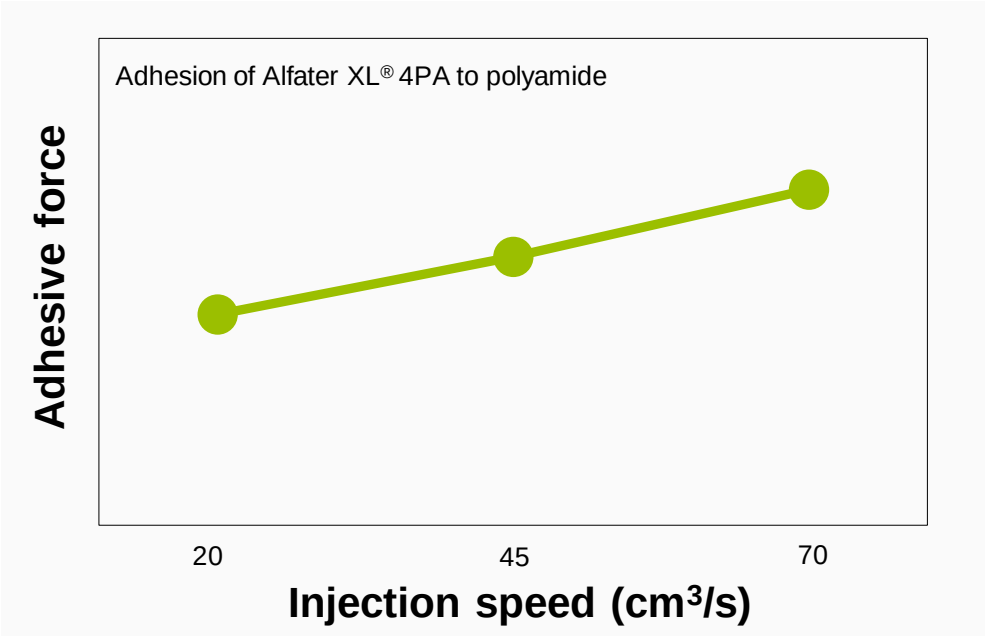


Figure 3: Influence of injection speed of Alfater XL® 4PA on the adhesion to PA.

Mold temperature

In general, an elevated mold temperature has a positive effect on the adhesion of Alfater XL® 4PA to the PA substrate. Figure 4 shows schematically the influence of the mold temperature on the adhesion of Alfater XL® 4PA. However, the mold temperature has a lower overall effect on adhesion compared to the delay time, injection speed and injection temperature. The mold temperature should optimally range from 40 - 70 °C.

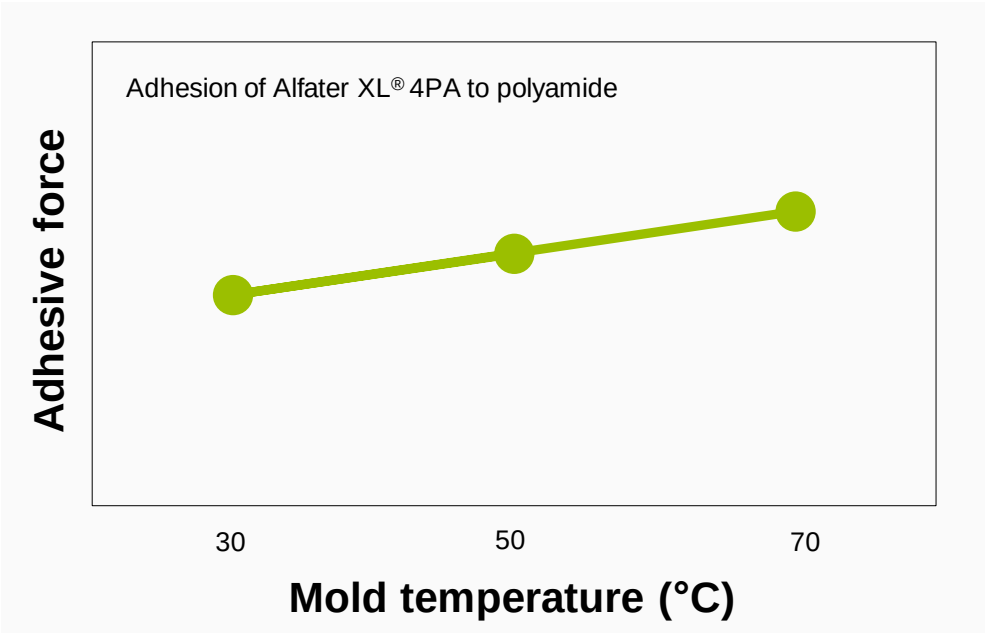


Figure 4: Influence of mold temperature of Alfater XL® 4PA on the adhesion to PA.

Mold temperatures above 70 °C are not recommended, as these can lead to demolding problems of the Alfater XL® 4PA layer. For example, if the mold temperature is too high, there is a possibility that the hard / soft part will still be too warm so that the soft Alfater XL® 4PA layer may peel off from the PA substrate during demolding, depending on the part geometry. Thus, the mold temperature and cooling time should be adjusted accordingly to avoid such demolding problems of the hard / soft part, especially when using softer Alfater XL® 4PA grades.

Holding pressure and holding time

A minimum holding pressure level promotes the adhesion, which is shown schematically in Figure 5. The holding pressure level for Alfater XL® 4PA should typically range from 50 - 70 % of the injection pressure. Excessive holding pressure can cause problems such as cold flow of the Alfater XL® 4PA layer which in turn will have negative effects on the PA adhesion performance. It is therefore preferred to achieve mold filling of 98 % or more during the injection phase of the Alfater XL® 4PA, followed by medium holding pressure for rather short holding times to control shrinkage only. It is advisable to generally adjust the holding phase to the gate freeze off time.

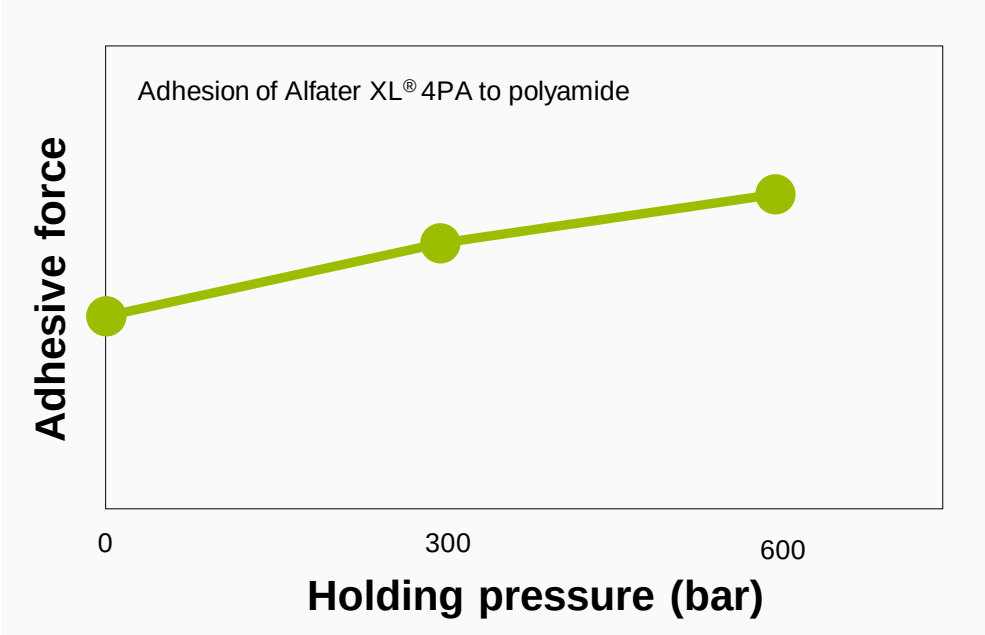


Figure 5: Influence of holding pressure of Alfater XL® 4PA on the adhesion to PA.

Part design

In case of (cold) insert molding (overmolding), it is absolutely essential that the surface of the insert (the previously molded PA component) is clean and free from impurities (e.g., dust, grease, oil or other fatty substances) as well being as smooth and uniform as possible.

Sufficient adhesion requires a minimum overlap or contact surface (interface) between the hard and soft component. The width of the contact surface (interface) is more important than the length. The width of the interface should be > 1 mm. A wide overlap will promote adhesion. The addition of undercuts in the part design for mechanical interlocks can further improve the adhesion of Alfater XL® 4PA to PA. Parts should be designed so that internal stress is homogenously distributed, and stress concentrations are avoided in the interface area. The part design should further avoid peeling, shear or delamination at the interface.

Sharp or step-like transitions between the PA substrate and the soft Alfater XL® 4PA layer are preferred to avoid edge peeling. Round or radiused shut-offs as well as gradual thinning of shut-offs are not recommended as they will promote peeling of the Alfater XL® 4PA layer. Below are two examples for a suitable shut-off design that can reduce or minimize peeling of the Alfater XL® 4PA layer (Figure 6).

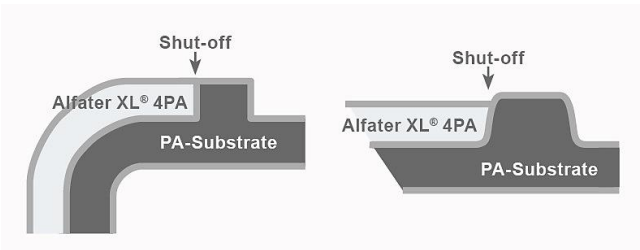


Figure 6: Examples for proper shut-off designs for hard / soft parts.

Very thin Alfater XL® 4PA layers (< 0.7 mm) in combination with very long flow paths are also not recommended because this will also have negative effects on adhesion and promote peeling. Multiple gates should be used for flow path / wall thickness ratios greater than 150:1. Large thickness differences within the Alfater XL® 4PA layer are not recommended and should not be greater than 4:1.

Verification of adhesion

Directly after demolding the 2K part, the Alfater XL® 4PA layer is usually still very hot and soft inside. Checking the adhesion to the PA substrate is therefore not advisable directly after demolding. Maximum adhesion can be achieved up to 24 h after production of the 2K part. To test the adhesion, it may therefore be advisable to store the 2K parts in a clean place for 24 h.

In order to evaluate whether a combination is technically feasible, adhesion or peel tests according to VDI 2019 can be carried out in advance. For possibilities of such adhesion tests with Alfater XL® 4PA, please contact the Technical Service Center of MOCOM Compounds GmbH & Co. KG or your contact person at our distribution partners.

Residence time

The residence time of the Alfater XL® 4PA melt in the machine should be kept as short as possible. This should be taken into account when selecting the machine and the remaining number of shots in the machine. Guide values for the residence time of Alfater XL® 4PA are 3 - 8 min, depending on the injection or overmolding temperature. As a rule: the higher the temperature profile, the lower the remaining number of shots or residence time of Alfater XL® 4PA melt in the machine.

Cleaning

It is recommended to clean the machine before and after processing of Alfater XL® 4PA. PP or PE with a low melt flow rate (e.g., MFR < 5 g/10min) should be used for purging. It is important to remove all PVC and acetal products (e.g., POM) from the machine before processing Alfater XL® 4PA. If necessary, the machine has to be cleaned mechanically.

Use of regrind

In principle, production waste from Alfater XL® 4PA can be easily recycled and can be used as regrind in a new production in the sense of zero-waste production. The maximum amount of regrind that can be added depends on many factors, e.g., the 2K part design and desired adhesion. Therefore, the specific feed level should be defined individually for each process and each part. As a general rule, we would recommend to limit the regrind amount to 10 %. It is essential that the regrind is clean and free from any impurities. Grinding or regranulation of the scrap to a particle size comparable to the granule size of the virgin material is recommended. This can minimize separation problems between the regrind and the virgin material. Pre-drying of the regrind is required. Pre-drying conditions are similar to the virgin material, 2 - 4 hours at 70 - 80 °C in a dry-air (desiccant) dryer.

Coloring

Natural-colored Alfater XL® 4PA grades can be easily colored. However, the best choice would be a colored Alfater XL® 4PA compound as this ensures the highest color consistency and batch-to-batch repeatability. For requests on a colored Alfater XL® 4PA, please contact the Technical Service Center of MOCOM Compounds GmbH & Co. KG or your contact person at our distribution partners.

As an alternative to a directly colored TPV compound, PP-based color masterbatches can also be used. They usually have good compatibility with the Alfater XL® 4PA. The color masterbatch used should have sufficient flowability and be suitable for use in injection molding. The feeding level of the color batch should be kept as low as possible to avoid negative effects on the PA adhesion. Empirical values with PP-based color masterbatch are 1 - 4 %. It is advisable to carry out practical tests for the optimum amount of color batch in order to check its impact on PA adhesion. It is also highly recommended to discuss the best feeding level either with the color masterbatch producer or with your local technical contact at MOCOM or your responsible distribution partner.

Sufficient mixing of the Alfater XL® 4PA melt with the color masterbatch is necessary to achieve high quality colored products. Mixing can be improved using appropriate injection molding parameters such as increased back pressure level. In addition, mixing elements such as mixing head or static mixers at the screw tip can further improve the dispersion of the color masterbatch.

Important parameters for adhesion at a glance

Parameter	Low	High
2K molding or overmolding temperature for Alfater XL® 4PA	🔴	🟢
Injection speed for Alfater XL® 4PA	🔴	🟢
Mold temperature for Alfater XL® 4PA	🔴	🟢
Holding pressure for Alfater XL® 4PA	🟢	🔴
Delay time for Alfater XL® 4PA	🟢	🔴
Overlap or contact surface between Alfater XL® 4PA and PA	🔴	🟢
Flow length of Alfater XL® 4PA layer	🟢	🔴
Moisture content of Alfater XL® 4PA and PA	🟢	🔴
Glass fiber content of PA	🟢	🔴
Flame retardant content of PA	🟢	🔴
Lubricant or release agent content of PA	🟢	🔴

🟢 Positive effect on adhesion 🔴 Negative effect on adhesion

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