ALFATER XL®

ALBIS

PA Adhesion-Modified ALFATER$^{XL®}$ 4PA0010 Grades

PROCESSING GUIDE

ALFATER$^{XL®}$ is a thermoplastic vulcanisate (TPV) based on PP and cross-linked EPDM. The ALFATER$^{XL®}$ 4PA0010 series is optimized for bonding to PA6 and PA66 and can therefore be used for multi-component injection molding processes such as 2K molding or (cold) insert molding (overmolding). Typical 2K parts are shown in Figure 1.

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

Figure 1: "soft touch" knife produced from ALFATER$^{XL®}$ and polyamide via 2K molding.

Figure 1: "soft touch" angle grinder produced from ALFATER$^{XL®}$ and polyamide via 2K molding.

DRYING

ALFATER$^{XL®}$ 4PA0010 should be dried for 2 - 4 hours at 70 - 80 °C in dry-air dryer. Drying of the PA is critical as moisture can inhibit sufficient adhesion of ALFATER$^{XL®}$ 4PA0010 to it. Opened bags should not be stored over a long period of time. The moisture content of PA should be < 0.1 %. For effective drying of PA, we recommend to follow the individual manufacturers' instructions or to use the drying conditions given in the technical data sheet of the PA.

FLOWABILITY AND SHRINKAGE

ALFATER$^{XL®}$ 4PA0010 are easy flow grades. Shrinkage of ALFATER$^{XL®}$ 4PA0010 is anisotropic and comparable to conventional TPV. Softer ALFATER$^{XL®}$ 4PA0010 grades tend to shrink more than harder ALFATER$^{XL®}$ 4PA0010 grades. Shrinkage depends strongly on the injection molding conditions and part design. The shrinkage values for ALFATER$^{XL®}$ 4PA0010 given below have been measured on standardized sample plaques under specific conditions and are therefore only a guideline. Depending on the injection molding process, the processing conditions and the part design, these values can vary.

Material	Shrinkage (ISO 294-4), after 24 h		Spiral Flow* (2 mm thickness)
	Parallel to flow	Transverse to flow	
ALFATER$^{XL®}$ A55I 4PA0010	1.7 – 2.5 %	1.4 – 1.9 %	> 75 cm
ALFATER$^{XL®}$ A70I 4PA0010	1.3 – 2.0 %	1.2 – 1.6 %	> 85 cm
ALFATER$^{XL®}$ A85I 4PA0010	1.3 – 1.8 %	1.2 – 1.6 %	> 85 cm

* Spiral Flow: thickness 2 mm, injection temperature 220 °C, mold temperature 70 °C, injection pressure 500 bar

MACHINERY AND EQUIPMENT

A three zone polyolefin screw with a screw length L > 18D and a compression ratio df/dm of 2:1 to 3:1 is recommended. The screw design should allow sufficient shearing of the ALFATER$^{XL®}$. Specific mixing elements at the screw tip can improve homogeneity of the ALFATER$^{XL®}$ melt. Screw designs with low shear input, e. g. screws for PVC processing, are not recommended.

The clamping force of the machine should be higher than the separating force caused by the injection process of molten ALFATER$^{XL®}$ into the mold. Quality problems can occur e. g. flashing if the clamping force is insufficient.

DELAY TIME

The delay time is defined as the time between molding the first component (in PA) and the second component, (ALFATER$^{XL®}$ 4PA0010). An increasing delay time has a generally negative effect on adhesion (reduction in adhesion) because the interface temperature will decrease drastically (Figure 2). Whenever possible, use 2K molding processes with zero delay instead of (cold) insert molding (overmolding). High overmolding temperatures for ALFATER$^{XL®}$ can partly compensate for the negative effect of an increasing delay time.

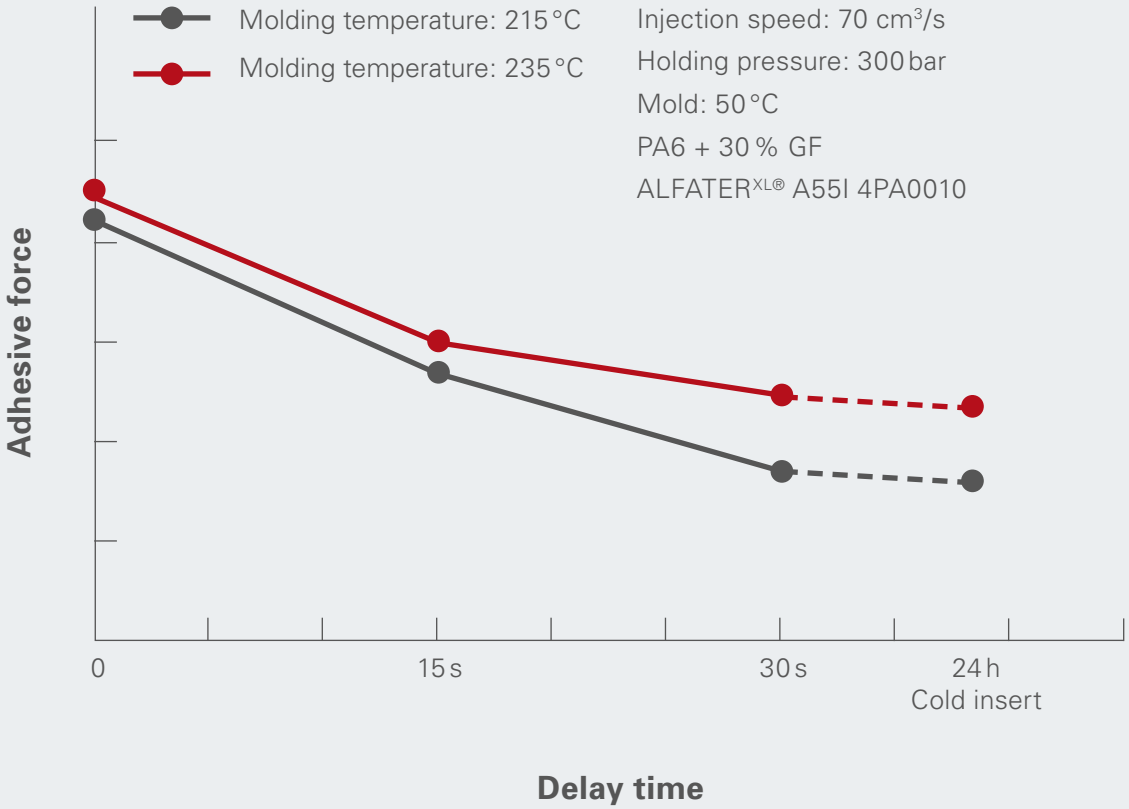
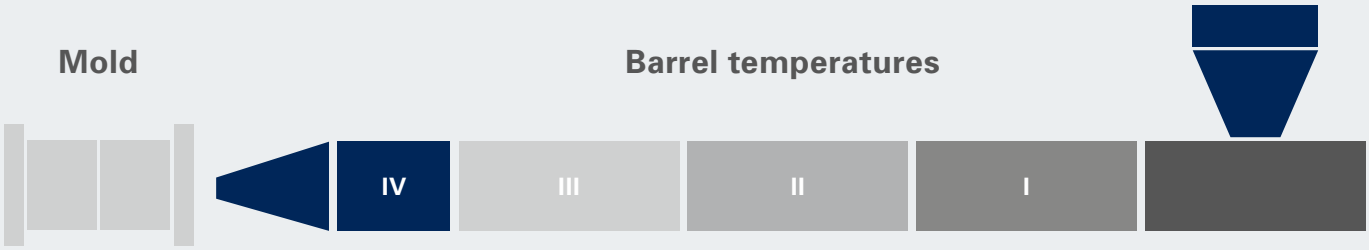


Figure 2: Influence of delay time (time before molding) of ALFATER XL® 4PA0010 on adhesion to PA.

TEMPERATURE PROFILE

A gradually increasing temperature profile is recommended. The temperature profile below is a guideline and a starting point for process optimizations (Figure 3). Temperature adjustments can be necessary depending on the multi-component injection molding process used, the part design, and the hardness of the ALFATER XL® 4PA0010.



Temperatures in degrees Celsius (°C)[1]

40 – 70	215 – 260	200 – 230	190 – 220	190 – 220

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

Figure 3: Recommended temperature profile for 2K molding of ALFATER XL®
(the temperatures are only a guideline).

A high interface temperature between the hard and the soft component is required for good adhesion. Therefore, a relatively high molding temperature of ALFATER$^{XL®}$ 4PA0010 is recommended. Ideally, the molding temperature for ALFATER$^{XL®}$ 4PA0010 should range from 230 - 260 °C. Temperatures significantly higher than 260 °C are not recommended, especially in conjunction with long residence times e. g. in hot runner systems, because this can cause thermal degradation of ALFATER$^{XL®}$ 4PA0010 and/or evaporation of additives.

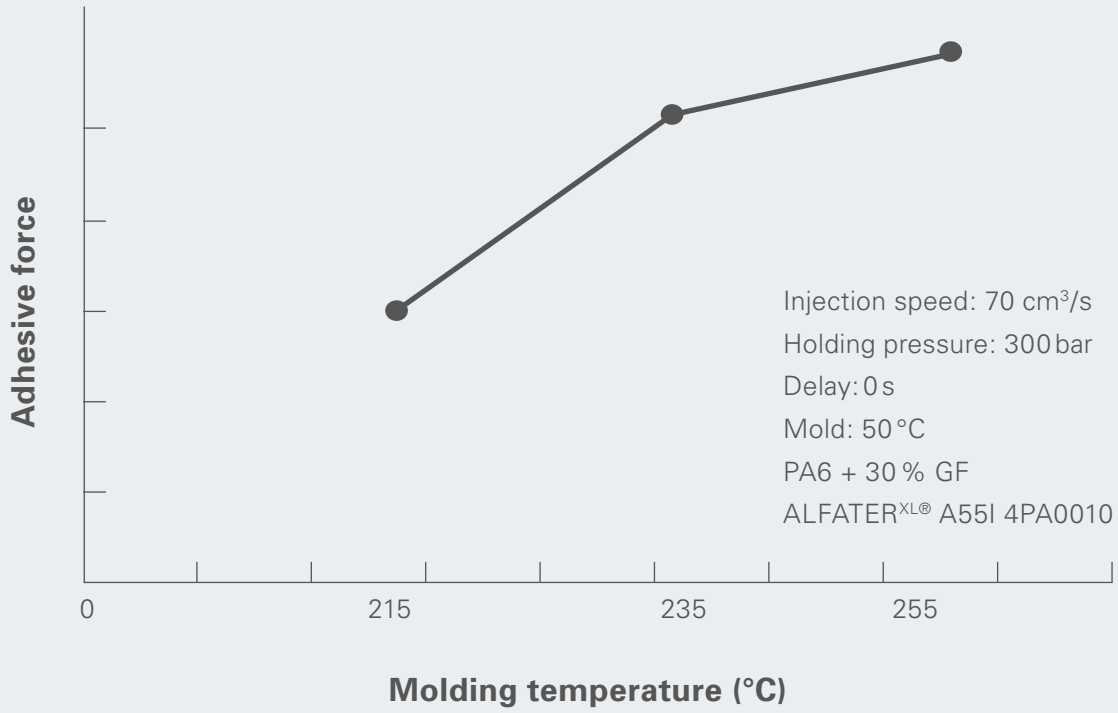


Figure 4: Influence of molding temperature of ALFATER$^{XL®}$ 4PA0010 on adhesion to PA.

INJECTION SPEED

The viscosity of ALFATER$^{XL®}$ is more sensitive to shear than to heat. For sufficient flow, mold filling and surface wetting of the hard substrate it is recommended to use rather high injection speed of ALFATER$^{XL®}$ 4PA0010. A high injection speed promotes adhesion of ALFATER$^{XL®}$ 4PA0010 to PA (Figure 5). However, part and gate design needs to be considered to avoid quality problems such as jetting.

Figure 5: Influence of injection speed of ALFATER$^{XL®}$ 4PA0010 on adhesion to PA.

MOLD TEMPERATURE

The mold temperature has a relatively moderate influence on the adhesion performance of ALFATER$^{XL®}$ 4PA0010 in comparison to delay time, injection speed and molding temperature. However, higher mold temperatures have a generally positive influence on the adhesion between ALFATER$^{XL®}$ 4PA0010 and PA (Figure 6). The mold temperature should optimally range from 40 - 70 °C. Mold temperatures higher than 70 °C are not preferred as this can cause demolding problems of ALFATER$^{XL®}$ 4PA0010 such as mold sticking.

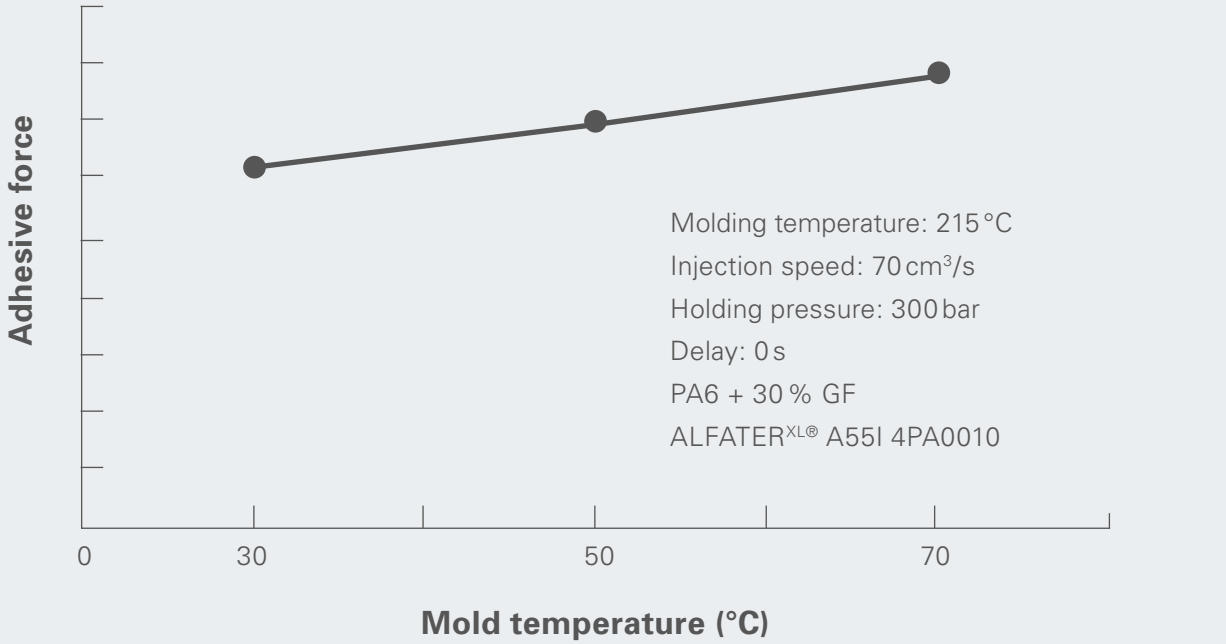


Figure 6: Influence of mold temperature of ALFATER$^{XL®}$ 4PA0010 on adhesion to PA.

HOLDING PRESSURE AND HOLDING TIME

A specific minimum holding pressure level is recommended to promote adhesion. The holding pressure level for ALFATER$^{XL®}$ 4PA0010 should range from 50 - 70 % of the injection pressure. Excessive holding pressure can cause problems such as cold flow of the ALFATER$^{XL®}$ 4PA0010 layer which in turn will have negative effects on adhesion performance. It is therefore preferred to achieve mold filling of 98 % or more during the injection phase, 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.

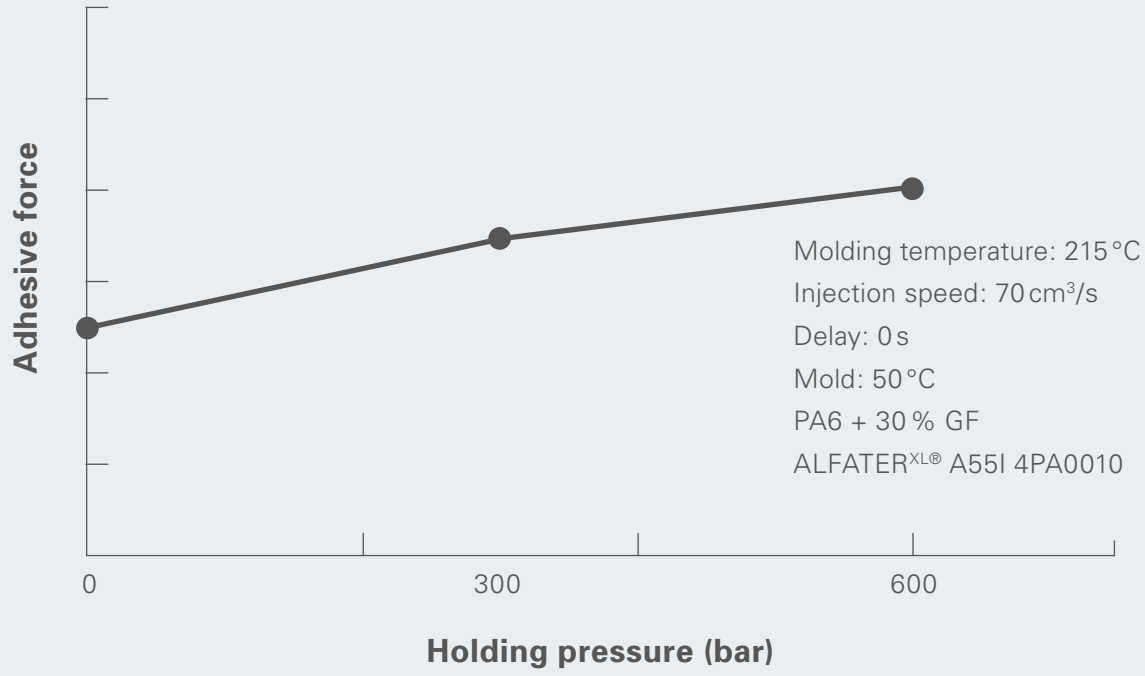


Figure 7: Influence of holding pressure of ALFATER$^{XL®}$ 4PA0010 on adhesion to PA.

PART DESIGN

In case of (cold) insert molding (overmolding), it is absolutely essential that the surface of the insert (the previoulsy 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 between hard and soft component. The width of the overlap is more important than the length of the overlap. An overlap with widths of < 1 mm can be critical. A wide overlap will promote adhesion. The addition of undercuts in the part design can further improve the adhesion of ALFATER$^{XL®}$ 4PA0010 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 hard component and the soft ALFATER$^{XL®}$ 4PA0010 layer are preferred to avoid 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$^{XL®}$ 4PA0010 layer. Very thin ALFATER$^{XL®}$ 4PA0010 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$^{XL®}$ 4PA0010 layer are not recommended and should not be greater than 4:1.

The table below summarizes the most important factors influencing the adhesion of ALFATER$^{XL®}$ 4PA0010 to PA.

Parameter	Decreasing	Increasing
2K or overmolding temperature	🔴	🔵
Injection speed	🔴	🔵
Mold temperature	🔴	🔵
Holding pressure	🔵	🔴
Delay time	🔵	🔴
Overlap surface area	🔴	🔵
Flow length	🔵	🔴
Moisture content of PA	🔵	🔴
Glass fiber content of PA	🔵	🔴
Lubricant or release agent content of PA	🔵	🔴

🔵 Positive effect on adhesion 🔴 Negative effect on adhesion

COLORING

Natural ALFATER$^{XL®}$ can be easily colored. The best choice would be a colored ALFATER$^{XL®}$ compound as this ensures the highest color consistency and batch-to-batch repeatability – please contact your local ALBIS Sales Office for more information on ALFATER colour compounds.

Alternatively polyolefin-based color masterbatches can be used. In this case, PP or PE color batches offer excellent compatibility with ALFATER$^{XL®}$ and are preferred. ALBIS offers a broad portfolio of PP and PE color batches from AMPACET. The viscosity of the color masterbatch should be in the range of a typical injection molding grade providing sufficient flowability. Typical feeding level of the batch is 1 – 5 %. However, the optimal dosage can vary depending on the product or application. It is therefore highly recommended to discuss optimal feeding level either with the color masterbatch producer or with the local TSAD (Technical Services & Application Development) of ALBIS PLASTIC GmbH.

Sufficient mixing of the color masterbatch with the ALFATER$^{XL®}$ melt 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 e.g. mixing head and/or static mixer further improves the dispersion of the color masterbatch.

Should you have any further questions regarding the processing or mold design for ALFATER applications, then please feel free to get in touch with your local TSAD engineer – contact details are available from the ALBIS website.

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