LATI® HIGH PERFORMANCE THERMOPLASTICS

POLYAMIDES
MOISTURE ABSORPTION

Moisture and equilibrium

Moisture absorption of polymers has always been an extremely important issue due to the repercussions that this phenomenon has on properties of these materials.

Plastic resins can be divided into two groups on the basis of their capacity to absorb moisture:

- **Non-hygroscopic resins**: where water does not diffuse into the polymer matrix, but merely forms a liquid film on the surface.
  In this case, moisture is easily and quickly removed without the need for peculiar treatments.
  PE, PP, PPS and PEEK are all non-hygroscopic polymers.

- **Hygroscopic resins**: in which water molecules diffuse very easily thanks to their strong affinity with the amorphous fraction of the polymer.
  These resins are more difficult to dry and require more complex methods than the simple use of hot air.
  All PAs are hygroscopic polymers.

In hygroscopic resins water molecules, in fact, bind with the polymer chains by the mean of hydrogen bonds, a **hydrogen bond** being a particular electrostatic interaction that is established between two polar molecules.
A hydrogen bond is quite strong, making it difficult to get rid of absorbed water.

In polyamides, hydrogen bonds are also responsible for the formation of the **crystalline phase**.
Alongside large areas where the macromolecules are tangled up in a completely disordered and random way (**amorphous phase**), there are regions where amide and carboxyl groups are aligned thanks to the above mentioned bonds, forming well-ordered structures (**crystallites**).

POLYMER	DEGREE OF CRYSTALLINITY [%]
PA 6	35 - 45
PA 66	35 - 45
POM	70 - 80
PET	30 - 40
PBT	40 - 50
PTFE	60 - 80

Tab. 1 - Degree of crystallinity for different polymers

This explains why moisture is absorbed differently in these two phases.
In the crystalline phase, water can hardly diffuse because of the limited intermolecular space.
In amorphous regions, on the other hand, distance between molecular chains allows absorption of moisture, and this results in the formation of hydrogen links between water molecules and polar groups in the chain *(fig.1)*.

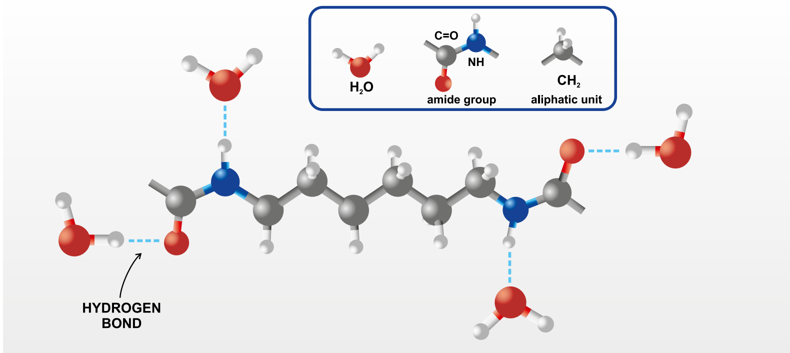


Fig. 1 - Interaction between polyamides and water

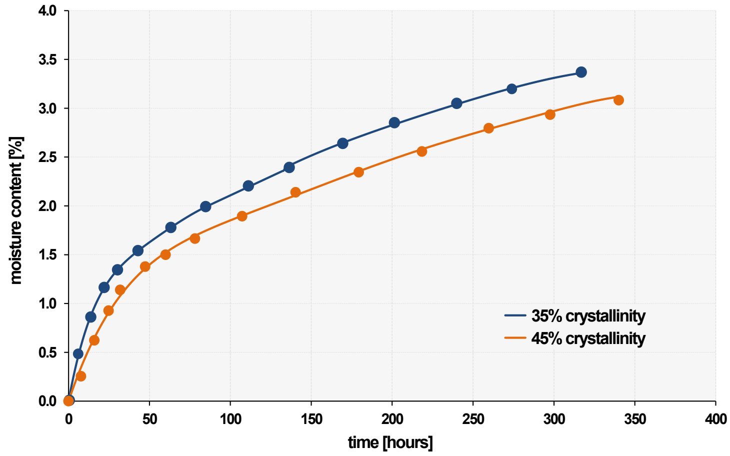


Fig. 2 - Crystallinity: polyamide 66, immersed at 23°C

Moisture absorption is a **reversible phenomenon:** a polymer exposed to certain temperature and relative humidity condition reaches an equilibrium state with the surrounding environment.

As environmental conditions change, the polymer will reach a new equilibrium by absorbing water, if the external relative humidity increases, or by releasing water, in case the surrounding environment becomes drier.

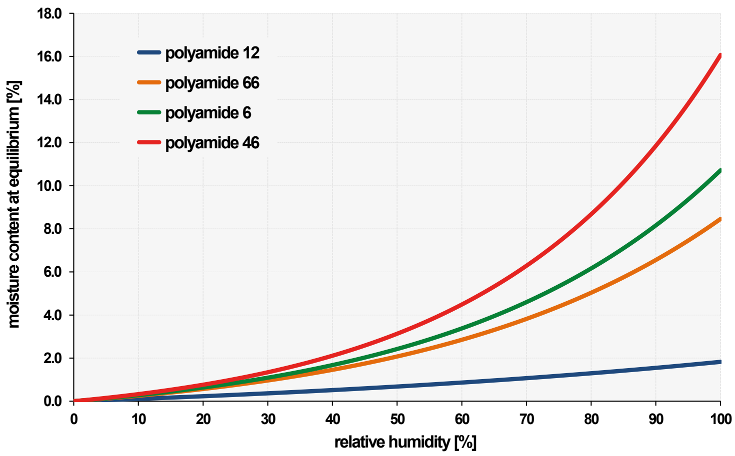


Fig. 3 - Moisture absorption of the main polyamides

Furthermore, in the case of polyamides, the higher the ratio between the number of amide groups and the number of aliphatic units available in the monomer units, the greater will be the moisture content that can be absorbed. This is due to polar nature of amide groups, that tend to bind with water molecules, whereas aliphatic units do not interact with moisture *(fig.3)*.

The effects of moisture on polyamides

In hygroscopic polymers, like polyamide, moisture absorption affects most of the material's mechanical, physical and electrical properties.

Depending on the application, this may result in several advantages, or lead to problems (*tab. 2*).

Elastic modulus	↓	Creep resistance	↓
Breaking strength	↓	Dielectric strength	↓
Elongation at break	↑	Dielectric constant	↑
Impact resistance	↑	Electrical resistivity	↓

Tab. 2 - Effects of moisture on main properties of PAs

For example, moisture has a plasticising effect on the resin, lowering its glass transition temperature and **reducing both elastic modulus and strength at break**.

Conversely, moisture absorption in controlled conditions – a process referred to as **conditioning** – can be adopted to ease mechanical assembly, thanks to a tougher and more ductile behavior of the so treated material.

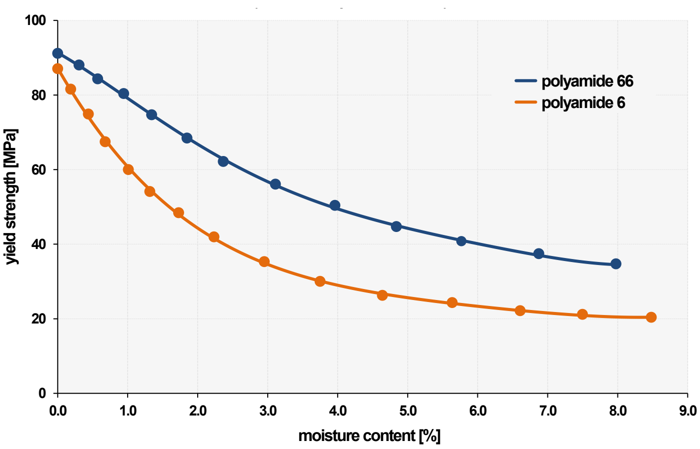


Fig. 4 - Mechanical strength at room temperature 23°C

The graph below *(fig. 5)* shows how resilience of a material conditioned in air at 23°C and 50% relative humidity (RH) is greater than the same material in "dry as moulded" (DAM) conditions.

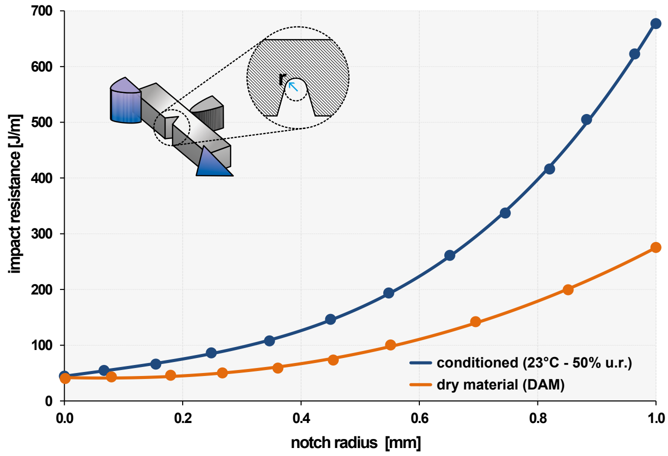


Fig. 5 - Impact resistance, polyamide 66

On the other hand, creep and fatigue resistance are worsen after moisture absorption.

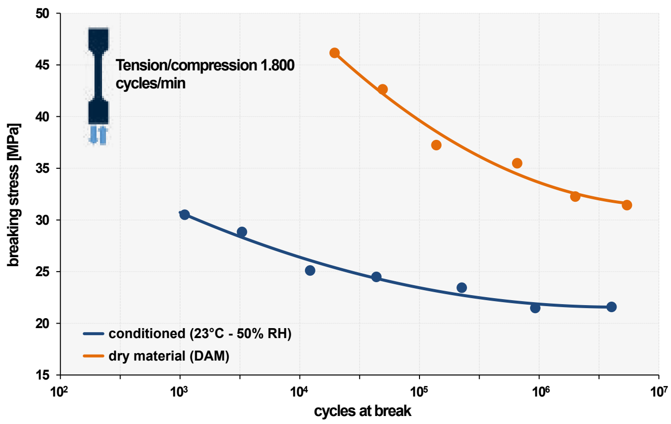


Fig. 6 - Fatigue resistance, polyamide 66

Geometric stability is also influenced by moisture absorption because of dimensional changes induced by humidity in manufactured articles.

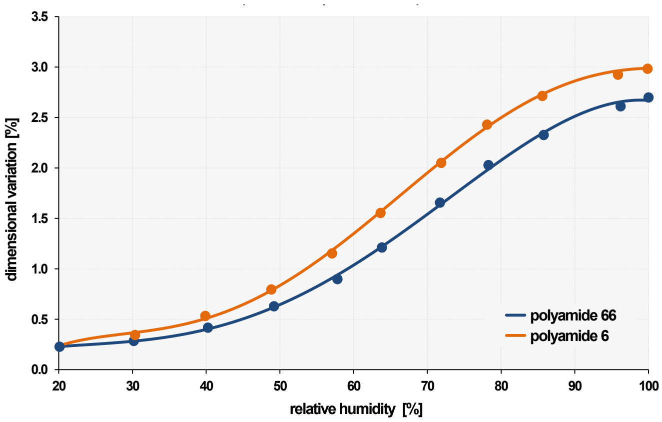


Fig. 7 - Dimensional stability, at room temperature 23°C

Electrical properties, such **as resistivity or dielectric strength** which are very important in the case of live applications, are strongly influenced by the amount of absorbed moisture.

Temperature and relative humidity can alter electrical characteristics, up to loss of electrical insulation *(tab. 3)*.

Therefore, insulating properties of moisture saturated materials has to be carefully evaluated, especially in the case of items used in geographical areas where high levels of environmental humidity are to be expected.

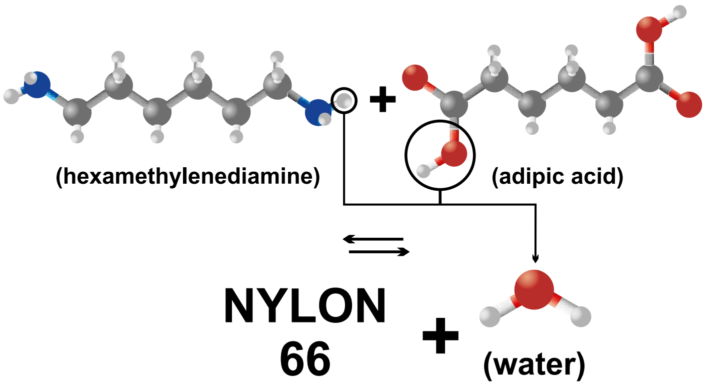


Fig. 8 - Polycondensation reaction between hexamethylenediamine and adipic acid

	DIELECTRIC STRENGTH [kV/mm]		VOLUME RESISTIVITY [Ohm*cm]	
MATERIALS	**40h - 23°C - 50% RH**	**96h - 35°C - 90% RH**	**40h - 23°C - 50% RH**	**96h 35°C - 90% RH**
LATAMID 66 H2 G/25-V0CT1	25	13	$8.00 \cdot 10^{13}$	$9.80 \cdot 10^{10}$
LATAMID 66 H2 G/50-V0KB1	27	21	$1.69 \cdot 10^{14}$	$1.73 \cdot 10^{11}$
LATAMID 66 H-V0	23	14	$5.70 \cdot 10^{14}$	$7.04 \cdot 10^{12}$
LATAMID 66H2 G/35-V0KB	26	14	$4.98 \cdot 10^{14}$	$1.07 \cdot 10^{13}$
LATAMID 66 H2G/35-V0	26	12	$7.88 \cdot 10^{13}$	$3.01 \cdot 10^{11}$
LATAMID 66 H2 G/50	27	15	$6.43 \cdot 10^{14}$	$5.37 \cdot 10^{12}$
LATAMID 66 H2 G/35-V0KB1	23	21	$5.54 \cdot 10^{14}$	$1.19 \cdot 10^{13}$
LATAMID 6 H2 G/30-V0CT1	22	9	$2.97 \cdot 10^{12}$	$2.63 \cdot 10^{9}$
KELON A FR H2 CETG/300 - V0	35	27	$1.83 \cdot 10^{12}$	$6.39 \cdot 10^{11}$
KELON B FR H CETG/250 - V0	21	13	$6.20 \cdot 10^{11}$	$4.80 \cdot 10^{9}$
KELON B H CET/30	34	13	$1.40 \cdot 10^{14}$	$1.00 \cdot 10^{11}$
KELON A H CE/40	29	18	$1.64 \cdot 10^{12}$	$6.49 \cdot 10^{11}$
LATAMID 68 H2-V0	23	22	$2.88 \cdot 10^{12}$	$6.70 \cdot 10^{11}$
LATER 4-V0	21	21	$4.40 \cdot 10^{14}$	$3.00 \cdot 10^{14}$
LATER 4 G/30-V0	24	22	$3.80 \cdot 10^{14}$	$3.10 \cdot 10^{14}$
LATER 4 G/30	32	32	$2.00 \cdot 10^{14}$	$1.80 \cdot 10^{14}$
LATENE7H2W-V0	28	27	$2.40 \cdot 10^{14}$	$2.10 \cdot 10^{14}$
LATILUB 66 20 T G/20	31	27	$1.80 \cdot 10^{14}$	$1.60 \cdot 10^{14}$
LATAMID 6 H2 G/35	27	10	$3.10 \cdot 10^{13}$	$3.49 \cdot 10^{9}$

Tab. 3 - Typical development of dielectric strength and volume resistivity according to environmental conditions

Hydrolysis

Polyamides, but also polyesters, are obtained through chemical polycondensation reactions, whose byproduct is water *(fig. 8)*.
Polycondensation reactions continue until a chemical equilibrium is reached between products and reagents still present in the reaction environment. For this reason, these reactions are reversible.
In favourable environmental conditions (i.e. presence of water and high temperature), they can also proceed in the opposite direction by breaking polymer chains down into its initial monomers.

This phenomenon, called **hydrolysis**, is particularly harmful when it occurs during moulding or extrusion as it causes rapid degradation of the material, which becomes **brittle and unreliable**.
For this reason, it is necessary to pre-dry polyesters and polyamides during extrusion, in order to guarantee a high-quality end-product, and before moulding, to avoid aesthetic defects (moisture streaks) or material degradation *(fig. 9)*.

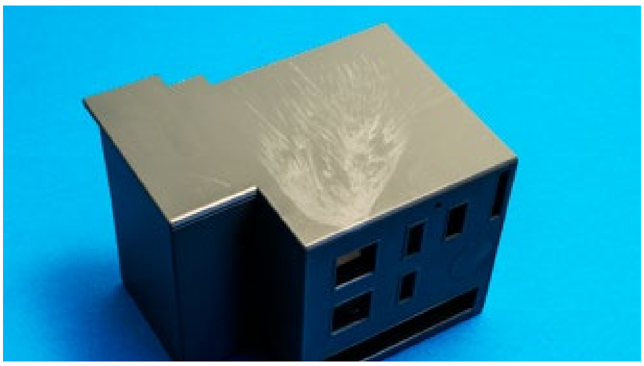


Fig. 9 - Streaks caused by the presence of moisture

Moisture absorption: the predictive modelling approach

As properties of polyamide-based thermoplastic compounds can be greatly influenced by environmental working conditions, especially in case of long periods of exposure to humid environments, it is worth gaining an in-depth understanding of phenomena leading to moisture absorption, in order to make the most out of these materials' properties.

Therefore, it is fundamental to understand how water molecules diffuse within the polymer matrix. This can be achieved by means of adequate mathematical models.

The diffusion of a generic substance within a volume of material can be described, in terms of local concentration, through **Fick's law:**

$$\frac{\partial C}{\partial t} = D \frac{\partial^2 C}{\partial x^2}$$

- C = moisture content at time point t [%]
- t = time [s]
- x = thickness [mm]
- D = diffusion coefficient [mm²/s]
- $\frac{\partial C}{\partial t}$ = change in concentration over time
- $\frac{\partial^2 C}{\partial x^2}$ = concentration flow

By solving these equations for specific boundary conditions, it is possible to build a mathematical model describing moisture diffusion in thermoplastic compounds.

The key parameter in the equation is the diffusion coefficient D, a value that measures the diffusion speed of a water molecule into the polymer bulk. This coefficient is determined through a reverse engineering operation that takes, as its starting point, absorption curves at different percentages of relative humidity and at various temperatures. Usually, curves at 50% relative humidity *(fig. 11)* or at saturation *(fig. 10)* are preferred.

Once relationship between diffusion coefficient, temperature and relative humidity *(fig. 12)* are carefully evaluated, it is possible to determine exactly how water molecules diffuse through the thickness of the polymer mass over time.

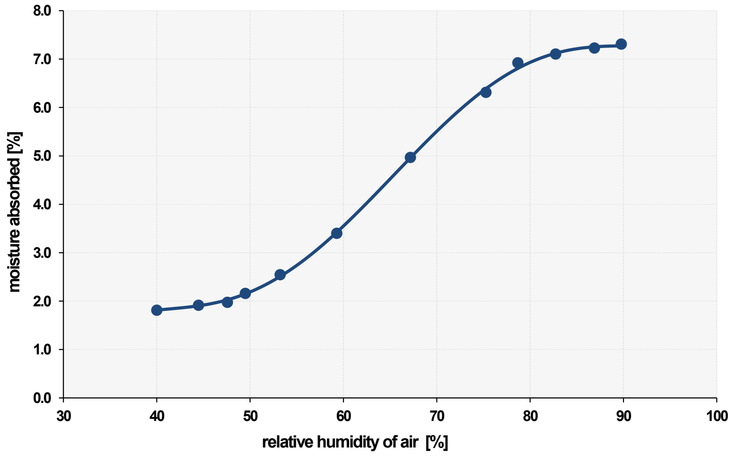


Fig. 10 - Polyamide 66: air, 23°C, at saturation

The diffusion coefficient is temperature dependent: the higher the temperatures, the higher the absorption rate.

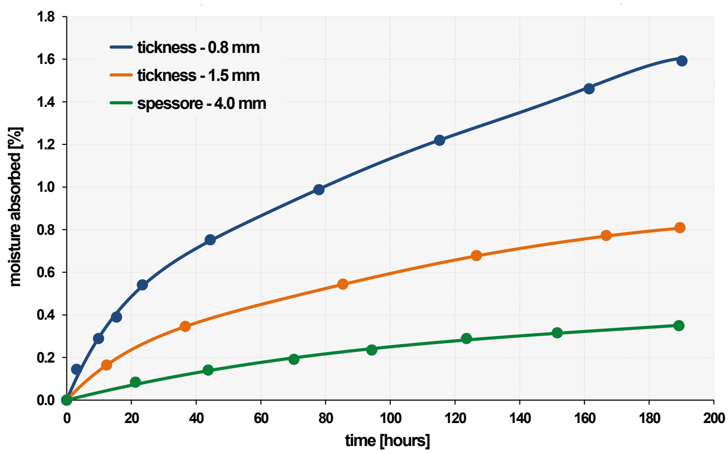


Fig. 11 - Influence of thickness - polyamide 66, room temperature 23°C, 50% relative humidity

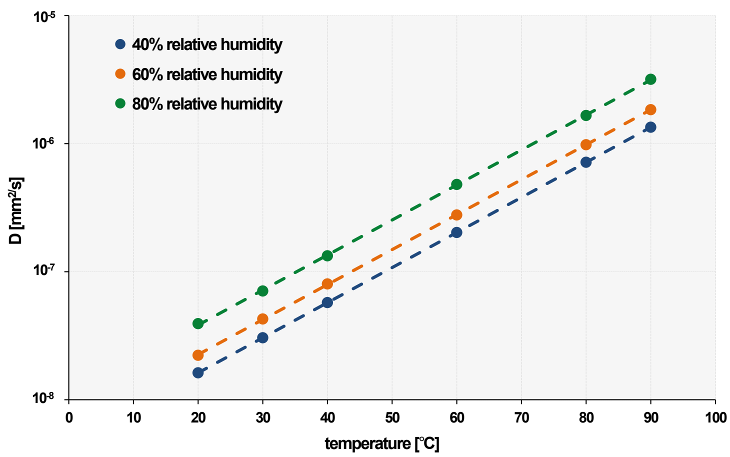


Fig. 12 - Diffusion coefficient

Conditioning: moisture absorption as a controlled process

Moisture absorption makes polyamides tougher and more ductile.When properly controlled, phenomenon of absorption can be used to improve material properties needed to the application *(fig. 16 and pag. 8)*.

In normal conditions, moisture absorption is a very gradual process, especially in case of thick walls. In such situations, it is necessary to modify some parameters, such as environmental temperature and relative humidity, in order to speed up humidity pickup and quickly achieve all desired features *(fig. 14 and fig. 15)*.

Diffusion speed is directly proportional to temperature and relative humidity of air, whereas it is inversely proportional to thickness *(fig. 13)*.

Conditioning can be carried out by using different methods.

AFTER MOULDING: moulded parts are immersed in cold water immediately after ejection. Diffusion process is accelerated by high temperature of hot parts.

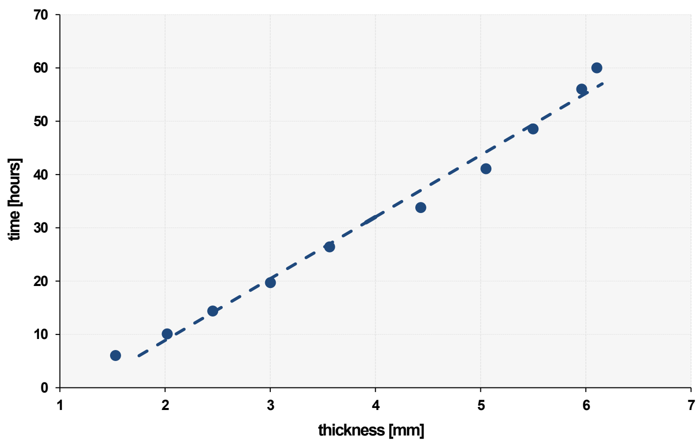


Fig. 13 - PA66 – time to reach a moisture content of 2.5%

IN HOT WATER: parts are immersed in hot water, at a temperature set between 40°C and 90°C. This procedure does not require any specific equipment and it is suitable for components not needing a particular aesthetic finish. Stains or imperfections may form on the surface, especially in the case of glass fibre-reinforced, coloured and self-extinguishing polyamides.

IN CLIMATIC CHAMBERS: parts are placed in special "ovens" where temperature and relative humidity can be set with great precision, and then kept constant throughout the treatment.

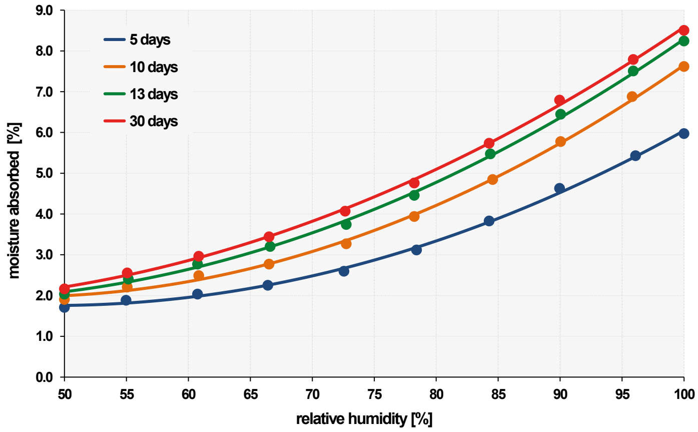


Fig. 14 - Influence of exposure time - polyamide 66, room temperature, 23°C

IN STORAGE: this method is suitable for parts that have to be stored in dry environments for long periods of time before being used or assembled.
Items can be kept in sealed polyethylene bags that have previously been moistened with a quantity of vaporised water equal to about 5% of the weight of the parts.

WITH SATURATED STEAM: this method is suitable for very thin thicknesses.
However, steam temperature must not be higher than 110-120°C to avoid damage of the polymer matrix.

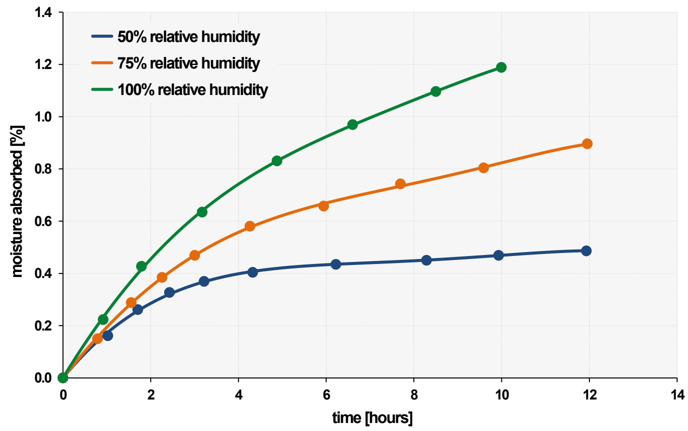


Fig. 15 - Influence of relative humidity - polyamide 66, room temperature 23°C

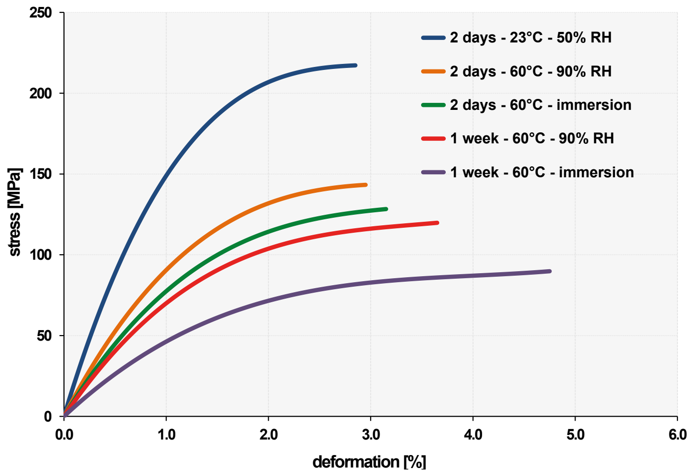


Fig. 16 - Effect on mechanical properties LATAMID 66 H2 G/50

To obtain the desired level of conditioning, parts need to be exposed to moisture for a sufficient length of time.

This time can be calculated by applying the **law of diffusion:**

$$t \propto \left[\frac{M_t}{M_m}\right]^2 \cdot 0.032 \cdot \frac{s^2}{D}$$

- M_t = moisture content at time point t [%]
- M_m = moisture content at saturation [%]
- s = thickness [mm]
- t = time [s]
- D = diffusion coefficient [mm²/s]

PART THICKNESS	2mm	3mm	4mm
moisture absorbed	**exposure time**		
20% of the content at saturation	36 hours	54 hours	72 hours
30% of the content at saturation	82 hours	122 hours	163 hours
50% of the content at saturation	9 days	14 days	18 days
60% of the content at saturation	13 days	20 days	27 days

Drying

Hygroscopic polymers tend to reach a state of equilibrium with the surrounding environment by absorbing moisture during processing, transport, storage and use.

To avoid the onset of degenerative phenomena, like hydrolysis, it is necessary to ensure that the granules are properly dried prior to any processing step (extrusion, moulding, etc.).
Their moisture content must be below the maximum suggested value *(tab. 4)*.

MATERIAL	RESIN	MAXIMUM MOISTURE
LATENE	PPh	0.1%
LATAN	POM	0.1%
LATILON	PC	0.02%
LATAMID 6	PA6	0.1%
LATAMID 66	PA66	0.1%
LATAMID 12	PA12	0.1%
LATER	PBT	0.05%
LARIL	PPOm	0.02%
LARAMID	PPA	0.06%
LARTON	PPS	0.1%
LASULF	PSU	0.05%
LAPEX A	PES	0.05%
LAPEX R	PPSU	0.05%
LARPEEK	PEEK	0.1%

Tab. 4 - Maximum residual moisture values before moulding

Drying can be managed by using suitable specific equipment *(see tab. 7 for details of the most common solutions)*.
Granules can be simply dehumidified by taking air drawn directly from the external environment, or they can be properly treated by the mean of previously dried air.

Pre-treating air, i.e. reducing its moisture content, is crucial in order to obtain optimal drying of thermoplastic compounds.

To reduce moisture, air can either be cooled down to its dew point, i.e. to the point at which the contained water starts to condense, or be passed over beds of highly hygroscopic desiccant material (*fig. 17*).
The lower the dew point, the lower the required drying time.

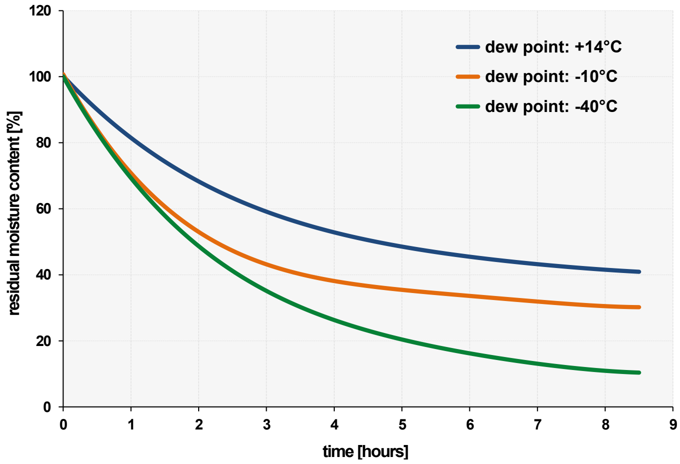


Fig. 17 - Drying time and air moisture content - polyamide 66, drying in hot air

On the basis of drying temperature and percentage of residual moisture in air, it is possible to plot a curve showing the time necessary to dry compound pellets below the suggested limit (*fig. 18*).

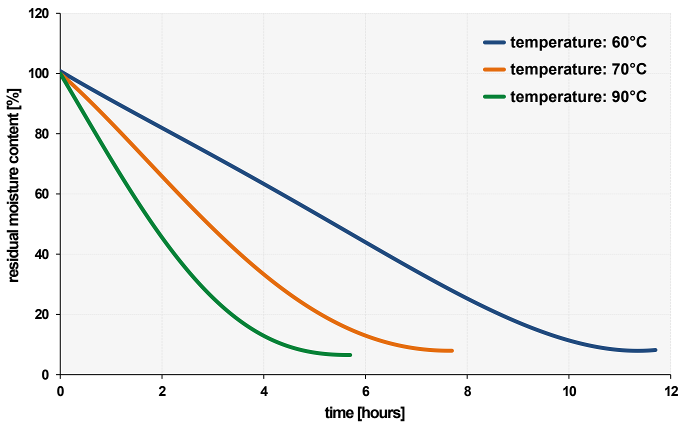


Fig. 18 - Drying time and temperature - polyamide 66, drying in hot air

As temperature increases, drying becomes faster because air can absorb a greater quantity of water before reaching its saturation point and heat facilitates the diffusion of water from the core of the pellet to its surface *(fig. 18)*.

It is therefore advisable to dry at the highest possible temperature without exceeding specific thermal limits of polymers *(tab. 5)*.

MATERIAL	TIME [h]	TEMPERATURE [°C]
ABS	2 - 3	70
PA	3 - 5	90
PBT	3 - 4	120
PC	2 - 3	125
PP	1 - 1.5	85

Tab. 5 - Drying temperature and time

Available air flow also plays an important role in optimising the process and it is therefore useful to know the precise volume of air (m^3) needed to dry the mass of polymer (kg) being processed. This applies in case of both continuous and discontinuous processes. *(tab 6)*.

MATERIAL	K(m^3/kg)
ABS	1.5
PA	2.2
PBT	1.6
PC	1.3
PP	0.95

Tab. 6 - Suggested air quantity for drying, per polymer

Fig. 19 - Under-vacum drying oven

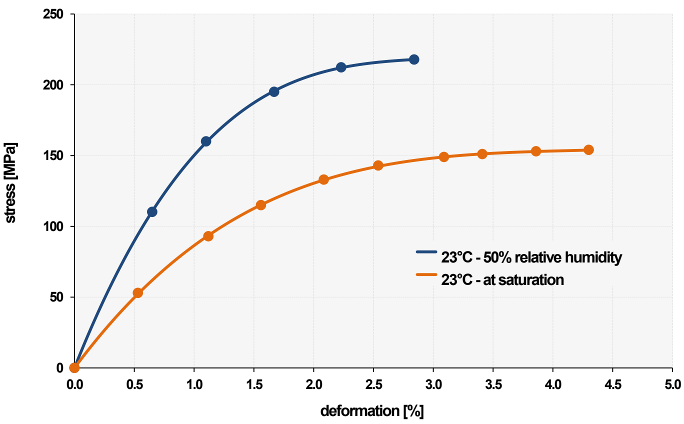
TYPE	CAPACITY [kg/hour]	INITIAL COST	-40 DEW POINT	ENERGY CONSUMPTION	ENVIRONMENTAL FOOTPRINT	MAINTENANCE	NOTES
Compressed air dryer	< 30	Low	No	High - Very high	Low	Low	Unfeasible process when required capacity is above 100 kg/hour
Compressed air dryer with optional membrane	< 30	Medium	Yes	Very high	Low	Low	
Vacuum dryer	15 - 500	Medium	No	Low	Low	Medium	The vacuum dryer does not work on the dew point principle
Dual bed desiccant dryer	10 - 2500	Medium - High	Yes	Medium - High	High	High	
Wheel dryer	15 - 2500	Medium - Low	Yes	Low	Low	Medium	Large wheel dryers are much less expensive than dual bed dryers
Infrared dryer (PET)	250 - 2500	Medium	Yes	Very low	Low	Low	

Tab. 7 - Airflow necessary for drying

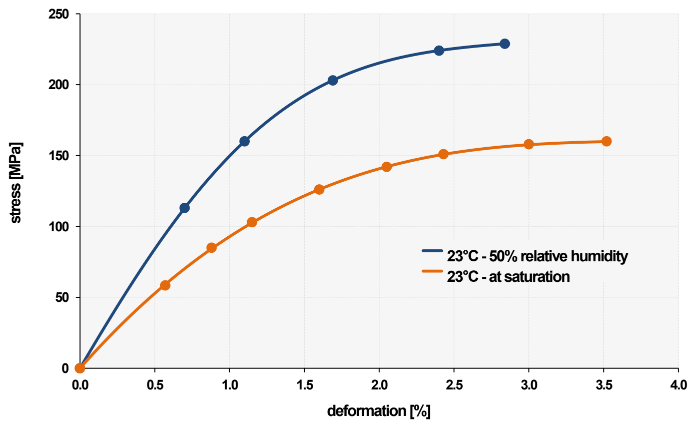
EFFECT OF MOISTURE ABSORPTION ON THE MECHANICAL BEHAVIOUR OF POLYAMIDE-BASED COMPOUNDS

(uniaxial tensile stress - DAM and at saturation in air, 23°C, 50% RH)

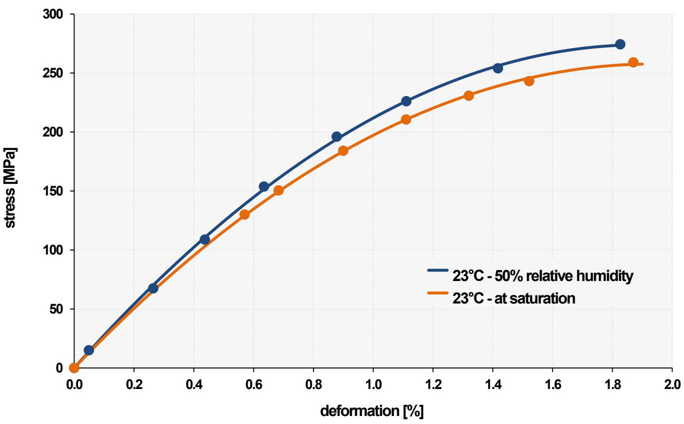
LATAMID 66 H2 G/50



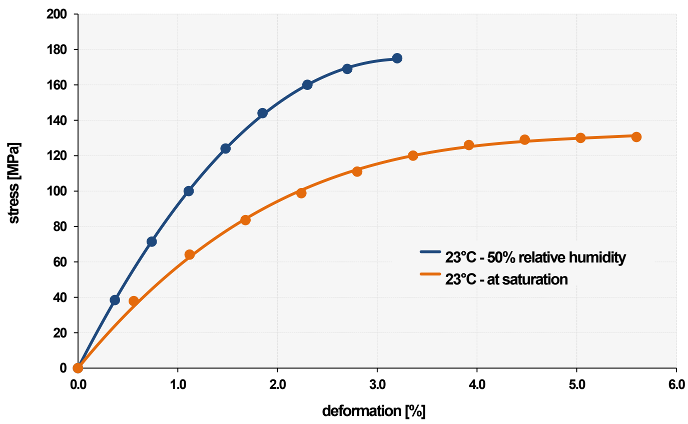
LATIGLOSS 66 H2 G/50



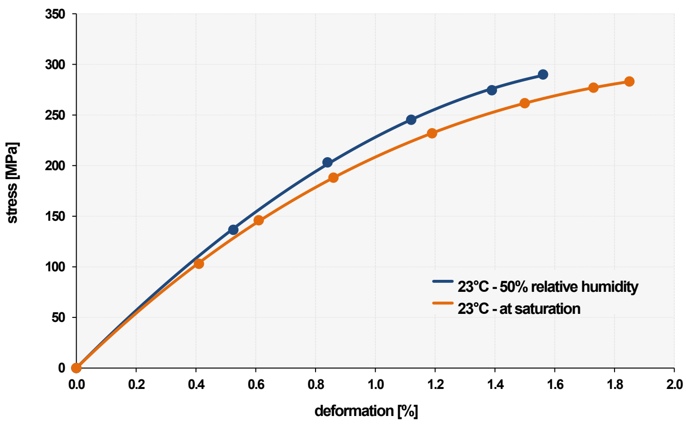
LARAMID G/60



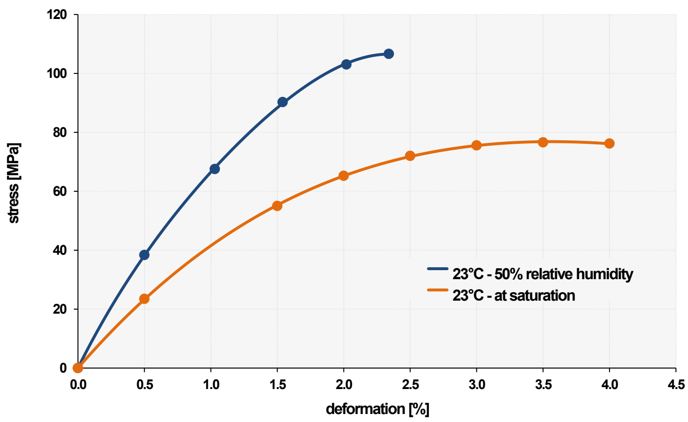
LATAMID 66 H2 G/30



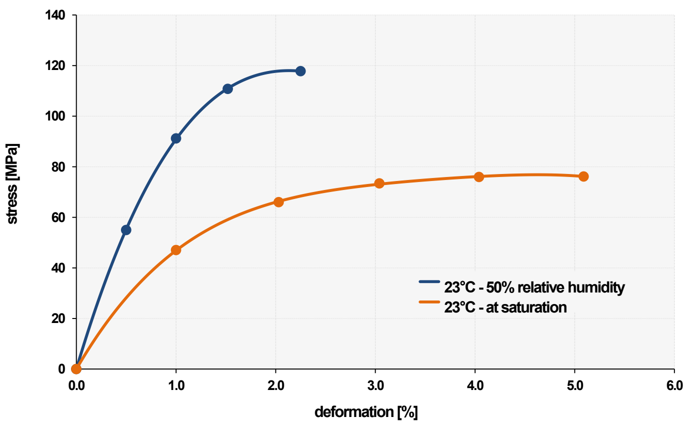
LATIGLOSS 57 G/60



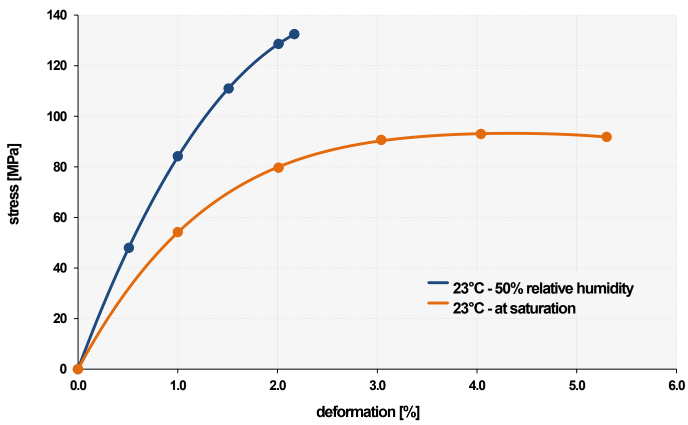
LATAMID 66 H2 G/25-V0KB1



LATAMID 6 H2 G/30-V0CT1



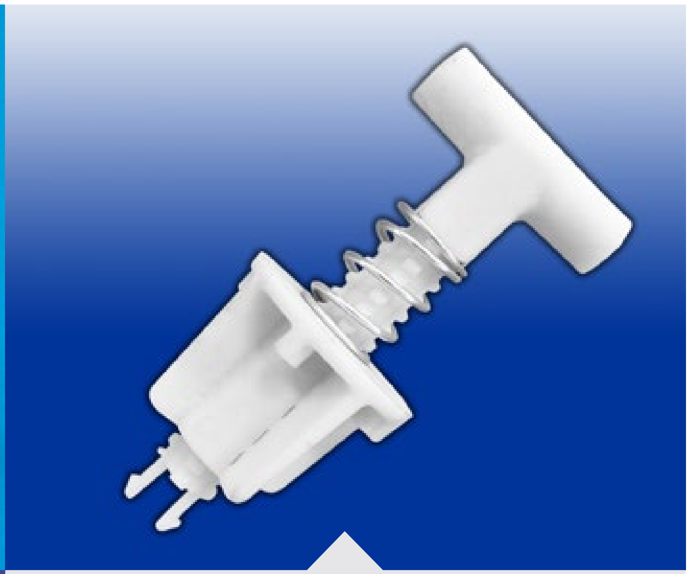
LATAMID 66 H2 G/25-V0HF1



Structural elements undergoing impulsive stress or complex stress conditions can perform better once conditioned.

Absorbed moisture increases plasticity of the polymer matrix, improving its resilience and extending the collaborative effect to larger regions of the part geometry.

Imposed stress levels are thus distributed on a wider area, reducing local stress concentration as, for instance, where resisting section is suddenly reduced.



The effects produced by absorbed moisture significantly contribute to the proper functioning of snap assembly systems.

The stem of conditioned snap fits will be more flexible, facilitating assembly and disassembly operations.

A greater elongation at break can help to avoid inopportune yielding or crack initiations in case of forced insertions as well.

The dimensional variations caused by absorbed moisture can be a problem in the case of high-precision applications, e.g. gears, kinematic mechanisms and other mechanical elements.

The use of polyamides should also be avoided in situations where deformations under stress must be minimal and/or of the same entity in any environmental condition occurring in different geographical areas.

It should not be forgotten that moisture diffusion in a polyamide reduces dielectric strength of the polymer matrix. This also applies to reinforced and self-extinguishing compounds- often found in the electrical and electronic sectors - even in case of a low volume fraction of resin compounded in the material. Any reduction of electrical insulation between live elements can cause malfunctions and safety problems.
The electrical behaviour of conditioned PA-based compounds is also monitored by certification bodies, such as UL and VDE.

Moisture diffusion in thermoplastic compounds

The quantity of water that can be absorbed by a thermoplastic compound in a given period of time depends on the type and amount of hygroscopic components found in the formula.

For example, in the case of a fibre-reinforced compound (i.e. featuring glass or carbon fibres, etc.), the diffusion coefficient will depend not only on the base resin and the temperature, but on the amount of reinforcement and orientation (longitudinal or transverse) as well:

$$D = D_L + D_T$$

$$D_L = v_f D_f + D_m (1 - v_f)$$

$$D_T = D_m \, f(v_f, D_f, D_m)$$

- D_T = transverse diffusion coefficient [mm²/s];
- D_L = longitudinal diffusion coefficient [mm²/s];
- D_m = polymer matrix diffusion coefficient [mm²/s];
- D_f = filler diffusion coefficient [mm²/s];
- v_f = volume fraction of the filler.

In the case of glass and carbon fibres, D_f is negligible, making it possible to simplify the functional dependency:

$$D_L = D_m (1 - v_f)$$

$$D_T = 1 - 2 \cdot \sqrt{\frac{v_f}{\pi}}$$

Because most of additives - fibres, mineral fillers, glass microspheres, flame retardants, etc. - are not hygroscopic, moisture absorption of a compound can be estimated from data of the base resin *(fig. 20, and tab. 8, 9)*.

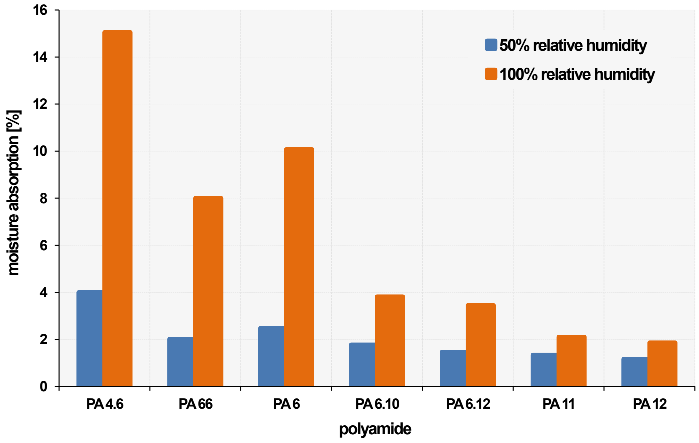


Fig. 20 - Moisture absorption of polyamides: room temperature - 23°C at equilibrium

Based on these data, by solving the Fick equation referred to in the previous pages, it is possible to simulate the development of **moisture concentration throughout the thickness of moulded parts**, in case of different temperature, environmental humidity conditions and exposure time.

$$\frac{\partial C}{\partial t} = \frac{\partial}{\partial x} D \frac{\partial C}{\partial x}$$

The following pages show graphs illustrating the concentration (percentage) of moisture in an ideal 1 mm-thick specimen in different conditions of relative humidity, for different types of interface (air - air, air - water, water - water) and various compounds.

T[°C]	RH 40%	RH 50%	RH 60%	RH 70%	RH 80%	RH 90%
20	$1.66 \cdot 10^{-8}$	$1.97 \cdot 10^{-8}$	$2.28 \cdot 10^{-8}$	$2.07 \cdot 10^{-8}$	$3.80 \cdot 10^{-8}$	$4.07 \cdot 10^{-8}$
30	$3.10 \cdot 10^{-8}$	$3.69 \cdot 10^{-8}$	$4.27 \cdot 10^{-8}$	$3.89 \cdot 10^{-8}$	$7.12 \cdot 10^{-8}$	7.63E*10^{-8}
40	$5.82 \cdot 10^{-8}$	$6.91 \cdot 10^{-8}$	$8.00 \cdot 10^{-8}$	$7.28 \cdot 10^{-8}$	$1.33 \cdot 10^{-7}$	$1.43 \cdot 10^{-7}$
60	$2.04 \cdot 10^{-7}$	$2.43 \cdot 10^{-7}$	$2.81 \cdot 10^{-7}$	$2.56 \cdot 10^{-7}$	$4.69 \cdot 10^{-7}$	$5.02 \cdot 10^{-7}$
80	$7.17 \cdot 10^{-7}$	$8.52 \cdot 10^{-7}$	$9.87 \cdot 10^{-7}$	$8.98 \cdot 10^{-7}$	$1.65 \cdot 10^{-6}$	$1.76 \cdot 10^{-6}$
90	$1.34 \cdot 10^{-6}$	$1.60 \cdot 10^{-6}$	$1.85 \cdot 10^{-6}$	$1.68 \cdot 10^{-6}$	$3.08 \cdot 10^{-6}$	$3.30 \cdot 10^{-6}$

Tab. 8 - Moisture diffusion coefficient of LATAMID 66 H2 G/50 [mm²/s]

MATERIAL	AIR, RELATIVE HUMIDITY 50%	IMMERSION
	EQUILIBRIUM	
LATAMID 6	2.70	9.00
LATAMID 66	2.50	8.00
LATAMID 66 H2 G/30	1.70	5.20
LATAMID 66 H2 K/30	1.75	5.50
LATAMID 66 H2 G/50	1.30	4.50
LATAMID 66 H2 G/60	1.20	4.30
LATIGLOSS 66 H2 G/50	1.35	4.50
LATIGLOSS 66 H2 G/60	1.25	4.40
LATAMID 6 G/20-V2HF	2.20	6.90
LATAMID 66 H2 G/25-V0HF1	1.30	4.30
LATAMID 66 H2 G/50-V0HF1	1.24	3.70
KELON B FR H CET/30-V0	1.60	5.60
LATAMID 66 H2 G/25-V0CT1	0.90	3.40

Tab. 9 - Percentage of moisture absorbed at equilibrium

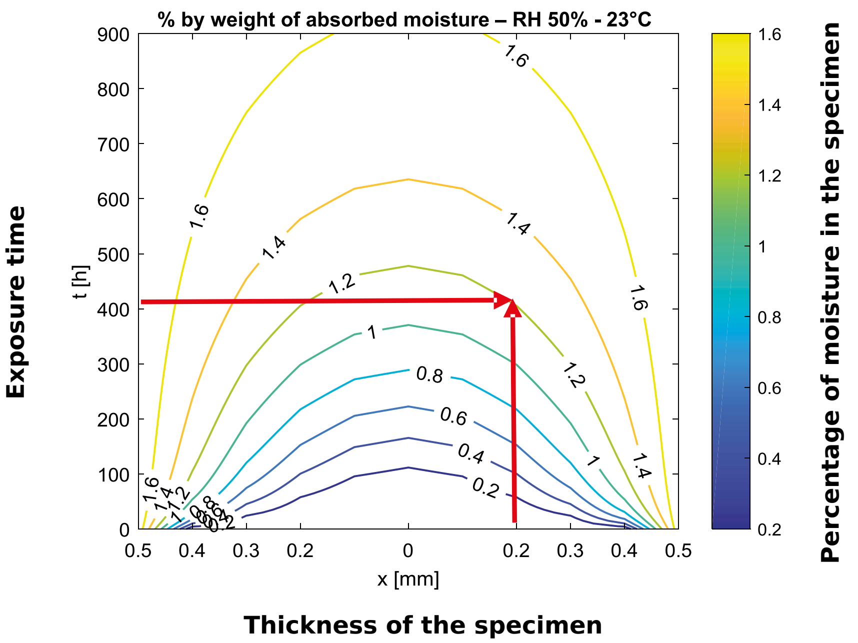
How to read the graphs?

Isoconcentration graphs show the moisture percentage by weight contained in a specimen after a certain time interval.

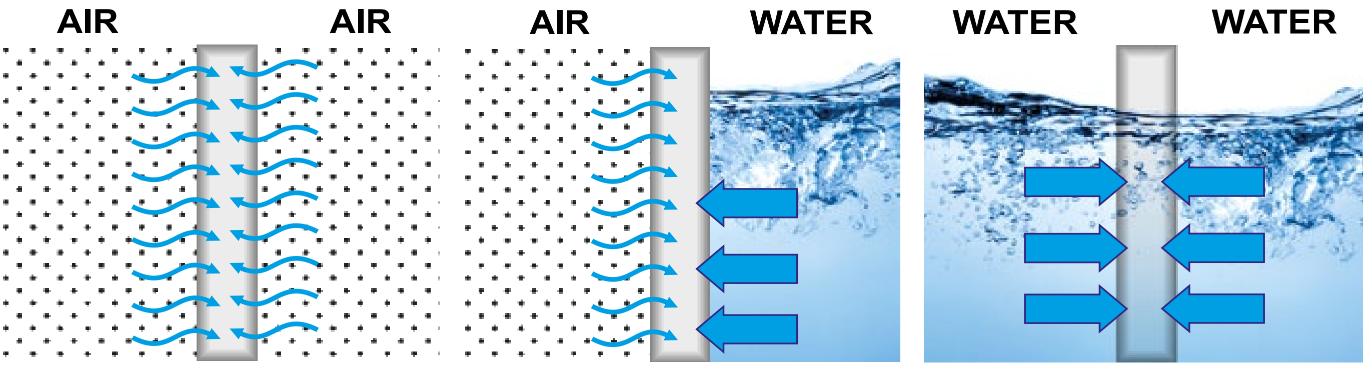
Time (hours) is shown in ordinate, while the distance from the centre of the specimen is given on the abscissa.

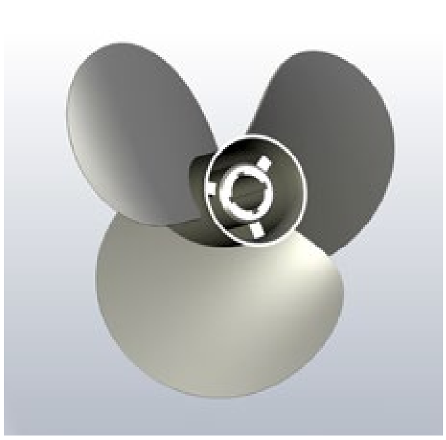
If, e.g., it is necessary to predict the percentage of moisture in a point placed at 0.2 mm from the centre after an exposure time of 400 hours, you need to identify, on the graph, where exactly the intersection between 400 hours and 0.2 mm lies on the moisture content reference curve.

It can be noticed that the outermost layers quickly reach saturation, whereas a much longer time is needed to the effects of moisture absorption to reach the sample core.



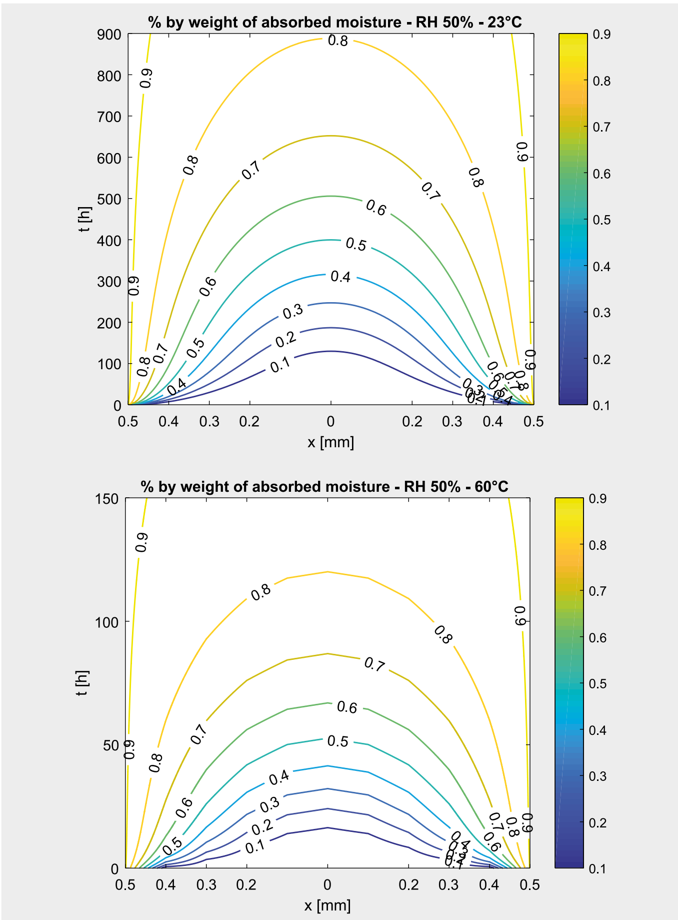
Type of contact (interface)



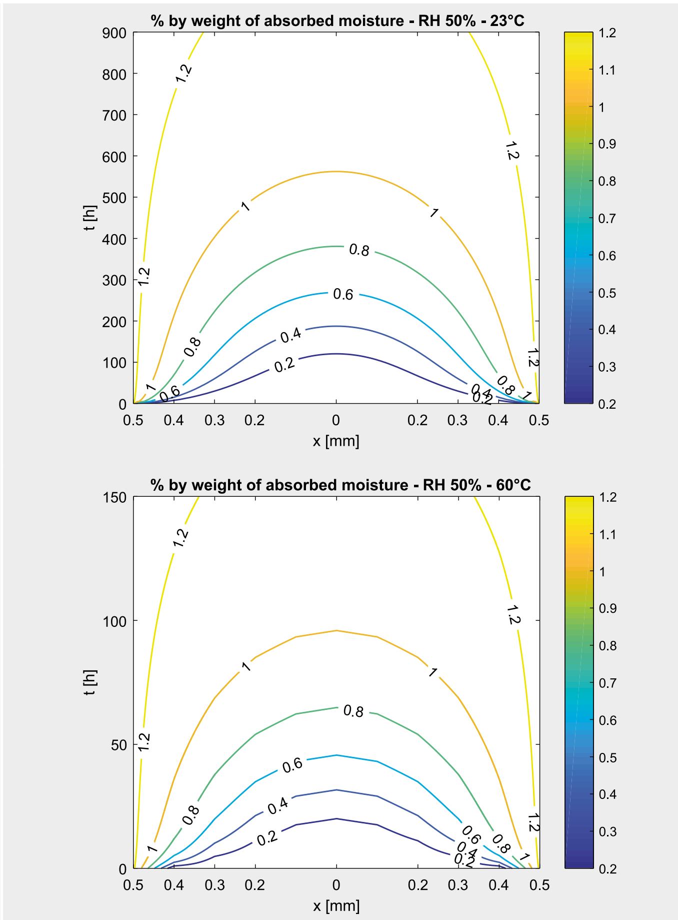


Self-extinguishing materials:

LATAMID 66 H2 G/25-V0CT1 AIR/AIR INTERFACE

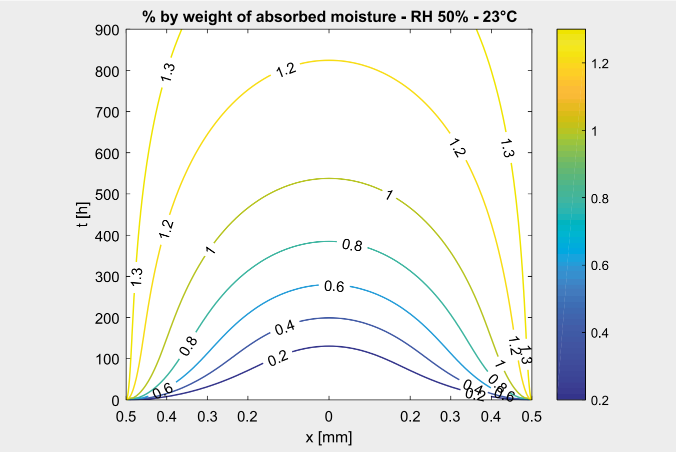


LATAMID 66 H2 G/50-V0HF1 AIR/AIR INTERFACE

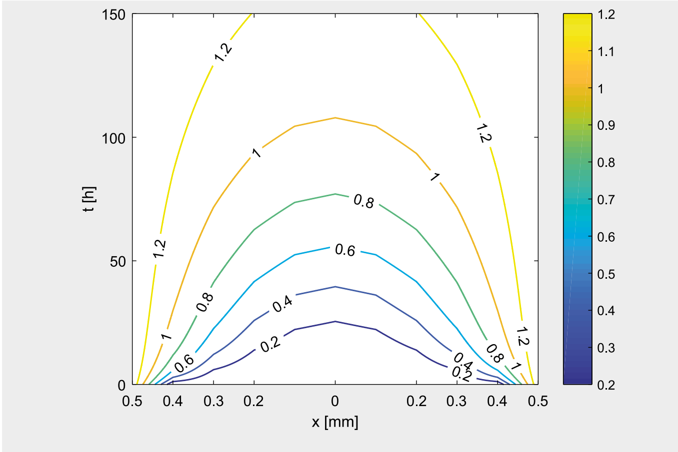


Structural and aesthetic materials

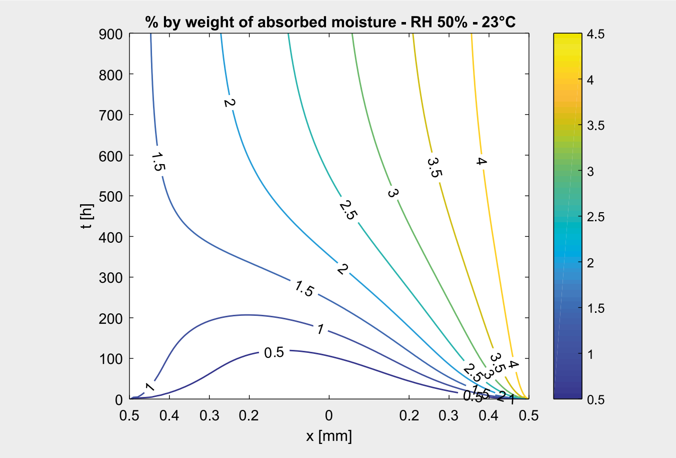
LATIGLOSS 66 H2 G/50 AIR/AIR INTERFACE



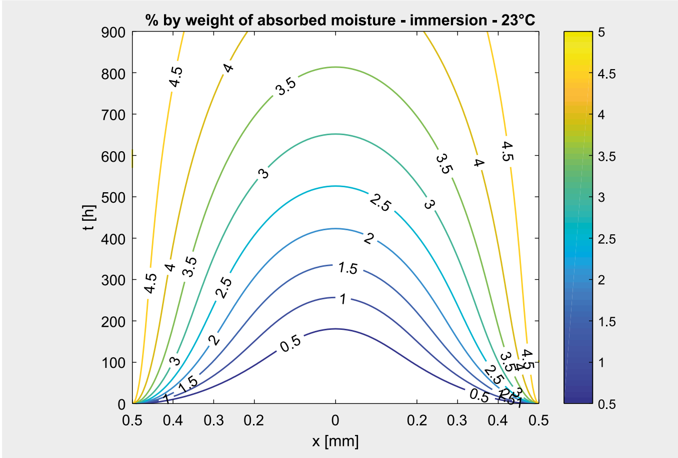
LATIGLOSS 66 H2 G/50 AIR/AIR INTERFACE



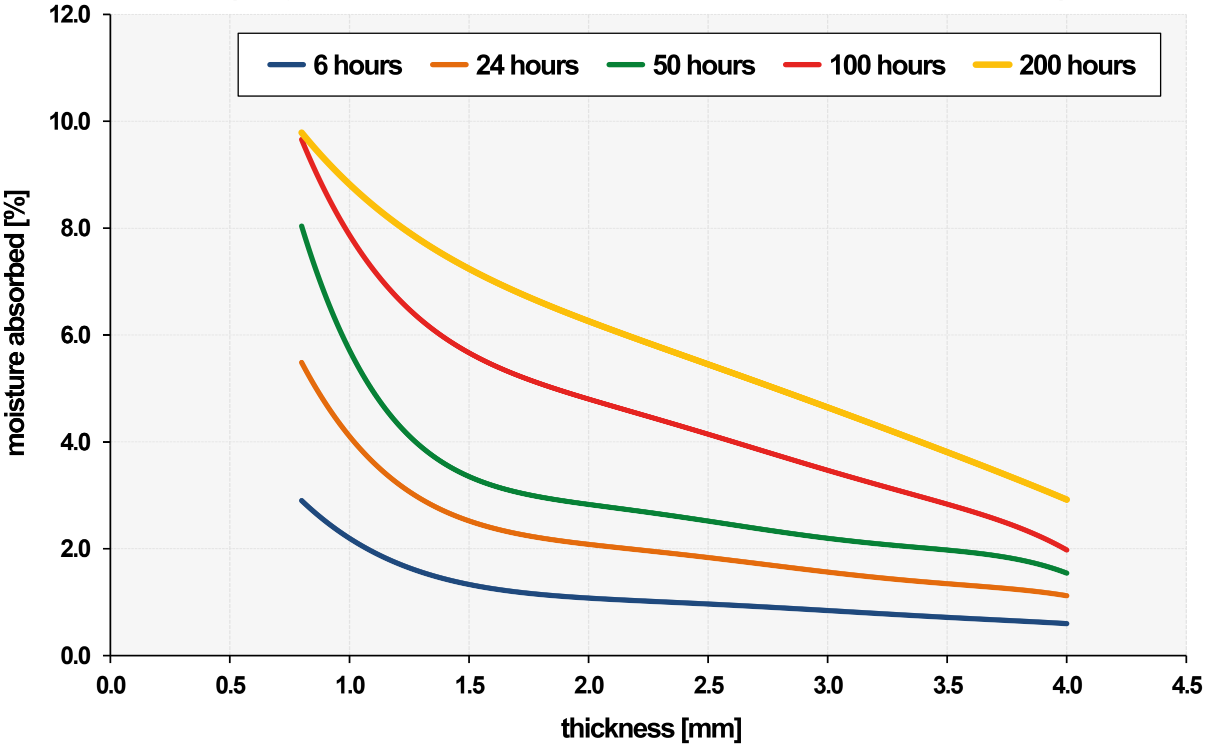
LATIGLOSS 66 H2 G/50 AIR/WATER INTERFACE



LATIGLOSS 66 H2 G/50 WATER/WATER INTERFACE

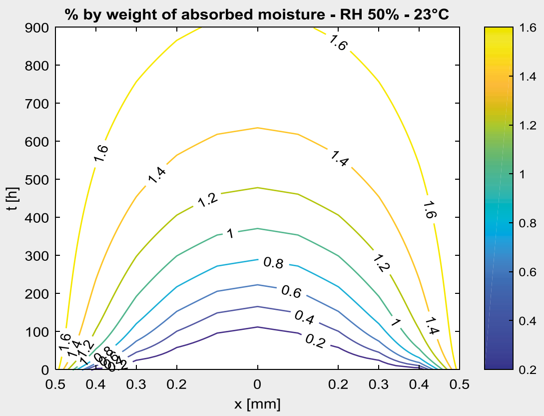


INFLUENCE OF THICKNESS
(polyamide 66 - room temperature - 23 °C - in immersion)

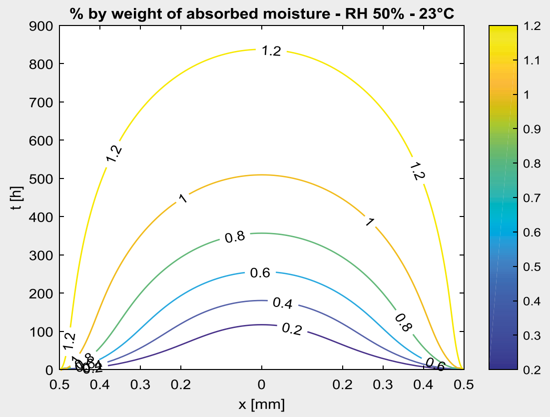


Structural materials

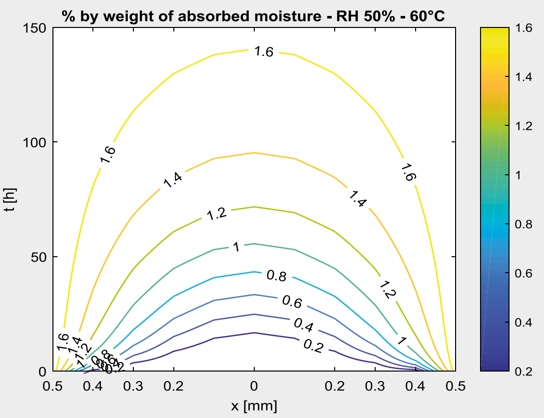
LATAMID 66 H2 G/30 AIR/AIR INTERFACE



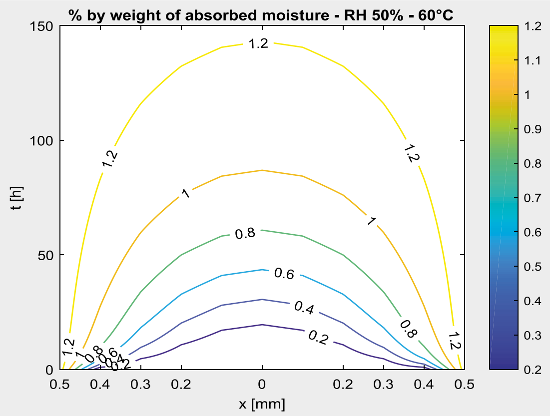
LATAMID 66 H2 G/50 AIR/AIR INTERFACE



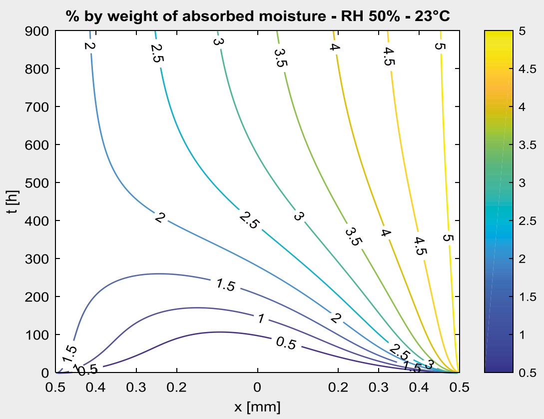
LATAMID 66 H2 G/30 AIR/AIR INTERFACE



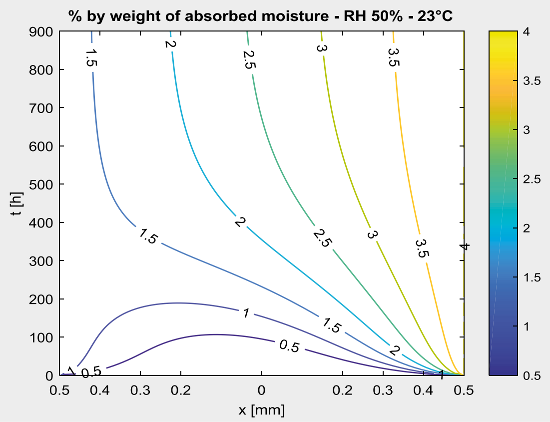
LATAMID 66 H2 G/50 AIR/AIR INTERFACE



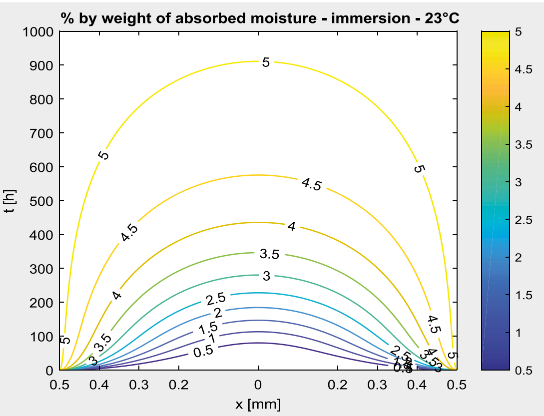
LATAMID 66 H2 G/30 AIR/WATER INTERFACE



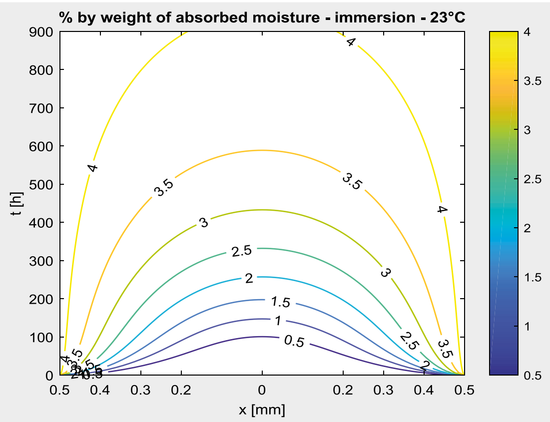
LATAMID 66 H2 G/50 AIR/WATER INTERFACE



LATAMID 66 H2 G/30 WATER/WATER INTERFACE



LATAMID 66 H2 G/50 WATER/WATER INTERFACE



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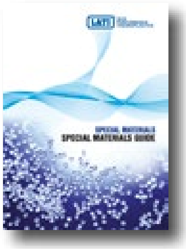
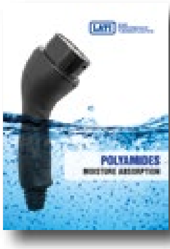


Special materials

Special materials guide



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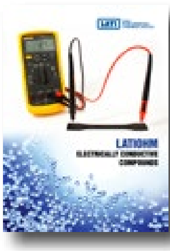

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