S PLASTICON

Technical Manual

IMAZ™

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Description

IMAZ™is a range of resin panels with encapsulated materials ready to suit a variety of applications. Select from our IMAZ™product range or create your own combination using our interlayers, adding color, depth, gauge, surface finish, resin or propose us your own material for encapsulation.

Chemical Resistance

IMAZ™ shows a good resistance to a number of chemicals. The overall chemical resistance is however dependent upon the following parameters:

· temperature (resistance decreases with higher temperatures)
· stress level (best resistance is with flat sheet, clamped in a frame)
· chemical concentration (mostly in water, from some ppm to pure)
· exposure time (from fumes over drips to continuous contact)

Following information is meant as a guideline. As to the above influences, it is recommended to perform own testing according to the final application.

Do not hesitate to contact us in case of questions regarding the chemical compatibility of IMAZ™.
In case you want Arla Plast to perform compatibility testing, the product and its MSDS, together with indications on above parameters are required.

In general, IMAZ™ shows a good chemical resistance for various chemicals such as dilute solution of acids, salts and aliphatic hydrocarbons, but it is significantly affected by aromatic hydrocarbons and ketones. All tests are performed on flat sheet, immersed in the reagent at room temperature

Reagent

		FORM	CRYSTAL	PLUS
Acetic Acid	5%	+	-	+
Acetic Acid	10%	0	0	0
Acetic Acid	conc.	-	-	-
Aceton		-		-
Ammonium Hydroxide	conc.	-		-
Ammonium Hydroxide	10%	-		-
Antifreeze, Automotive Ethylen Glycol Type		+	+	+
Benzene		-	-	-
Brake Fluid, DOT3		+		+
Brake Fluid, off		0		0
Carbon Tetrachloride		-		-
Chromic Acid	40%	+	-	+

Citric Acid	10%	+	+	+
Cottonseed Oil		+		+
Deionized Water		+		+
Detergent, Alconox (0,25%)		+		+
Di(2-Ethylhexyl) Phthalate				
Dibutyl Sebacate		+		+
Diesel Fuel		0		0
Dimethyl Formamide		-		-
Ethanol	50%	+	-	+
Ethanol	50%	0		0
Ethanol	100%	+		+
Ethyl Acetate		-	-	-
Ethylene Dichloride		-	-	-
Gasohol, 10% Ethanol		0		0
Gasohol, 10% Methanol		0		0
Gasoline, Base for Gasohol	5%	0		0
Gasoline, Premium Unleaded	10%	0		0
Gasoline, Regular		+		+
Gasoline, Regular Unleaded		0		0
Gasoline, Regular Unleaded		-	-	-
Grease, Automotive		+		+
Hexane		+		+
Heptane		-	-	-
Hydrochloric Acid	conc.	-	-	-
Hydrochloric Acid	10%	0	+	0
Hydrogen Peroxide	3%	+		+
Hydrogen Peroxide	28%	+		+
Isooctane		+		+
Kerosene		+		+
Lacquer Thinner		-		-
Methyl Alcohol		-	-	-
Mineral Oil		+	+	+
Motor Oil		+		+
Nitric Acid	conc.	-	-	-
Nitric Acid	10%	+	+	+
Nitric Acid	40%	0		0
Oleic Acid	83%	+		+
Olive Oil		+	+	+
Phenol	5%	-	-	-
Silicone Spray Lubricant		-		-
Soap Solution	1%	+		+
Sodium Carbonate	2%	+		+

Sodium Carbonate	20%	+		+
Sodium Chloride	10%	+		+
Sodium Hydroxide	1%	+		+
Sodium Hydroxide	10%	-		-
Sodium Hypochlorite	3,5%	+		+
Sulphuric Acid	conc.	-		-
Sulphuric Acid	3%	+		+
Sulphuric Acid	30%	0	0	0
Tapping Oil		+		+
Toluene		-	-	-
Transformer Oil		+		+
Transmission Fluid		+		+
Turpentine		+	+	+
Water		+	-	+

Legend:
+ Resistant
0 Limited Resistance
- Not Resistant

Test condition:
(1) Stress free, immersion, 23°C, 1 year
(2) Stress free, immersion, 23°C, 30 days

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Fabricating

1 GENERAL

General Guidelines

IMAZ™ sheet can be worked with most tools used for machining wood or metal. Tool speeds should be such that the sheet does not melt from frictional heat. In general, the highest speed at which overheating of the tool or plastic does not occur will give the best results. It is important to keep cutting tools sharp at all times. Hard, wearresistant tools with greater cutting clearances than those used for cutting metal are suggested. High-speed or carbon-tipped tools are efficient for long runs and provide accuracy and uniformity of finish. Since plastics are poor heat conductors, the heat generated by machining operations must be absorbed by the tool or carried away by coolant. A jet of air directed on the cutting edge aids in cooling the tool and in removing chips. Plain water or soapy water is sometimes used for cooling unless the trim scrap is to be reused.

2 SAWING

Circural saw

The table saw type is the most frequently used for sawing flat sheet. Sawing thinner gauges (below 2 mm) may display a cracked edge due to vibration of the sheet. This can mostly be solved by sawing stacks of ±16 mm using a thicker sheet or strip (3 mm) beneath as a support. When sawing thin gauge sheet, decrease saw speed, feed rate and pitch. Keep the gap between blade and table as small as possible.

Band saw

Band saws are used to cut out formed parts, or irregular shapes. For a series of the same shape, a supporting caliper can be useful in preventing chipping. Thicker gauges are best sawn with a bigger tooth size. To achieve a smooth edge, circular saws and routers are preferable to a band saw.

	Band saw	Circular saw
Clearance angle	20 - 40°	10 - 30°
Rake angle	0 - 5°	5 - 15°
Tooth angle	-	15°
Cutting speed (m/min.)	600 - 1.700	1.000 - 4.000
Tooth distance (mm) t (larger for thicker sheet)	1,5 - 3,5	2 - 10

Trouble shooting

Chipping: Increase blade tooth size and saw speed, decrease feed rate.
Gumming: decrease blade tooth size and saw speed, increase feed rate.
Cracks or notches: as for chipping, check clamping.

In all cases, inspect blade sharpness, check blade fence alignment and if needed use air to cool blade. Change of sound or vibration during sawing, is an indication that sharpness and alignment might have changed.

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3 ROUTING

Routing is especially recommended for trimming work pieces. Always use routers of at least 750 Watts, and a speed of 18.000 to 25.000 rpm is preferred. Bits should be straight fluted preferably two-fluted, carbide-tipped, or high-speed steel, with a diameter of 4 to 12 mm. Always feed counter rotation-wise up to 1,5 m/min, and cool with compressed air only.

4 DRILLING

Drills designed for plastics are recommended, but standard twist drills for metal will do the job as long as they have not been used on metals before, though they require slower speeds and feed rates to produce a clean hole.
For deep holes, in the edges of thicker gauge sheet for example, cool with compressed air and frequently back out the drill to free chips and prevent melting of them. Never use cutting oils. Like other transparent plastics.

IMAZ™ is a notch-sensitive material and cutting threads develop stress points that can create stress crazing or cracking. Always keep a distance from the edge, minimum 1.5 times the diameter of the hole. Be sure drilled holes are smooth with no evidence of cracks or roughness, which can cause breakage when fastening.

Do not use countersunk screws with IMAZ™ sheet. (see mechanical fastening)

Clearance angle	5 - 15°
Rake angle	0 - 5°
Top angle	110 - 130°
Helix angle	30°
Cutting speed	30 - 60 m/min.
Feed	0,1 – 0,6 mm/rev

5 MILLING

Standard high-speed milling cutters for metal achieve best results, provided they are sharp (not been used on metal before) when applied on.

Typical parameters are 500 rpm and feed 0.25 mm/rev.

6 LASER CUTTING

Lasers can be used to cut IMAZ™, giving clear edges up to 5 mm thickness. The result of the cut also depends on the encapsulated material and its parameters. Preliminary cutting-tests are recommended. Laser power and travel speed must be optimised to minimise 'whitening' of the IMAZ™ sheet while cutting. Fumes coming off during cutting might smell unpleasant and therefore it is recommended to use appropriate exhaust systems.

Do not to induce stress into freshly laser cut sheet (e.g. cold brake forming), as breakage might occur. Therefore it is recommended to anneal the sheet (max 50 °C) or stock it for some time (min 2 week).

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Forming
(REFER ONLY FOR IMAZ FORM SHEETS)

This is only general guideline as the find result depends always from the encapsulated material.

1 COLD FORMING
Cold curving
IMAZ™ can be cold curved with a minimum radius of 175 times the gauge thickness for outdoor applications, and 125 times the thickness for indoor applications. When smaller radii are needed thermoforming is the solution.

2 THERMOFORMING
There is no need to pre dry IMAZ™ sheet. Only very old thick sheet could have absorbed so much moisture as to make pre drying (at 60°C) desirable.

IMAZ™ sheet can be thermoformed at low temperature (110-155°C). Sheet temperatures over 160°C may cause blistering and damage the sheet.

Take care while heating the sheet. Heating too fast will result in heat accumulating at the sheet surface and degrade it. Because of its low specific heat, IMAZ™ sheet requires only a little energy to be formed. The most appropriate heaters are infra red heaters. Contact heating and high-frequency heating are not suitable.

Hot line bending
The Hot Line Bending equipment is a simple IR- or electrical resistance heater, bending-calliper coated with fabric and a clamping device. Perform a preliminary test to find out the correct heating time.

The heating time depends on the power of the IR heaters. With one side heating, it takes about 2 min to make a 3 mm sheet weak enough to bend. Thicker sheet need to be heated from both sides. If not available, turn periodically during the heating cycle. Always bend the sheet with the last heated side forming the outside radius.

When IMAZ™ softens, remove from heating source, bend, place into calliper and clamp. Cool slowly to prevent distortion. Keep the part close to the heating device to make it cool down evenly. Once the part is at about 75 °C, it can be placed in a fixing device and cool down in the air.

Drape forming
Uni-axial bent parts can be achieved by drape forming. The mould can be made out of wood or aluminium covered with felt. Slight pressure (with soft gloves or cloth, e.g. linen) is sufficient to drape the IMAZ™ sheet over a positive mould.

The sheet temperature should be about 130°C to achieve easy forming. Place sheet on the mould immediately after heating; therefore minimize distance between mould and oven. Cool in surrounding air, but take care for drafts which could cause distortion of, and stress in the finished parts.

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Bonding and fastening

1 SOLVENT BONDING

Use extreme caution when working with solvents: they may be toxic or contain carcinogens. Adequate ventilation is essential. Obtain Safety Data Sheets from the solvent manufacturer.

This technique has been used for years to make displays from acrylic sheet, but can also be used to construct threedimensional shapes with IMAZ™ sheet. To bond small pieces, one can use a hypodermic needle and making sure that the solvent flows throughout the area to be cemented. Edge dipping is another method used to assemble two flat parts under a 90° angle. The edge of the sheet which is to be bonded, is dipped in the solvent until it becomes soft. Then it is put on the flat sheet under slight pressure. The jointed articles can be safely placed on a table to dry after the solvent has been applied. Special care should be taken that no air bubbles are left after curing. Both methods depend on smooth edge preparation, pressure and curing.

Application solvents	Boiling point
Methylene dichloride	40,5 °C
Acetone	56,5 °C
Chloroform	61,1 °C
Tetrahydrofurane (THF)	66 °C
Methyl ethyl ketone (MEK)	79.7°C
Trichloroethylene	87,0°C
Cyclohexanone	155,0°C

When using solvents it is advisable that the work area be climate controlled with low humidity to minimise joint 'whitening'. If this is not possible, the addition of 10 % glacial (> 99.8%) acetic acid (boiling point 116.5 °C) to the solvent or use of a slower curing cement-type bond is suggested. Solvents with a low boiling point, may cause whitening or insufficient softening of the treated surface which results in improper joints.

To prevent early evaporation, use mixtures of the above mentioned solvents or dissolve IMAZ™ chips (e.g. saw dust) or granules in one of them to increase boiling point.

Mixture suggestions :
- 42% MEK, 42% Trichloroethylene and 16% Methylene dichloride
- 85% Methylene dichloride, 12% Trichloroethylene and 3% MEK

When using a solvent in which 8% of IMAZ™ chips have been dissolved, the curing time is longer, allowing you to adjust the position of the two parts to be bonded, and preventing them from whitening.

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2 ADHESIVE BONDING

When working with adhesives, the usual safety and health precautions should be taken and eventual special instructions from the adhesive manufacturer should be observed.

A lot of commercial adhesives have proven their effectiveness for bonding IMAZ™ (to IMAZ™ or other materials). Adhesives on polyurethane or acrylic (toughened) basis give good results. Take into account that stresses in the sheet or parts in combination with solvents or adhesives may cause cracking. Cut and finish the surfaces to be bonded carefully. A good alternative is a 2 component polyurethane adhesive, which exists in a clear transparent grade or transparent UV curable. Fast curing cyanoacrylics often cause whitening.

Note that there is no universal glue. Applicable glue type depends on the application: substrates to be bonded, temperature, humidity, UV resistance, fixed load – shocks or vibrations, bonding speed, bonding surface, ...

Manufacturers of adhesives:
Agomet Klebstoffe GmbH, Bostik Findley B.V., Engineering Chemicals BV, Kömmerling Chemische Fabrik KG, Loctite Corporation, Lord Corporation (Europe) Ltd., Meco GmbH, National Starch & Chemical NV, Bison International bv, Permabond, Rectavit NV, Ruderer GmbH, UHU GmbH, Vantico

3 RECOMMENDED BONDING DESIGNS

Joint design, often overlooked, should be such that the bonding area carries the load equally, with the major stresses in tension or shear thereby minimising cleavage and peel stresses. The lap joint is the most frequently encountered joint type when working with relatively thin gauge materials.

4 TAPE BONDING

Double sided self adhesive tapes, transparent and mostly on an acrylic basis, can be used to make quick fastenings. These tapes are elastic and stick to different materials. They can be quite useful in bonding thin sheet materials to other plastics, glass or metals.
Use following procedure to make proper bondings:
· Bend along the part for more than tape width.
· Clean this zone with a 50% Isopropyl alcohol - water solution.
· Pressing with wooden roller evacuates trapped air and improves strength.

Manufacturers of bonding tapes:
3M Company, MACtac Europe S.A., Scapa Tapes

5 MECHANICAL FASTENING

Due to its high impact resistance, all types of mechanical fastening can be applied, depending on thickness of the IMAZ™ sheet Up to 1.5 mm, it can be nailed, stapled or riveted. These kinds of fastening are not recommended for industrial applications.

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The best way to fasten IMAZ™ is to use screws with a cylindrical head. Never use screws with chamfered heads. They cause stress cracking. Drill holes 0.5 mm larger than the screw. Screws of plastic can always be used. When using metal screws or bolts, use plastic washers (nylon). Metal thumbscrews can be used without washers.

Use galvanised types only.
Never use glue to tighten bolts.
No more than 2 extra twists after turning firm by hand.
Mechanical fastening will produce a stronger part than solvent bonded parts and allows for easier disassembly and cleaning.

6 WELDING

While mechanical fastening and solvent bonding are the most often recommended methods of joining IMAZ™, another alternative is welding.

Ultrasonic welding and spin welding have both proven to be appropriate. High frequency welding is not suited. Contact manufacturers of ultrasonic welding equipment for recommendations on section and joint design.

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Finishing

1 SANDING

The sheet edges can be sanded using both wet and dry systems. Dry sanding can result in gumming as frictional heat build-up is created. Wet sanding gives a smooth finish. In both cases, further finishing in order to restore the gloss will be necessary.

Example: start with 80-grit paper and end with 400 or 600-grit.

2 POLISHING

Polishing is a time consuming activity and should only be applied for smaller series and parts made out of thick gauge sheet. The edges can be polished by different techniques. Keep in mind the specific colour of IMAZ™:
a glass clear edge will rarely be achieved.

Mechanical polishing

After grinding, surfaces of IMAZ™ sheet can be polished in order to obtain a better surface finish. Burnish wheels of cloth or fleece and felt polishing bands, together with a suitable polishing wax, give good results. Keep surface temperature low, in order to a later appearance of fine cracks. Suppliers of mechanical polishing tools:

Suppliers of mechanical polishing tools:
3M, EFC (US)

Diamond polishing

IMAZ™ sheet can be diamond polished resulting in an excellent surface quality that does not need further treatment. No pre-grinding step is required, as per step up to 0.5 mm can be removed.

Flame polishing

Use a standard propane - or butane torch or a hot nitrogen welder. It is very important to control the distance between the sheet and the heat source. Without proper control, surface whitening or material flow of the IMAZ™ might occur.

Instead of a torch, an electrical hot air device can be used. Typically 400-550 °C for 5 seconds moving at 100 mm can be used to remove scratches. As with Acrylics, flame polishing IMAZ™ sheet can cause long-term edge cracking. However, with continued practice and by using proper techniques, excellent results can be achieved.

Solvent polishing

The appearance of saw-cut edges can be improved by first sanding them. For smoother, glossy edges, consider solvent polishing with MEK or methylene dichloride. To prevent humidity blush after drying, add a small amount of a slow-drying component such as diacetone alcohol.

Use extreme caution when working with solvents. Adequate ventilation is essential. Follow precautions Safety Data Sheets from the solvent manufacturer.

3 DECORATING

Flat sheets can be screen printed, tampon printed, hot stamped or decorated with self adhesive films. Vacuum formed parts can be tampon printed or hot stamped. Other techniques are (spray) painting, laser marking, sand blasting.

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Cleaning

IMAZ™ sheet may be cleaned by using a clean soft sponge and washing with lukewarm water containing a mild soap or a slightly acidic, neutral or slightly alkaline detergent. Then rinse thoroughly with clean water and dry with a chamois leather or a moist sponge.

A subsequent anti-static treatment is recommended. Fresh paint splashes, grease, smeared glazing compounds, etc. can be removed before drying by rubbing lightly with isopropyl alcohol on a soft cloth followed by a thorough wash and rinse as described above. Rust stains can be removed with a 10% oxalic acid solution. Do not use abrasive or highly alkaline cleaners, acetone, benzene, leaded gasoline or carbon tetrachloride on IMAZ™ sheet.

Never scrape with razor-blades or other sharp instruments. Minor scratches can be removed or made less noticeable by polishing with hot air. Having good electrical insulating properties, IMAZ™ sheet is subject to electric static charge and dust attraction. Treatment with an anti-static agent keeps the sheet free from static charge and dust over prolonged periods.

There are some commercially available products, which act simultaneously as cleaning agent and anti-static agent. Before commencing certain operations on IMAZ™ sheet such as painting, screen printing or thermoforming, it is recommended that dust particles be blown off first, using an ionised air gun. Dusting with a regular air gun or a cloth only moves the particles rather than removing them.

Renew Surface - Recycling

All the IMAZ™ range can renew their surface. This procedure can be done only in our facilities, so please contact us if need any.

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IMAZ™ FORM

Property	Unit	Value	Standard
Physical Properties			
Density	g/cm^3	1.27	ISO 1183
Light transmission (Light source D65, thickness 1 mm)	%	88	ASTM D1003
Refractive index		1.57	ISO 489
Moisture absorption 24 hours, 23°C, immersion	%	0.2	ISO 62
Mechanical Properties			
Tensile strength at yield	N/mm^2	53	ISO 527
Elongation at yield (at break)	%	40	ISO 527
Modulus of elasticity	N/mm^2	2200	ISO 527
Charpy unnotched impact strength +23°C	kJ/m^2	NH	ISO 179/2D
Izod notched impact strength +23°C	kJ/m^2	11.5	ISO 180/1A
Izod notched impact strength -30°C	kJ/m^2	4.4	ISO 180/1A
Rockwell hardness		R115	ISO 2039-2
Thermal Properties			
Linear coefficient of thermal expansion (23-40°C)	$10^{-6} \times K^{-1}$	51	ASTM D696
Heat deflection temperature, HDT A (1,80 N/mm)	°C	68	ISO 75
Heat deflection temperature, HDT B (0,45 N/mm)	°C	72	ISO 75
Thermal conductivity λ	W/m K	0.19	DIN 52612
Fire Properties			
Fire classification according to UL94	Class	HB	UL 94
Fire classification according to EN 13501-1	Class	B-s2,d0	EN 13501-1
Oxygen Index	%	25	ASTMD2863-77
Electrical Properties			
Volume resistivity, dry	$\Omega \times cm$	10^{16}	IEC 60093
Surface resistivity, dry	Ω	10^{15}	IEC 60093
Dielectric strength, dry (1 mm)	kV/mm	30	IEC 60243
Dielectric constant, dry 1 MHz		2.4	IEC 60250
Dissipation factor (tan δ), dry 1MHz		0.02	IEC 60250

All the above statements and data correspond with our current know-how and are subjects to changes. Though a legally binding assurance of certain characteristics or suitability of any product type for a special purpose can not be derived. Any indication is only a nonbinding recommendation. Subject to changes.