Technical information, January 2020

Makrolon®
Chemical resistance

General chemical behaviour :

The chemical resistance of Makrolon® depends on the concentration of the substance, the temperature, the contact time and the internal tension level of the polycarbonate sheet due to fabrication etc.

Several types of damage can arise, sometimes more than one at the same time.

Dissolving / Swelling

Low-molecular, aromatic, halogenated and polar components migrate into the plastic. The damage can range from a sticky surface to complete dissolving.

Stress cracking

Some chemicals migrate to a minor extend and in very low quantity into the surface, and lead to relaxation of tensions in the material. This results in stress cracking, which can be optically disturbing. Because of increased notch occurrence, some mechanical properties are negatively influenced. Stress cracking is usually easy to see in transparent sheets.

Molecular reduction

Some properties of materials are determined by the molecular weight. If a substance initiates a molecular reduction through a chemical reaction, the impact resistance and elastic properties of the material will be influenced. Electrical properties are almost not influenced; thermal properties are only slightly influenced by the molecular weight.

Examples	
Solvents / not resistant to	Dichlorine methane Chloroform Tetrahydro furane
Swelling agents	Benzene Chlorine benzene Acetone
Not influenced by / resistant to	diluted mineral acids, many organic acids, oxidizing or reducing agents, neutral and acid salt solutions, many fats, waxes and oils

In the following table you can find the resistance of Makrolon® to chemicals and several other substances.

The test results have been obtained at samples with low internal tensions, which have been stored during 6 months in the substance at a temperature of 20°C, without any mechanical load.

Apart from the nature of the substances, the chemical resistance is also depending on the concentration of the substance, the temperature during the contact, the contact time and the internal tension of the tested specimen.

This means that our products can be resistant to a number of chemicals for short contacts, but are not resistant in case of long exposure, such as performed in these tests.

Therefore, it is always recommendable to execute a test in the actual application conditions, if these differ from the test environment described above.

Technical information, January 2020

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Chemical resistance

The tested substances have been chosen in function of their importance in several areas. In a lot of cases it is possible to deduct results to other, chemically comparable, substances, even if these have not been tested.

Our UV-protected materials (Makrolon® UV) are slightly more sensitive to chemicals in comparison to the unprotected materials, but in general the results shown in the table still comply.

Scratch resistant materials (Makrolon® AR) show improved chemical resistance, as long as the sheet surface remains intact.

Damaged Makrolon® AR sheets will show on the mid- to longterm comparable results as sheets without improved scratch resistance.

Legend

Explanation of the symbols:

+	resistant
O	partially resistant
-	not resistant

The results shown in the sections 2 upto 10, and especially the commercial products marked with ® , are based on a one-time test.
Changes in the composition by the producers of these substances can influence the product properties.

1. Chemicals	
Acetaldehyde	-
Acetic acid, upto 10% solution	+
Acetone	-
Acetylene	+
Acrylonitril	-
Allylalcohol	O
Alum	+
Aluminum chloride, saturated aqueous solution	+
Aluminum oxalate	+
Aluminum sulphate, saturated aqueous solution	+
Ammonia	-
Ammoniacal liquor	-
Ammonium chloride, saturated aqueous solution	+
Ammonium nitrate, saturated aqueous solution	+
Ammonium sulphate, saturated aqueous solution	+
Ammonium sulphide, saturated aqueous solution	-
Amylo acetate	-
Aniline	-
Antimony chloride, saturated aqueous solution	+
Arsenic acid, 20% solution	+
Benzaldehyde	-
Benzene	-
Benzoic acid	-
Benzyl alcohol	-
Borax, saturated aqueous solution	+
Boric acid	+
Bromic benzene	-
Bromine	-
Butane (liquid or gaseous)	+
Butyl acetate	-

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Butanol	+	Diethylether	-	Lead tetraethylene, 10% in gasoline	O
Butylene glycol	+	Diglycolic acid, saturated aqueous solution	+	Lighting gas	+
Butyric acid	-	Dimethyl formamide	-	Ligroin (hydrocarbon compound)	+
Calcium chloride, saturated aqueous solution	+	Dinonyl phthalate (plasticizer)	O	Lime milk, 30% in water	O
Calcium hypochloride	+	Dioctyl phthalate (plasticizer)	O	Magnesium chloride, saturated aqueous solution	+
Calcium nitrate, saturated aqueous solution	+	Dioxane	-	Magnesium sulphate, saturated aqueous solution	+
Calcium-soap, fat/pure	+	Diphyl 5,3	O	Manganous sulphate, saturated aqueous solution	+
Carbon acid, wet	+	Ether	-	Mercuro chloride, saturated aqueous solution	+
Carbon monoxide	+	Ethyl alcohol, 96% pure	+	Mercury	+
Chlorine benzene	-	Ethyl amine	-	Methacrylic acid-methyester (MMA)	-
Chlorine gas, dry	O	Ethyl bromide	-	Methane	+
Chlorine gas, wet	-	Ethylene chlorhydrine	-	Methanol	-
Chlorine lime slurry	+	Ethylene chloride	-	Methyl amine	-
Chlorine lime, 2% in water	+	Ethylene glykol	+	Methyl ethyl ketone (MEK)	-
Chloroform	-	Ferritrichloride, saturated aqueous solution	+	Methylene chloride	-
Chrom alum, saturated aqueous solution	+	Ferro bisulphate	+	Nitric acid, 10%	+
Chromic acid, 20% in water	+	Formaline, 10%ig	+	Nitric acid, 10-20%	O
Citric acid	+	Formic acid, 30%	O	Nitric acid, 20%	-
Copper sulphate, saturated aqueous solution	+	Gasoline	+	Nitric Gas, dry	-
Cresol	-	Glycerine	O	Nitrobenzene	-
Cupric chloride, saturated aqueous solution	+	Glycol	+	Oxalic acid, 10% in water	+
Cuprous chloride, saturated aqueous solution	+	Heptane	+	Oxygen	+
Cyclo hexane	-	Hexane	+	Ozone	+
Cyclo hexanol	O	Hydrochloric acid, 20%	+	Pentane	+
Cyclo hexanone	-	Hydrochloric acid, conc.	-	Perchloric acid, 10% in water	+
Dekaline	+	Hydrofluoric acid, 5%	+	Perchloric acid, concentrated	O
Diamyl phthalate	-	Hydrofluoric acid, conc.	-	Perchloro ethylene	-
Dibutyl phthalate (plasticizer)	-	Hydrofluorosilicic acid, 30%	+	Perhydrol, 30%	+
Diethylene glykol	+	Hydrogen peroxide, 30%	+	Petroleum	O
		Iodine	-		
		Isoamyl alcohol	O		
		Isopropyl alcohol	+		
		Lactic acid, 10% in water	+		

Makrolon®
Chemical resistance

Petroleum ether	O
Petroleum spirit	+
Phenol	-
Phenyl ethyl alcohol	-
Phosphor trichloride	-
Phosphoric acid, conc.	+
Phosphoric oxichloride	-
Potassium aluminum sulpate, saturated aqueous solution	+
Potassium bichromate, saturated aqueous solution	+
Potassium bromide, saturated aqueous solution	+
Potassium carbonate, saturated aqueous solution	+
Potassium chloride, saturated aqueous solution	+
Potassium cyanide	-
Potassium hydroxide	-
Potassium metabisulphide, 4% in water	+
Potassium nitrate, saturated aqueous solution	+
Potassium perchlorate, 10% in water	+
Potassium permanganate, 10% in water	+
Potassium persulphate, 10% in water	+
Potassium rhodanide, saturated aqueous solution	+
Potassium sulphate, saturated aqueous solution	+
Propane gas	+
Propargyl alcohol	+
Propionic acid, 20%	+
Propionic acid, conc.	-
Propyl alcohol	+
Pyridine	-
Resorcin oil solution, 1%	+
Carbon disulphide	-
Hydrogen sulphide	+
Soda	+
Sodium bicarbonate, saturated aqueous solution	+
Sodium bisulphate, saturated aqueous solution	+
Sodium bisulphide, saturated aqueous solution	+
Sodium carbonate, saturated aqueous solution	+
Sodium chlorate, saturated aqueous solution	+
Sodium chloride, saturated aqueous solution	+
Sodium hydroxide	-
Sodium hypochloride, 5% in water	+
Sodium sulphate, saturated aqueous solution	+
Sodium sulphide, saturated aqueous solution	O
Styrene	-
Sublimate, saturated aqueous solution	+
Sulphur	+
Sulphur dioxide	O
Sulphuric acid, 50%	+
Sulphuric acid, 70%	O
Sulphuric acid, conc.	-
Sulphurous acid, 10%	-
Sulphuryl chloride	-
Tartaric acid, 10%	+
Tetrachlorocarbon	-
Tetrachloroethane	-
Tetrahydrofurane	-
Tetraline	-
Thiophene	-
Toluene	-
Trichloro acetic acid, 10%	O
Trichloroethyl amine	-
Trichloroethyl phosphate (plasticizer)	O
Trichloroethylene	-
Tricresyl phosphate (plasticizer)	-
Urea, saturated aqueous solution	+
Water	+
Xylene	-
Zinc chloride, saturated aqueous solution	+
Zinc oxide	+
Zinc sulphate, saturated aqueous solution	+

2. Disinfectants

Baktol®, 5%	+
Carbolic acid	-
Chloroamine	+
DDT	-
Delegol ®, 5%	+
Dimamin T, 5%	O
Hydrogen peroxide	+
Iodine tincture	O
Lysoform, 2%	+
Maktol ®	+
Merfen ®, 2%	+
Oktozon ®, 1%	+

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Perhydrol	+
Resorcinol solutions, 1%	+
Sagrotan ®, 5%	O
Spirit, pure	+
Sublimate	+
TB-Lysoform	-
Trosilin G extra ®, 1,5%	+
Zephirol ®	O

3. Pharmaceutics, Cosmetics

Blood plasma	+
Delial-Sunmilk ®	+
Hydroplex	+
Iodine tincture	O
Klosterbalsam	+
Lanoline	+
Menthol, 90% in Alcohol	O
Nail polish	-
Nail polish remover	-
Odol-mouthwater ®	+
Periston blood substitute ®	+
Vaseline	+
Vick-Vaporub ®	+

4. Nutrition

All-spice	-
Apple juice	+
Beef sebum	+
Beer	+
Beets sirup	+
Brandy, 38%	+
Butter	+
Chocolate	+
Cinnamon	+
Clove	-
Cod-liver oil	+
Coffee	+
Common salt	+
Fish	+
Fruit juice	+
Fruit sirup (Raspberry)	+
Gherkins	+
Grape sugar	+
Grapefruit juice	+
Juniper berry	+
Lard	O
Linseed oil	+
Liquor	+
Maggi ®	+
Margarine	+
Meat	+
Milk	+
Mineral water	+
Mustard	+
Nutmeg	-
Onion	+
Orange juice	+
Paprika	+
Pepper	+
Rum	+
Salad oil	+
Sirup	+
Sugar solution, saturated aqueous solution	+
Tea	+
Tobacco	+
Tomato juice	+
Tomato puree	+
Vanilla	+
Vegetable juice	+
Vegetable oils	+
Vinegar	+
Vodka	+
Water	+
Wine	+
Worcester-Sauce	+

5. Wash and cleaning agents

Ajax ®	+
Bleaching agent	+
Calgonit ® dishwassing	-
Calgonit ® rinsing agent	+
Calgonit D ®, DM, DA, R	-
Calgonit S ®, 1%	+
Dor ®	+
Fewa ®	+
Green soap	+
Horolith M ®	+
Household soap	+
Impact ®, 0,2%	O
Into-Fensterklar ®	+
Natril ®	+
Omo ®	+
P3 Asepto ®	-
Pantex ®, 2%	+
Persil ®	O
Pril ®	+
Rapdosept ®	O
Rei ®	+
Riseptin ®	+
Sidolin ®	+
Siliconoil emulsion	+
Somat W ® 731	O
Suwa ®	+
Trosilin F ® extra, 2%	+

Makrolon®
Chemical resistance

Tuba ® carpet shampoo, conc..	O
WK 60 ® (Kron-Chemie)	+

6. Technical oils and fat

Aral BG ® 58	+
Baysilon ® Silicone oil	+
BP Energol EM 100 ®	+
BP Energol HL 100 ®	+
BP H LR 65 ®	+
Brake fluid (ATE)	-
Cable isolation oil IG 1402	+
Cable isolation oil KH 190	+
Calciumsoap fat	+
Camphor oil	-
Castor oil	+
Cod-liver oil	+
Contact oil 61	+
Diesel oil	O
Drilling oil	-
Esso Estic 42-45 ®	+
Fish oil	+
Fuel oil	O
Hydraulik oil Vac HLP 16	+
Jet engine fuel JP 4 (Kp 97-209°C)	O
Lubricant based on nafta	+
Lubricant based on paraffin	+
Lubricant R2 Darina ®	+
Mobil DTE Oil-Light ®	+
Mobil Special Oil 10 W 30 ®	+
Molikote ® -Paste	+
Molikote ® -Powder	+
Nato-Turbine oil 0-250	+
Paraffin oil	+
Polyran ® MM 25 (lubricant)	+
Rape oil	+
Sewing machine oil	+
Shell Spirax 90 EP ®	+
Shell Tellus 11-33 ®	O
Shell Tellus 33 ®	O
Silicone oil	+
Skydrol 500 A ®	-
Sodium soap fat	+
Tanning oil Brunofix ®	+
Texaco Regal Oil BRUO ®	+
Texaco Regal Oil CRUO ®	+
Thenocalor N	+
Turbo oil 29	+
Turpentine ersatz	+
Valvoline WA 4-7	O
Varnish	O
Whale fat	+

7. Adhesives and joining media

All-purpose glue	O
Cellux-sticking foils ®	+
Isolation tape	+
Perbunan C ®	+
Plaster	+
Plasticiserfree glazing kit	+
Putty	+
Terostat ®	+
Tesafilm ®	+
Tesamoll ®	+

8. Polish paste and anti-statics

Antistatik C, 5%	-
Antistatikum 58	O
Arquad 18 ®, 50%	O
Delu-Antistatiklösung ®	+
Persoftal ®, 2%	+
Perspex Polish 3 ®	+
Plexiklar ®	+
Polifac grinding paste ®	+
Statexan AN ®	+

9. Inks

Ballpoint paste Diplomat	O
Ballpoint paste Othello	O
Ballpoint paste V77 (Linz)	+
Geha stamping ink	+
Indian ink S	-
Indian ink T	+
Multi-Marker (Faber-Castell)	O
Pelikan Royal Blue 4001	+
Register-ink DIA type U rot	+
Visor-Pen 7 blau	+

10. Miscellaneous

Acid-containing combustion gasses	+
Basilit ® UAK, 20% in water (wood protection agent)	+
Battery acid	+
Blood	+
Castor oil	+
Cement	+
Cleaning gasoline	+
E 605 ®, 0,5% (pesticide)	+
E 605 ®, conc.	-
Final-photo developer (normal use concentration)	+
Freon ® TF (propellant)	+
Freon ® T-WD 602 (propellant)	+
Frigen ® 113, R113 (propellant)	+
Gasoline, normal	O
Gasoline, super	-
Green chrom oxide (polish	+

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paste)	
Isolation tape	+
Kaltron ® 113 MDR (propellant)	+
Kerosene (Flugbenzin)	-
Lightin gas	+
Marlon ®, 1% (moisturizing agent)	+
Metasystox ®, 0,5% (pesticide)	-
Natural rubber	+
Nekal BX ®, 2% (moisturizing agent)	+
Neutol ® photo developer (normal use concentration)	+
Oleic acid, conc.	+
Orthozid ® 50, 0,5% (pesticide)	+
Plaster	+
PLK 4 (wood protection agent)	+
Polishing wax	+
Polyamide	+
Polyethylene	+
Polymer plasticizer	O
Polyvinylchloride (plasticizer free)	+
Polyvinylchloride, (containing plasticizer)	O
Sea water	+
Shell IP 4 (fuel)	-
Soap suds	O
Starch	+
Sweat, acid (pH 4,7)	+
sweat, alkaline (pH 9,5)	O
Tanigan ® CLS, 30%	O
Tanigan ® CV	O
Tannic acid	-
Test fuel	-