

# Chemical resistance of luminaire components



## Introduction

Philips Lighting products are manufactured to function under normal environmental conditions without any problems during the technical lifetime of the product. Preventive maintenance should be carried out to keep the lighting installation in optimal condition. For lighting installations, maintenance is limited to lamp and starter replacement and luminaire cleaning. Without restriction, we can say that luminaires and lamps will function for extended periods without problems under environmental conditions in which people can live continuously without adverse health effects. Luminaire components will undeniably age during the lifetime, but this is no problem as long as mechanical and electrical safety is not influenced. Especially in industry, environmental conditions are not always optimal (extreme temperatures, pollution, severe vibrations), and this could have an adverse effect on the lifetime of lighting products. This brochure gives some examples and guidelines with respect to the chemical resistance of luminaires.

## Examples

Every luminaire/lamp combination is assembled using various components, made of basic materials. Commonly used materials for lamps are glass and metal, while occasionally lamp caps are made of plastic instead of metal. Metal and glass are well known for their good chemical resistance, although not all chemicals in all concentrations can be withstood. Luminaire housings generally consist of combinations of aluminium, painted galvanised sheet steel, glass, stainless steel and various kinds of plastics like polycarbonate, polymethylmethacrylate, polyvinylchloride and various kinds of styrenic polymers, polyester and polyurethane. The electrical wiring is made of copper encapsulated in a heat-resistant insulation plastic. Apart from these materials, small components may be made of galvanised steel, copper and rubbers. Each of these materials has its typical chemical resistance against its environment, which of course differs for the various sorts of materials.

A few examples illustrate the complex problem of chemical resistance.

In the near environment of a professional car wash installation, closed indoor luminaires are utilised. A car is cleaned by use of aggressive chemical detergents in combination with hot and cold water. After each wash the car is carefully washed down with clean water. However, detergent splashes that reach the closed luminaires are not washed off carefully with water, and within some weeks a layer of aggressive detergents is collected on the surface of the luminaire. An unexpectedly rapid chemical degradation of the plastic components of the luminaire will be the result. A second example is the presence of chemical vapours just under the ceiling. In factories, contaminated water vapour, cutting oil or mineral oil vapour often appears at ceiling level, influencing the lifetime of certain plastics negatively. In swimming pools, a high humidity in combination with chlorine vapours can lead to an unexpectedly rapid corrosion of painted galvanised sheet steel and even stainless steel.

Each of the applied materials assembled in a luminaire has a certain chemical resistance. Unfortunately, a product that can withstand all concentrations of chemicals does not exist. Even luminaires made of stainless steel and glass only are sensitive to certain chemicals. The combination of temperature, concentration in the environment and the chemical resistance of the materials determines whether a luminaire can successfully be used under specific environmental circumstances. Unfortunately, no unequivocal guidelines about when to use which luminaire type under specified circumstances can be given. For this reason, we should limit ourselves to the most common materials used in luminaires.

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## application information

### Chemical resistance of synthetic materials

The table below offers an indication of the chemical resistance of the main synthetic materials applied in luminaires. The indications in the table are valid at a temperature of 25°C. Where appropriate concentrations are mentioned, combination of chemical substances might cause more severe effects.

Household chemicals					
Chemical substance	Polystyrene (PS)	Polycarbonate (PC)	Polymethyl methacrylate (PMMA)	Synthetic rubber	Remarks
Acetone	-	-	-	+	
Ammonia 25%	+	- / x	+	+	Livestock stalls
Animal fats	+	+	+	-	Food industry
Bleach saturated	+	+	+	+	Dry cleaner
Chlorine water	+	+ / x	-	+ / o	Swimming pool
Citronella oil	-				
Detergents	+	o	+	+	b)
Dish washing	o	+ / -	+	+	
Diesel fuels	o	+	+	-	Petrol station
Gasoline	-	- / o	- / o	-	Petrol station
Glycerine	+	+ / o	+	+	
Hand lotion	-		+	-	
Household cleaners	+	+ / o	+		b)
Greases	+	+ / -	+	-	Garage
Inks	+	+	+		Printing industry
Insecticides	+ / o		+		
Lacquer thinner	-	-	-	-	Printing industry
Lemon juice	-	+	+		
Margarine	+	+	+		Food industry
Mayonnaise	+	+	+		Food industry
Milk	+	-	+	+	Dairy
Mineral oils	+	+	+	-	
Motor oils	+	+ / o	+	-	c)
Vegetable oils	o / -	+ / o	o	-	Food industry
Olive oils	+	+	+	o	Food industry
Paraffin oil	+	+	+		
Petrol normal	-	o	+	-	Petrol station
Petrol super	-	-	+	-	Petrol station
Pine oil	-	+	+	-	
Sea water	+	+	+	-	Ships
Shampoos		x	+		b)
Silicon oils (aliphatic)	+	+	+ / o	+	
Soap solutions		o	+	+	b)
Sodium chloride	+	+	+	+	
Soy bean oil	+	+	+	-	
Turpentine	-	-	-	-	Paint industry
Water	+	+	+	+	
Waxes	+	+	+		

a) depends on concentration  
 b) depends on composition  
 c) depends on type

+ resistant  
 o limited resistance  
 - not resistant  
 x can cause environmental stress cracking

Chemicals					
Chemical substance	Polystyrene (PS)	Polycarbonate (PC)	Polymethyl methacrylate (PMMA)	Synthetic rubber	Remarks
Acetic acid 25%	+	+	+ / o	+	a)
Ammonium salts	+	- / x	+	+	
Aqua regia	o	o	-	-	
Benzene	-	-	-	-	
Butane	o	+	+		
Butanol	+	+	-	+	
Carbon dioxide	+	+	+	+	
Carbon tetrachloride	-	- / x	-	-	
Chloroform	-	-	-	-	
Chromic acid 20%	+	+	+ / o	-	
Cyclohexane	o	+ / o	-	-	
Dibutyl phthlate	+	-	-	+	
Dichlorobenzene	-	-	-	-	
Ethyl acetate	-	-	-	+	
Ethyl alcohol 40%	o / x	+ / o	o	+	
Ethylene glycol	o / x	+	+	+	
Formaldehyde 30%	+	+	+	+	
Formic acid	+	+ / -	+ / o	+	
Freon	o	- / +		- / o	c)
Hydrochloride acid 10-	+	+	+	+	
Hydrogen peroxide <	+	+	+	+	
Isopropyl alcohol	+	+	o	+	
Kerosene	o / x	-	+	-	airfield
Lactic acid 10%	+	+	+	+	
Methyl alcohol	o / x	x	o	+	
Methylene chloride	-	-	-		
Methyl ethyl ketone	-	-	-	+	
Naphtha	-		+	-	
Nitric acid 20-30%	o	+ / o	+	+	
Ozone < 0.5 ppm	+	+	+	+	
Perchloroethylene	-	-	-	-	
Potassium hydroxide	+	-	+	+	
Propane	-	+	+	-	
PVC plasticized	x	x	-	+	
Saponified oil	o		+	-	
Soda saturated solution	+	+	+	+	
Sodium hydroxide	+	- / o	+	+	
Stearic acid	+	+	+	o	
Sulphuric acid 10%	+	+	+	o / -	
Toluene	-	-	-	-	
Transformer oil	+	+	+	-	
Trichloro-ethylene	-	-	-		
Xylene	-	-	-	-	

**Aluminium** used as housing for floodlights or as an optical element, will not be affected easily due to the presence of the aluminium oxide layer always present on an aluminium surface. Only concentrations of acids will affect the aluminium; this will not occur frequently.

**(Pre-)painted galvanised sheet steel** is on the long term sensitive for corrosion if applied in a continuously humid environment. For this reason the advise is to apply luminaires manufactured of synthetic materials in a humid environment. Apart from the sensitivity for corrosion, painted galvanised sheet steel can withstand many chemical products in the environment. The white paint will yellow slowly during the time. Unsafe situations or breakdown of the luminaire function due to chemicals affecting the painted galvanised sheet steel will seldom occur.

**Stainless steel** is applied for cover clips and suspension brackets of luminaires. The kind of steel applied by Philips Lighting does not corrode, except under severe aggressive corroding circumstances as appears at ceiling level of a chlorinated swimming pool. Only the very best, thus therefore very expensive kinds of stainless steel have a limited resistance against such extreme corrosive atmospheres.

Two clear transparent materials are available for the clear cover of a closed luminaire: **polycarbonate (PC)** and **polymethylmethacrylate (PMMA)**.

**Polycarbonate (PC)** is a thermoplastic material used for transparent covers of water protected luminaires. Main feature of PC is its impact resistance. For this reason PC is used in luminaires in industry and for outdoor residential area lighting. Unfortunately both standard PC and pre-yellowed PC discolours under the influence of time and ultra-violet radiation. PC cannot withstand all solvents. Unless washed off immediately with water, the material will not be affected seriously by acids and bases.

**Polymethylmethacrylate (PMMA)** is a very transparent thermoplastic material which does not age neither yellows. Its scratch resistance is acceptable, however, the impact resistance is poor compared with polycarbonate. PMMA is not resistant against all solvents, it can withstand low concentrations of acids and bases better than polycarbonate. PMMA can be cleaned with most household detergents in the appropriate concentrations. On basis of its impact resistance, PC is preferred over polymethylmethacrylate (PMMA), however, on basis of the chemical resistance, PMMA performs better than PC.

**Polyester** Glass fibre re-inforced polyester is generally used for synthetic housings of luminaires. The material, which can be coloured easily, combines a high mechanical strength with a good chemical resistance. However, high concentrations of acids and bases will damage polyester. Polyurethane is used as seal between cover and housing in closed luminaires to secure the dust and water tightness. The material has a poor chemical resistance against acids and bases, polyurethane can withstand oil and solvents.

**Synthetic rubber** is applied as gasket via which the cable enters a closed luminaire. The material has a good chemical resistance; however, oil products will damage the rubber.

All mentioned materials can withstand standard household detergents if applied according the instructions of the detergent supplier. Abrasive detergents will influence the surface of the luminaire negatively.

### Conclusion

All materials used in a luminaire will age during their life time. Disappointing results can be omitted by realising that especially synthetic materials cannot withstand all chemicals. Especially solvents and concentrated acids and bases can damage the synthetic materials. Philips Lighting selects the best available components for their products. Selection criteria are performance of the materials and environmental aspects related to manufacturing and disposal. Electrical and mechanical safety is guaranteed for all Philips Lighting products if used under normal environmental circumstances. Under extreme environmental conditions, the ambient temperature in combination with chemicals should be taken into consideration selecting the appropriate product from the catalogue.

