**NEDRON POLYMERS**

***Partners in Progressive Plastics***

## ABS, Acrylonitrile-Butadiene-Styrene

**ABS** is a "polymerised alloy" of the tree materials acrylonitrile, butadiene and styrene. The material is located under the group styrene plastic. Styrene plastics are in volume one of the most used plastics.

### Properties

The mechanical properties for **ABS** are good for impact resistance even in low temperatures. The material is stiff, and the properties are kept over a wide temperature range. The hardness and stiffness for **ABS** is lower than for PS and PVC.

### Weather and chemical resistance

The weather resistance for ABS is restricted, but can be drastically improved by additives as black pigments.

The chemical resistance for **ABS** is relatively good and it is not affected by water, non organic salts, acids and basic. The material will dissolve in aldehyde, ketone, ester and some chlorinated hydrocarbons.

### Processing

**ABS** can be processed by standard mechanical tools as used for machining of metals and wood. The cutting speed need to be high and the cutting tools has to be sharp. Cooling is recommended to avoid melting of the material.

If the surface finish is of importance for the product, the **ABS** can be treated with varnish, chromium plated or doubled by a layer of acrylic or polyester.

**ABS** can be glued to it self by use of a glue containing dissolvent. Polyurethane based or epoxy based glue can be used for gluing to other materials.

### Generally

By the introduction of additives the properties and the look of the material may change.

### Application

**ABS** is used for auto body parts, suitcases, toys etc. Extruded profiles, tubes and bolts can be made from **ABS** when the requirements are high impact resistance and a nice surface.

## PA, Polyamide

**PA** is made from a diamine and a dicarbolic acid. There are many variants of **PA** with different physical and chemical properties where **PA 6** and **PA 66** are the most common used.

### Properties

**Polyamide** is recognized for good abrasion resistance, low friction coefficient, good resistance to heat and good impact resistance. In dry conditions **PA** is a good electrical insulator.

**Polyamide** is hygroscopic. The material do absorb water. This absorption will change some of the materials properties as insulation, tensile strength and stiffness. The impact resistance is increased by a higher content of water.

The **polyamide** has a white or slightly yellow colour.

**Weather and chemical resistance**
The chemical properties of polyamide are good. It is resistant to most oils and grease. The resistance to the most commonly used solvents are also good. The resistance to acid and basic is limited. Common detergents based on basics is normally not a problem.

**Processing**
**Polyamide** can be drilled, machined in a lathe, milled and sawed. Tools for machining of soft materials can normally be used. In general the tools and edges need to be sharp. Cooling of the process will give a better result.

**Polyamide** can be glued to itself by use of a glue containing dissolvent. A two component epoxy glue can be used for gluing to non organic materials. The surfaces will need degreasing and grinding before gluing.

**Polyamide** can with a good result be hot welded or friction welded.

**Generally**
By the introduction of additives the properties and the look of the material may change.

Compared to the other thermoplastics **PA** is a relatively expensive material.

**Applications**

**PA** is used by the industry for tubes bolts, toothed wheels, joints etc where the need for high abrasion resistance and good mechanical properties are of importance. Further it can be mentioned that the well known nylon stockings/panties are made from **PA**.

## PC, Polycarbonate

There are different types of **polycarbonate** where the most common are made from phosgene and biphenol A

**Properties**
**PC** is a transparent material with a high impact resistance, high stiffness, good dimension stability and good electrical properties. The properties remains over a wide temperature range. Break from fatigue can occur when exposed to dynamic load with a high frequency. A high temperature combined with a high humidity can make the material more brittle. **PC** can become more yellow when exposed to sunlight. The effect can be additives containing UV stabilisers. If ignited, the material is self-extinguishing.

**Weather and chemical resistance**
**PC** has a relatively good chemical resistance. It is resistance to water deluted mineral and organic acids, oxidants, neutral and acid solutions, aliphatic carbon hydrogen, fat, oils and alcohol (except methanol). It is not resistant to alkalis, ammonium, amines. **PC** will dissolve exposed to methylene chloride, ethylene chloride, tetra chlorine ethane, chloroform and pyridine. **PC** does swell in contact with acetone and benzene.

**Processing**
**PC** can be machined by standard cutting tools preferable tools design for processing of metal and three. The cutting speed must be high and the tools will need to be sharp. Cooling is recommended to avoid melting of the material.

Gluing of **polycarbonate** to it self is done by the use of solvents. Polyurethane or epoxy glue can be used for gluing to other plastic materials. Two component epoxy is recommended for gluing to metals. The surfaces must be thoroughly degreased.

Friction or ultrasound welding methods can be used for welding of **polycarbonate**. For hot welding a temperature of approx. 400°C.

**PC** can be varnished metalled or applied printing. The selection of varnish and glue should be done carefully as components can be applied that will damage the material.

**Generally**
The performance as well as the appearance of **PC** can be altered by the use of additives and / or by blending with other thermoplastic materials. **PC** is a relative expensive material.

**Applications**

**Polycarbonate** is a natural choice in manufacturing of electrical components due to the good electrical properties and the self-extinguishing effect. PC is commonly used for shielding of work places and machines, sight glass, tubes etc. due to its transparency and high impact resistance.

## PE, Polyethylene

PE is made from polymerised ethylene. The PE material is divided in two groups. One is produced under extremely high pressure and the other under moderate pressure. They are known as LD-polyethylene (low density, PELD) and HD-polyethylene (high density, PEHD). PE is one of the most commonly used thermoplastic material do to the good properties combined with a low price.

**Properties**
PE has a general low density (0,91-0,96 g/cm^3), it is crystalline and has a good impact resistance even in low temperatures below freezing. PEHD is a stiffer and harder material. PE (specially PEHD) has a low friction coefficient and abrasion resistance. The colour is white/colourless.

The electrical properties for PE are very good.

**Resistance to weather and chemicals**
PE will get brittle and crack after some time exposed to sunlight. To partly overcome this effect UV stabilising additives can be added.

PE has very good chemical resistant properties. It can withstand most chemicals with the exception of strong oxidant acids and some organic solvents. PE do not absorb water. One should be aware of that the chemical properties for PE will alter some when exposed to high temperatures.

**Processing**
PC can be machined by standard cutting tools preferable tools design for processing of metal and three. Normally there is no need for cooling when machining.

Gluing of PE is very difficult and will require extensive pre-treatment. The material is well suited for joining by most welding methods.

**Generally**
By the introduction of additives the properties and the look of the material may change.

Compared to other thermoplastics PE is a relatively inexpensive material.

**Applications**
PE is a non hygroscopic material very much used for water tanks, tubes, fittings, foil and plastic bags. The good electrical properties makes it very much used by the electro industry for insulation material etc.

## PMMA, Polymethylmethacrylate

**PMMA** is a amorphous thermoplastic that can be delivered clear as glass. The material is more known as "Plexiglass". PMMA is a thermoplastic polymer made by polymerisation of the methacrylate acids methyl residuals.

**Properties**
**PMMA** is a hard and stiff material with a very good weather resistance. The material is clear as glass, but is also well suited for dying. It has good tensile and flexural strength. The impact resistance is 10 times higher than glass. **PPMA** has the highest surface hardness of all common thermoplastics. The scratch resistance can compare to the metals aluminium and brass.

The electrical properties are very good.

**Resistance to weather and chemicals**
**PMMA** is resistant to water, basics, inorganic salts diluted in water, most diluted acids. It is not resistant to strong acids, basics and polar solvents.

**Processing**
**PMMA** can be machined by standard cutting tools preferable tools design for processing of metal and three. The cutting speed has to be high, and a good cooling is recommended. A low cutting force is of importance to avoid cracking of the material.

**PMMA** can be hot welded by using a PVC or PMMA thread. Recommended temperatures are 220-260°C for PVC and 200-220°C for PMMA. The material can also be contact welded at 190-220 °C or ultrasonic welded.

Gluing of **PMMA** can be done by use of a glue containing solvent, or by use of a two component glue of the brand Araldit or similar. The material has to be thoroughly de-greased by methylene chloride or chloroform. The gluing process requires a high degree of skill as stress corrosion in the material can easily occur. Often the PMMA parts will need heat treatment to eliminate the stress.

**Generally**
By the introduction of additives the properties and the look of the material may change.

**Applications**

The "glass looks" and the water resistant property of **PMMA** makes it commonly used for decoration articles, transparent tubes, signs, windows, level glass etc.

## PP, Polypropylene

**PP** is made from PE is made from polymerised propylene. PP is normally delivered with an isotactic configuration that gives a material of high crystallinity (70-80 %).

**Properties**
**PP** is one of the lightest thermoplastics on the marked. It has a high stiffness, good strength even in relatively high temperatures, abrasion resistant, good elastic properties and a hard glossy surface. In low temperatures PP gets brittle (< 0°C). The electrical properties are very good. The PP material has a white/colourless colour.

**Resistance to weather and chemicals**
The chemical properties are good. PP is resistant to inorganic chemicals and water. It is resistant to most strong mineral acids and basics. PP is not resistant to nitrous gasses, halogens and strong oxidising acids. The chemical properties will alter in high temperatures.

**PP** will degrade exposed to direct sunlight. Adding additives as UV stabiliser or carbon black can compensate for this effect.

**Processing**
PP can be machined by standard cutting tools preferable tools design for processing of metal and three. Normally cooling is not required for the machining process.

Gluing of **PP** is difficult and do require an extensive pre-treatment. The material is well suited for the most welding methods.

**Generally**
By the introduction of additives the properties and the look of the material may change.

**PP** is among the most inexpensive thermoplastic on the marked.

**Applications**

**PP** are used for tubes, fittings, packing material, auto parts etc. The material is often used for hinges as it can be flexed millions of times before breaking.

## PS, Polystyrene

**Polystyrene** belongs to the group styrene plastics. Polystyrene is made from monomer styrene.

**Properties**
**PS** is an amorphous thermoplastic that can be obtained clear or dyed. The material is hard and brittle. It has good mechanical properties, but is not resistant to weather exposure (the resistant to weather can be improved by introducing additives).

**PS** has a limited use in the electrical industry due to the weak heat resistance and the tendency to take electrostatic charge.

**Resistance to weather and chemicals**
**PS** is resistant to water, diluted acids and basics. It is non resistant to oxidising acids, aliphatic and aromatic hydrocarbons, esters, ethers and ketones.

**Processing**
**PS** can be machined by standard cutting tools preferable tools design for processing of metal and three. The cutting tools has to be sharp and the cutting speed has to be high as the **PS** is brittle. Cooling when machining is recommended.

**PS** can be glued to itself by the use of a solvent like acetone, toluene, methylene chloride etc. Gluing to other materials can be achieved by use of glues based on acrylics, epoxy or polyurethane.

**PS** can be welded by ultrasonic or hot weld.

**Generally**
The performance as well as the appearance of PS can be altered by the use of additives and / or by blending with other thermoplastic materials.

**Applications**

**PS** is commonly used for disposable articles, signs, cabinets, machine parts and picture frames etc.

## TPU, Thermoplastic Polyurethane, Elastomer

TPU is a urethane based TPE (thermoplastic elastomer). It is made of long chained molecules of diols and diisocyanates.

**Properties**
**TPU** has a very good abbrasion resistance. It is a tough material with a good elasticity over a wide temperature range. TPU is filling the gap between rubber material and the more traditional thermoplastics.

The electrical conductance is very low. TPU is a hygroscopic material, and the conductance is dependent on the content of moisture.

**Resistance to weather and chemicals**
TPU is resistant to oil, fat, gasoline, and ozone. It is not resistant to hot water, steam, strong acids and basics. Polyether based TPU is resistant to microbes.

**Processing**
Mechanical machining of TPU is dependent of the hardness of the material. The possibilities of mechanical processing like grinding, cutting and punching of TPU is restricted as it is a viscous and elastic material.

**TPU** is easy to glue and many types of glue can be used. It is important to thoroughly clean the surfaces before gluing.

**Generally**
**TPU** is available in a variety of qualities. Additives can be addded to improve or change the properties of the material as UV stabilising pigmenting, reducing the surface friction etc.

**Applications**

**TPU** are used for hoses, tubes, sleeves, cushions, coating, insulators, apron rollers etc.

# PVC, Polyvinylchloride

**PVC** is one of the oldest and most commonly used thermoplastic material. The material is a colourless polymer of vinyl chloride. By use of additives the PVC can have numerous properties and alter the characteristics completely. As an example PVC products can be made soft and flexible as well as stiff and brittle.

## Properties

We distinguish between two main groups of PVC, hard and soft.

Hard **PVC** has a high mechanical strength and stiffness with a good resistance to chemicals and weather. PVC can be mixed with stabilisers and lubricants and made into products with a high degree of transparency and/or softness. Hard PVC is from start a brittle material that can be made extremely impact resistant by the introduction of additives.

The properties of the soft **PVC** can not be generalised as they are dependant of the type and content of softener. Soft **PVC** can be tailor made for many applications by adding the feasible additives. Soft **PVC** can be delivered as transparent or dyed.

Normally **PVC** has a softening point of approx. 80°C as can limit the applications. There is also qualities with a softening point of more than 100°C.

The electrical properties for **PVC** are good.

## Resistance to weather and chemicals

**PVC** is resistant to commonly used chemicals with the exception of specific organic connections as ketone (ie acetone), chlorinated and aromatic hydrocarbons and low molecular esters. PVC is not affected by fungus and bacteria.

## Processing

**PVC** can easily be machined by standard cutting tools preferable tools design for processing of metal and three. It should be noted that hard PVC can be brittle and hence will require sharp tools and high speed. Cooling should be considered.

**PVC** can be welded by most known methods and is easily glued.

## Generally

**PVC** can be added a great range of additives that can alter the materials properties entirely. Additives can be stabilisers lubricants, softeners, pigments, fillers, froathing agent, anti static agents etc.

## Applications

**PVC** has a great range of applications. Within extruded products are rubbing strakes, electrical insulation, profiles for construction work, hoses, tubes, plates, gutters, toys etc. Other commercial products are packing material, electrical articles, foils, bottles, buoys etc.

# PVDF, Polyvinylidenfluoride

**PVDF** belongs to the group fluoride plastics. The material is crystalline and has a high molecular weight.

**Properties**
**PVDF** is a stiff material with high tensile strength, high impact resistance and good abrasion resistance. The material is resistant to weather. The mechanical properties are kept over a great temperature range.

**Resistance to weather and temperatures**
The chemical and electrical properties for PVDF are remarkably good. The material is resistant to most chemicals with the exception of some strong basic amines and strong polar solvents. The chemical properties will to some degree alter when exposed to high temperatures.

**Processing**
**PVDF** can easily be machined by standard cutting tools preferable tools design for processing of metal and three. Cooling should be considered to avoid melting of the material, The tools will need to be sharp.

**PVDF** is non-glueable, but can easily be hot welded at welding temperatures 175-180°C.

**Generally**
By the introduction of additives the properties and the look of the material may change.

**Application**
**PVDF** has very good mechanical properties. The additional good chemical properties and the high temperature tolerance makes it fit for a wide range of industrial products as tubes, fittings, sliding surface, guides, machine parts, containers etc.

**FEEDBACK & COMMENTS**

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