Materials: plastics

Introduction

At the end of the nineteenth century, the word "plastic," which had only been used to refer to non-elastic materials, began to be used for organic and synthetic material which could be deformed by heat or pressure to shape it. Nowadays plastic is one of the most-used modern materials.

These materials are called polymers. They are made of macromolecules, composed basically of carbon, oxygen, hydrogen, nitrogen, and sulfur.

Macromolecules are groups of molecules of the same family.

Atoms join together forming **molecules** of many different types. In the right circumstances, some molecules group together to form large chains. These chains are called **polymers**, and **monomers** are its constituent blocks.

Obtaining plastics

Introduction

The preparation and manufacture of plastics goes through the following stages:

1. **Sourcing of raw materials**
   They may be of mineral, plant, or animal origin.
2. **Synthesis of monomers**
   Sometimes monomers are obtained directly from nature, but usually they require a chemical process to extract them from raw materials.
3. **Synthesis of the basic polymer**
   Raw materials undergo several chemical processes, among which is polymerization.
4. **Incorporation of additives**
   Specific substances are added to the polymers for them to have certain properties.
5. **Shaping and finishing**
   The product resulting from the previous stages is worked to give it the final shape.

Sourcing of raw materials

Raw materials can be of mineral, plant, or animal origin. They are extracted directly from nature and some require chemical modification to obtain plastic properties. The following are some important examples:

- **Plant origin**
  Latex is a liquid which is obtained from certain tropical trees. Rubbers and gums are made with this.
  Cotton and wood **cellulose** are used to make celluloid, rayon, and cellophane.
  Some **oils** from oily seeds are used to make varnishes.
- **Animal origin**
  Casein is a protein found in milk which is used to make galalith and lanital.
  The **resin secretion from the lac bug** is used to make shellac.
- **Mineral origin**
  Petroleum, coal, and other **fossil fuels** are the origin of a long industrial process. The basic substances (monomers) are extracted from them to manufacture most plastics.

Synthesis of monomers

This stage is especially important in plastics derived from petroleum and other fossil fuels.
It consists of extracting the monomers from the raw material through chemical reactions. These monomers will be used to make plastic substances.
The whole process is carried out in petrochemical industries, which are pillars of our society, as their products do not only include the monomers we are learning about, but also gasoline, diesel, kerosene, etc.
Some examples of semi-processed products from the petrochemical industry, important in the production of plastics, are **ethylene** and **propylene**.

Synthesis of basic polymers

Basically, plastics are prepared by mixing components in specific quantities, according to the type of plastic we wish to obtain.
The components, when they are mixed together, are subjected to chemical processes like polymerization, polycondensation, polyaddition, etc. This modifies their properties, making new materials in the shape of grains, resins, flakes, powders, pastes, liquids, etc.

Additives

These are chemical products which are added in the precise proportions to give the polymer properties like thermal and electrical conductivity, resistance to fire, rigidity, flexibility, etc.

Dyes or pigments
Give it color.

- **Plasticizers**
  Improve the plasticity and intensify the shine on the surface.
- **Antistatic agents**
  Reduce the static electric charge so that dust and dirt do not stick.
- **Fireproof or fire-retardant agents**
  Delay the formation of flames.
- **UV stabilizers**
  Protect it from UV radiations and atmospheric phenomena. Also prevent decomposition.
- **Fillers, reinforcements, and lubricants**
  Improve the mechanical properties and facilitate the manufacturing process.
- **Mold release agents**
  Make the piece come out of the mold easily.
- **Antioxidants**
  Prevent reactions with oxygen.

Shaping and finishing

In this stage the plastic is manipulated to make products. Different methods are used, depending on the type of plastic, its components, and the shape that the products should have.

- **Thermocompression**

This method is used to make thermosetting plastic products.
The plastic passes through a chute into a hot mold. The hot plastic is compressed by a press which shapes it. When the plastic cools and hardens, the mold is opened and the piece is removed.

- **Extrusion molding**

This method is used to make pipes, bars, and laminated profiles.
The plastic passes through a chute into a heat pipe. In the pipe there is a worm screw which makes the plastic move forward. The melted plastic is pushed through an opening which shapes it. It then goes on to a cooling chamber, and once it is cool and hardened, it is cut to measure.

- **Blow molding**

This method is used to make containers for liquids.
The plastic is preformed with another method. Then it is put in a mold, which closes and fills with pressurized air, making the plastic stick to the walls of the mold. When the plastic has cooled and hardened, the mold is opened and the piece is removed.

- **Injection molding**

This method is used to make objects with complex shapes, parts for vehicles, casings for appliances, buckets, bowls, and pans.
The plastic passes through a chute into a heat pipe. The plastic is melted and injected into a mold. When the plastic has cooled and hardened, the mold is opened and the piece is removed.

- **Foam molding**

This method is used to make packaging, thermal and acoustic insulation, mattresses, pillows, and sponges.
The plastic used contains foaming agents. It passes through a mold and is heated to a temperature which makes it form a solid, spongy mass and expands to fill the complete volume of the mold.

- **Vacuum forming**

This method is used to make glasses, packaging, and boxes.
A plastic sheet is placed on an open mold with channels through which air flows. It is heated until the sheet softens and a vacuum is formed between the sheet and the mold. Thus, the sheet is compressed against the mold and takes shape.

- **Calandering**

This method is used to make plastic tablecloths, plastic wrap, and plastic sheets.
The plastic passes between hot rollers which press it. Different thicknesses can be achieved this way.

Commercial shapes

For commercial use, plastics are presented in bars, laminated profiles, slabs, rolls, sheets, etc.
We can also find other objects that are made from plastic, like bottles, cups, plates, flatware, furniture, etc.

Properties of plastics

Physical properties

- **Electrical conductivity**

Electrical conductivity is a material's ability to let current flow through it. The higher the electrical conductivity of a material, the more easily charges travel through it.

Plastics have a very low electrical conductivity, which is why they are used to cover electrical cables, and for switches, lamp holders, electrical cable pipes, etc.

The researchers A. Heeger, A. McDiarmid, and H. Shirakawa won the Nobel prize in the year 2000 for the development of polymers that, with certain modifications, can conduct electricity. This discovery made the development of new technological devices possible.

- **Thermal conductivity**

Thermal conductivity is a material's ability to let heat pass through it.

The higher the thermal conductivity of a material, the more easily heat passes through it. Plastics have a very low thermal conductivity, which is why they are used as heat insulation.

- **Density**

Density is the amount of material mass per unit of volume.

In general, the density of plastics is low. This means the objects manufactured are lighter than if other materials were used.

- **Expansion**

Expansion is the relative variation in the dimensions of a material due to a change in temperature. Plastics have a high coefficient of expansion. However, reinforced plastics have a lower coefficient of expansion.

- **Melting point**

The **melting point** is the temperature at which a material goes from a solid state to a liquid state.

The melting point for plastics is not usually above 200 °C, which is extremely important for the manufacturing of pieces and their subsequent applications.

- **Fusibility**

Fusibility is a property of materials that refers to the amount of heat required to melt them. In order to increase the temperature of a unit of mass of a material by one kelvin (degrees centigrade), a certain amount of heat is needed, which is different for each material. This amount is called the **specific heat capacity**.

Fusibility has to do with both the melting point and the specific heat capacity, as well as with other properties.

Mechanical properties

Types of stress

When forces of any kind act upon an object, we say that the object undergoes **stress**.

The reaction of a piece of a certain material subjected to stress depends on many factors: the intensity of the stress, the size of the piece, the material it is made of, and also the type of stress.

The following are the main types of stress:

• **Traction**

Traction is the stress a material is subjected to by two opposing forces that pull on it.

A stress of this type always increases the length of a piece in the direction of the forces, and if it strong enough, it reduces its cross section and will finally break it.

• **Compression**

Compression is the stress a material is subjected to by two opposing forces that push on it.

A stress of this type always reduces the length of the piece in the direction of the forces, and if it is strong enough, increases its cross section and will finally break it.

- **Bending**

Bending is the stress a material is subjected to by forces that try to bend it.

A stress of this type always makes the piece curve, and if it is strong enough, will finally break it.

- **Shearing**

Shearing is the stress a material is subjected to by two opposing forces acting on different points that are very close to each other, and try to cut the piece.

A stress of this type always produces deformations in the piece, and if it is strong enough, will finally break it.

- **Torsion**

Torsion is the stress a material is subjected to by two forces which try to twist it around an axis.

A stress of this type always produces deformations in the piece, and if it is strong enough, will finally break it.

Response to stress

Each material responds in a particular way to different types of stress, depending on their intensity.

Despite these differences, some general conclusions can be drawn. As the intensity of the stress increases, materials first display their **elastic properties**, then their **plastic properties**, and finally their **resistance properties.**

- **Elasticity**

Elasticity is the ability of a material to deform when it undergoes stress and then to return to its original shape when the stress is removed.

A material behaves elastically when it undergoes low-intensity stress to a certain limit, called the **yield point**, which is different for each material. If this is limit is exceeded, the deformation becomes permanent and the material could break.

- **Plasticity**

Plasticity is the ability of a material to remain deformed by a stress when the stress is removed.
A material behaves plastically when it undergoes stress of an intensity that is higher than its yield point for the specific type of stress.
It is a very important property of plastics, especially at temperatures higher than room temperature. This is why it is so easy to give them such complex shapes.
A material displays its plastic properties more clearly according to the type of stress it undergoes:

- **Malleability**

Malleability is the ability of a material to be permanently deformed under the stress of compression.
Malleable materials are used to produce slabs and sheets.

- **Ductility**

Ductility is the ability of a material to be permanently deformed under the stress of traction. Ductile materials are used to produce bars and wires.

- **Resistance**

Resistance is the ability of a material to undergo stress without breaking.
No matter what type of material and the type of stress applied, all materials will eventually break. In regards to resistance, the only thing that matters is the intensity of the stress applied.
Materials that bear high-intensity stress without breaking are very resistant and materials that break under low-intensity stress are not very resistant.
Plastics are not resistant at all.

Other mechanical properties

- **Hardness**

Hardness is the ability of a material to resist being scratched or punctured.
Plastic have a wide range of hardness.

- **Toughness**

Toughness is the ability of a material to resist breaking when it is hit.
In general, the response of a material to sudden stress is different than when the stress is applied gradually. Therefore, this response is defined by properties other than elasticity, plasticity, and resistance. One of these other properties is **toughness**.
When a material is not very tough, meaning it breaks easily when hit, we say it is **fragile**.

- **Fatigue**

Fatigue is the property of a material to lose resistance to breaking when subjected to repeated stress.
Neither do materials behave the same way when stress is applied repeatedly. In general, more intense stress is needed to break a piece when applied once than when applied repeatedly.

- **Creep**

Creep is the slow deformation of a material from its own weight or very small loads.

- **Machinability**

This varies a lot, as it not only depends on physical properties and on certain mechanical properties, but also on other more practical issues.

- **Weldability**

Weldability is the ability of a material to join solidly with another piece when heated, and if needed, with other additional materials.
To weld plastic, we can use the plastic itself, or thermofusible silicone, etc.

Chemical properties

Chemical properties are the behavior of a material when it comes in contact with other substances.

- **Permeability**

Permeability is the ability of a material to let water or other fluids pass through them.
Normally, plastics are impermeable.

- **Solubility**

Solubility is the ability of a material to mix homogeneously with another substance, acting as a solvent. Normally, plastics are not soluble, although there are some that dissolve in water or organic liquids.

- **Combustibility**

Combustibility is the ability of a material to burn. Plastics burn easily, but this is very polluting.

Biological properties

Biological properties are the effects that a material has on living organisms and the environment.

- **Recyclability**

Recyclability refers to our ability to transform a used product into another product with a new useful life.
In general, the new product is not of the same type as the previous one.
It is important to emphasize that the recyclability of a material depends basically on our technical capacities. Many materials that could not be recycled in the past, now can.
•

- **Toxicity**

Toxicity is the ability of a material to produce negative effects on living organisms.
The greatest risk of plastics is when they come in contact with food and drink, especially when heated in plastic packaging. Some plastics used for toys, glues, and paints can also be toxic.

- **Biodegradability**

Biodegradability is the ability of a material to decompose as a consequence of interactions with the environment.
In general, the period of decomposition of plastics is very long. As a result, along with society's massive use of them, storage of plastic waste has become a serious problem.
This is why it is so important to recycle plastics. Also, many plastics have compounds added to accelerate their decomposition.

Classification of plastics

Thermosetting

Thermosetting plastics do not soften or deform easily due to heat. They can only be shaped when they are manufactured. That is why thermocompression is the most commonly-used method with them.

Phenolic resins (PF)
• **Characteristics**
They are hard, insoluble, resistant to temperatures of up to 170 °C, and inelastic.
• **Uses**
Electrical accessories, buttons, switches, handles, and kitchen utensil handles.

Ureic resins (UF)
• **Characteristics**
They can be dyed. They are elastic and impermeable to liquids.
• **Uses**
Coatings for household furniture, pressed pieces for electrical accessories, handles, door and drawer knobs, bottle caps, plates, cups, and pans.

Melamine resins (MF)
• **Characteristics**
They can be dyed. They are impermeable to liquids and elastic.
• **Uses**
Coatings for household furniture.
Polyester resins (UP)
• **Characteristics**
Mixed with a catalyst, they solidify and harden. They are colorless, but can be dyed, impermeable, and good electrical and thermal insulators.

• **Uses**

Manufacture of paints and putties. Mixed with fiberglass, they are used in tanks, bodywork of vehicles, carriages, boats, corrugated casings and roofs.

Epoxy resins (EP)

• **Characteristics**

Mixed with a catalyst, they solidify and harden. They are good electrical insulators, resistant to humidity and high temperatures.

• **Uses**

Adhesives, paints, varnishes, coatings for word, plastics, and electrical and electronic systems.

Thermoplastics

Thermoplastics soften and deform with an increase in temperature and then harden again when the temperature decreases. They can be heated and shaped as many times as needed.

Polyethylene terephthalate (PET)

• **Characteristics**

It can be dyed easily. It is transparent, tough, resistant to mechanical stress and oils, acids, solvents, and ultraviolet radiation.

• **Uses**

Packaging for carbonated beverages, oils, water, preserves, cosmetics, chemical products, pharmaceutical products, bags, and trays.

Objects made of polyethylene terephthalate are marked with the symbol 

.

Polycarbonate (PC)

• **Characteristics**

It can be dyed easily. It is transparent, shiny, resistant to mechanical stress, and shatterproof.

• **Uses**

Lenses for cameras, videos, microscopes, airplane windows, helmet visors, household appliances, and mirrors for vehicles.

Objects made of polycarbonate do not have a specific symbol and they are marked with 

.

Polyvinyl chloride (PVC)

• **Characteristics**

It is white or transparent, resistant to mechanical stress, and hard while at the same time easy to mold and cut.

• **Uses**

Profiles for windows, doors, tanks, pipes, waterproof clothing, hoses, toys, office material, cable insulation covering.

Objects made of polyvinyl chloride are marked with the symbol 

.

Polypropylene (PP)

• **Characteristics**

It is cheap, light, tough, and resistant to heat and chemical products.

• **Uses**

Suitcases, small household appliances, artificial grass, toilet seats, toys, food packaging and bags, disposable flatware, fenders, tabletops, pillars, and doors.

Objects made of polypropylene are marked with the symbol 

.

Polyethylene (PE)

• **Characteristics**

It is white or transparent and can be dyed easily.

• **Uses**

Toys, pipes, tanks, trash cans, containers for liquids, bags, greenhouses, sleeping bags, and covering for electric cables.

Objects made of polyethylene are marked with two different symbols, depending on if they are high-density (

) or low-intensity (

).

Methacrylate or Polymethyl methacrylate (PMMA)

• **Characteristics**

It is transparent, dyed easily, and maintains its color over time. It is light and easy to mold, work, and scratch.

• **Uses**

Bathroom accessories, protective goggles, and windows and mirrors for boats, airplanes, and cars.

Objects made of methacrylate do not have a specific symbol and they are marked with 

.

Polystyrene (PS)

• **Characteristics**

It is fragile and resistant to atmospheric agents.

• **Uses**

Automobile interiors, cups, packages, film wrap, cassettes, video tape, packaging.

Objects made of polystyrene are marked with the symbol 

.

Polyamide (PA)

• **Characteristics**

It is tough and resistant to mechanical stress and chemical agents.

• **Uses**

Fabrics, household utensils, bearings, gears, screws, household appliance parts, and electrical connectors.

Objects made of polyamide do not have a specific symbol and are marked with 

.

Teflon or Polytetrafluoroethylene (PTFE)

• **Characteristics**

It is fireproof, nonstick, and resistant to chemical products and high temperatures.

• **Uses**

Nonstick coatings, joints, and insulation for high-temperature cables.

Acrylonitrile butadiene styrene (ABS)

• **Characteristics**

It is impermeable and resistant.

• **Uses**

Toys and casings for computers and television sets.

Objects made of ABS do not have a specific symbol and are marked with 

.

Elastomers

Elastomers are very elastic.

Rubber (CA)

• **Characteristics**

It is impermeable and a good electrical and acoustic insulator. It is also resistant to mechanical stress, diluted acids, and detergents.

• **Uses**

Natural rubber products.

Polychloroprene (PCP)

• **Characteristics**

It is impermeable and a good electrical and acoustic insulator. It is also resistant to mechanical stress, solvents, acids, detergents, and atmospheric agents.

• **Uses**

Insulated wetsuits, joints, straps, cables, pipes, sleeping bags, boots, protective clothing, and gloves.

Silicone (SI)

• **Characteristics**

It is impermeable and resistant to atmospheric agents, greases, oils, acids, and detergents. It is also a good thermal insulator.

• **Uses**

Flexible molds, medical equipment, adhesives, and waterproofing agents.

Polyurethane

• **Characteristics**

It is resistant to chemical agents and wear and tear. It is also a good electrical, thermal, and acoustic insulator.

• **Uses**

Mattresses, foam rubber, adhesives, and paints.

Synthetic rubber

• **Characteristics**

It is resistant to organic liquids, oils, petroleum, petroleum derivatives, and atmospheric agents. It is impermeable and a good electrical and acoustic insulator.

• **Uses**

Tires, solid wheels, hoses, and transmission belts.

In 1887 John Boyd Dunlop, a Scottish veterinarian, invented the first air chambers for bicycles of the time. This is how tires were invented.

Tools for plastics

All the information contained in this section is available in the web version of the chapter.

Working with plastics

Tool usage and safety

When working in the workshop, the following rules must be respected:

- Good-quality tools must always be used.
- Tools must be used for the task for which they were designed.
- Tools must be kept clean and tidy.
- Measuring tools must be stored protected from the rest.
- Cutting tools must be well-sharpened. They should be kept in boxes or cases, with the cutting edge well-protected.
- The pieces must be firmly held in the bench vise or clamps of the machine tool.
- To tighten or loosen screws, the tool with the best fit must be used.
- The monkey wrench should only be used when there is no one-size wrench available that appropriately fits the head of the screw or nut to be tightened or loosened.

  Protective equipment (goggles, gloves, mask) must be used for tasks that would be dangerous to do without them.

- **Goggles**

They are normally made of resistant plastic. They protect eyes and parts of the face near them. They should be used whenever there is a risk of material flying up, for example, while drilling, grinding, cutting, or sawing.

- **Mask**

It protects the airways in dusty environments. Its use is recommended while sanding, grinding, painting, or sweeping.

- **Gloves**

They are usually made of leather. They protect hands from cuts and splinters. Their use is obligatory when working with machine tools and when there is a risk of cutting, for example, while sawing, drilling, sanding, bending, or grinding.

Joints

Normally, a piece of plastic that has been worked with tools is not used alone.

It is part of an object, something that is useful. For example, shelving, an automobile, a headphone connector, etc.

All of these objects are made up of several pieces joined together. These joints may be **temporary** or **permanent**.

Permanent joints

A permanent joint is one that damages the pieces if it is taken apart.

Rivets

They are cylindrical pieces.

Rivets have two basic parts:

• **Head**

It may be flat, countersunk, tapered, hemispherical, etc.

• **Shaft**

It is the cylindrical part. It is introduced in the pieces to be joined and forms the buck tail of the rivet.

This type of rivet is the most-used since ancient times and requires special technique and preparation. That is why currently it has been replaced by the **blind rivet**. This riveting is done with a machine called a **riveter**.

The blind rivet has two basic parts:

- **Body**. It is made of aluminum and is made up of:
  - **Rivet head**

    May be flat or conical.
  - **Shank**

    Part of the upset head and is the reference for determining the measurements of the rivet.
- **Mandrel**. A steel rod which makes the upset head of the rivet. The parts of it are:
  - **Mandrel head**

    Hemispherical and on one end of the mandrel.
  - **Break notch**

    The place where the mandrel will break after making the upset head.
  - **Traction area**

    The part where the clamp of the riveter is set.
  - **Fill area**

    The part of the broken mandrel that stays inside the body of the rivet.

Glues

The range of glues for plastics is very extensive, and for working each type of plastic the most appropriate one must be selected.

- **Hot-melt silicone**

It is available in bars of solid adhesive.

It is applied with a hot glue gun. The silicone is introduced in the rear of the gun, which has a resistor to melt it. When the glue melts in the mouth of the gun, it can be applied on the surfaces to be joined and later pressed together until the glue has cooled.

- **Contact adhesives**

Normally very toxic. They are used to join plastic with wood or metal.

A thin layer is applied on the pieces to be joined, it is left to dry a few minutes, and then the pieces are pressed together.

- **Instant adhesives**

Normally very toxic.

A few drops or a thin layer is applied on the pieces to be joined and then the pieces are pressed together.

Temporary joints

A temporary joint is one that will not be damaged if it is taken apart.

To join two pieces with a screw and a nut, they must have a diameter that is slightly larger than the screw (between 0.5 and 1 mm larger).

If one of the pieces to be joined could be easily damaged by the pressure on it from the joint, we can place a washer between this piece and the joint (the nut or screw head).

To join plastic pieces temporarily, wood screws can be used if the plastic is relatively soft and there is no possibility of it breaking.

Screws or bolts

They have the same basic parts as the previous joints.

- **Head**

It is usually cylindrical (grooved or Allen), square, hexagonal, or countersunk (with a hexagonal socket). This type of screws is tightened and loosened with the right tool.

- **Shank**

This is the cylindrical part that is introduced into the hole. It has a triangular thread along all or part of its length on which the nut will be screwed.

- **Classification of screws**

They are classified according to the shape of the head, the diameter of the shank, and the length. The thread is indicated by an abbreviation, corresponding to the type of thread: **M** (metric thread, expressed in millimeters), **W** (Whitworth thread, expressed in inches).

Nuts and washers

- **Nuts**

They have a threaded hole in the center, where the screw or bolt is screwed. Their shape can be square, hexagonal, butterfly, blind, or cap. They are classified according to their outer shape and the type of thread, like screws.

- **Washers**

They are cylindrical with a hole in the center. The outer diameter and thickness vary according to the diameter of the hole in the center, which is always slightly larger than the screw to which it is joined. When plastic pieces are mounted with pieces made out of other materials, a washer is placed between the joint and the soft material.

Pins

They are normally cylindrical or conical. In order to place them in the hole, their ends have a chamfered or rounded shape. There are different types, but the most common ones are cylindrical, conical, elastic, and cotter. In some cases, pins act as a safety element. For example, if there is an overload, the pin breaks and prevents the deformation or breakage of the pieces it joins, which are costly and difficult to manufacture.

Finishing techniques

Materials

Finishing plastic surfaces involves applying liquid products (lacquers, varnishes, and paints) and other similar materials to protect the plastics, and enhance or change their appearance or even their texture.

• **Varnishes or lacquers**

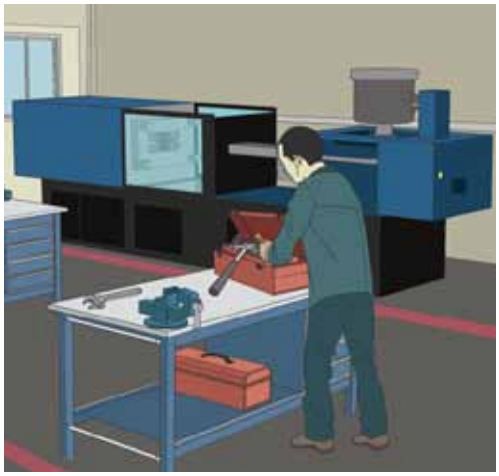
They may be natural or synthetic, transparent, gloss, or matte. Once dry, they form a protective layer on the surface that resists humidity and small bumps.

• **Paints**

Their basic components are a dye or pigment and a binder.

• **Dyes or pigments**

Elements which provide color. They are produced with organic chemical materials in the form of powder or with certain metal oxides.



• **Binders**

Liquid products (oils, resins) that when mixed with dyes, produce paint. They aid drying and adherence, and create a protective layer.

• **Priming**

Process previous to painting which aids adherence.

Rules

Processes of dyeing, varnishing, and painting require care and following guidelines prior to the final process.

1. **Preparation of the surface**

   After finishing the surface, all dust, grease, shavings, and oil that might be left on the surface must be removed.

2. **Protection**

   During the finishing process, protective equipment must be used, like gloves and a mask, as many of the products used are toxic if inhaled.

3. **Priming**

   This consists of applying a sealant to the plastic surface to improve adherence of paints and varnishes. This prevents the posterior products from slipping off and reduces the amount of finishing product required.

4. **Application of the product**

   This must be done with tools which are appropriate for the type of surface and the characteristics of the plastic. If necessary, apply another layer after the first dries.

5. **Maintenance and cleaning**

   When the process is finished, carefully clean the tools with the correct products, let them dry, close the containers, and store everything in its place.

Reduce, reuse, recycle

The 3 Rs: plastics and the environment

The consumption of plastics in our society is very high: Toys, furniture, household appliances, cables, mattresses, sleeping bags, dive suits, adhesives, paints, tires, hoses, etc.

Because of this, we need to remember the rule of the 3 Rs: reduce, reuse, and recycle. It is a very important step in protecting the environment. Remember that the majority of plastics, especially thermoplastics, can be recycled. This represents a huge savings in energy, water, and natural resources, and is a fundamental step in the battle against pollution.

Reduce

In order to reduce the amount of unnecessary waste created, plastics must be used correctly.

As much as possible, try to:

- Not use non-recyclable containers.
- Not use plastic wrap to wrap food, sandwiches, fruit, etc.
- Not buy plastic products that are not recyclable or biodegradable.
- Not use paints with toxic elements.
- Not use machine tools if the task (sawing, drilling, filing) can be done by hand. This way we reduce energy consumption considerably.
- Control the warming of the hot glue gun.
- Use hot-melt silicone instead of other types of toxic glues.
- Not waste or misuse materials, glue, paint, etc.
- Not use aerosols and sprays (deodorants, cleaning products, paints) that contain CFCs, as these damage the ozone layer.

Reuse

Before starting a project, it is necessary to check what we need, what we have, and what we can use again.

As much as possible, try to:

- Not buy unnecessary materials.
- Share materials with classmates.
- Reuse shopping bags to store and transport objects, throw out trash, and for other shopping trips.
- Take the exact measurement of material needed.
- Generate less waste.

Recycle

Try to:

- Buy recyclable products.
- Use biodegradable plastic products.
- Place recyclable products in the boxes and bins as indicated.
- Take plastic products that are not easily recycled (batteries, cell phones, computers, small household appliances, toys) or toxic products to special collection points.
- Recycle plastic packaging of preserves, drinks, and foods (aluminum foil, tetra-bricks, plastic wrap) and electrical cables. The process of manufacturing thermoplastics is especially damaging to the environment.