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Synthetic Materials

Outline:

- **Thermoplastics**
- **Thermoset plastics**

Synthetic Materials

The term synthetic denotes materials made with human intervention as opposed to natural materials.

Properties

Most synthetic materials are based on the carbon atom, and are derived from petrochemicals made from petroleum or natural gas. They are usually polymers, composed of very large chains of molecules made up of many simpler molecules.

Synthetic plastics are valued for their durability and flexibility of form. They are very stable and difficult to destroy, making their ultimate disposal difficult.

Most plastics will soften and melt at relatively low temperatures. They tend to be poor electrical conductors. Most plastics exhibit a high level of thermal expansion. Plastics generally have a high ratio of tensile strength to weight.

All synthetic plastics are combustible and most emit noxious fumes (typically carbon monoxide) in fires. Some plastics that have high surface flame spread levels produce burning droplets.

Manufacturing Synthetics

Most plastics are derived from petrochemicals, but some are based on natural products, such as rubber or cellulose.

Molten plastic molecular chains move freely and can be molded. Lowering the melting temperature of a plastic reduces the freedom of movement of the molecular chain, and the plastic eventually solidifies at its melting-point temperature, where it typically remains rubbery or flexible. Lowering the temperature further creates rigid, brittle materials; plasticizers are added to alter this effect.

Many synthetic materials are proprietary formulations, and their exact composition and effect on public health and the environment is not publicly known. As a designer and specifier, it is prudent to choose materials that have been shown to minimize health and environmental risks, rather than ones that may result in harm, even when full information is not publicly available.

Synthetic materials deplete oil and natural gas, have high levels of embodied energy, and produce long-lasting wastes that degrade the environment.

Synthetic materials can last for hundreds of years, and pollute both the land and the marine environment. Large quantities of plastic accumulate as wastes that are slow to degrade in landfills.

According to the EPA, 31 million tons of plastic wastes were generated in 2010, only 8 percent of which was recovered for recycling.

TYPES OF SYNTHETIC MATERIALS

The great many varieties of plastic are categorized as two basic types: thermoplastic and thermoset.

Thermoplastics: become soft when heated, and can be remolded repeatedly. They harden when cooled. Thermoplastics have long, tangled chains of molecules that give them flexibility.

Thermoset plastics: are permanently hardened, and cannot be softened and remolded. Thermoset plastics have cross-linked molecular chains that reduce their flexibility

Thermoplastics

Of the two types of plastic, thermoplastics have higher impact strength, are easier to process, and are more adaptable to complex designs. They are able to soften when heated and then harden as they cool, but plasticizers must be added to retain flexibility. Thermoplastics include nylon, acrylics, polyesters, vinyls, and a variety of other plastics.

Thermoplastics are usually produced in the form of powder or as small granules called “nurdles.” Thermoplastics are often formed in a two-stage process, with the raw materials made into an extrusion or sheet, and then reformed into the final product.

Acrylics

Acrylics are very clear, hard, lightweight thermoplastics. They are chemical- and weather-resistant, colorfast, and nonyellowing. Acrylics have good structural and thermal properties, and are dimensionally stable. Acrylic glazing is made of polyacrylate (PMMA) and known by the trade names, Plexiglas and Lucite. It is hard and transparent, and it handles and processes well. However, it can become brittle and tends to scratch more than glass

Nylon

Nylon is a strong, translucent, and rigid thermoplastic in the polyamide family. It is resistant to chemicals, ultraviolet (UV) light, impact, and abrasion. Its low coefficient of friction makes it useful for small components such as chair casters and rollers.

There are several different types of nylon. Nylon 6 and nylon 6,6 are both used for carpet.

They are strong and elastic, dye very well, and have the same resilience characteristics as wool. Carpet tests show no significant difference in performance between the two types.

Polyesters

The term “polyester” refers to both a category of polymers, and specifically to one type of polymer,

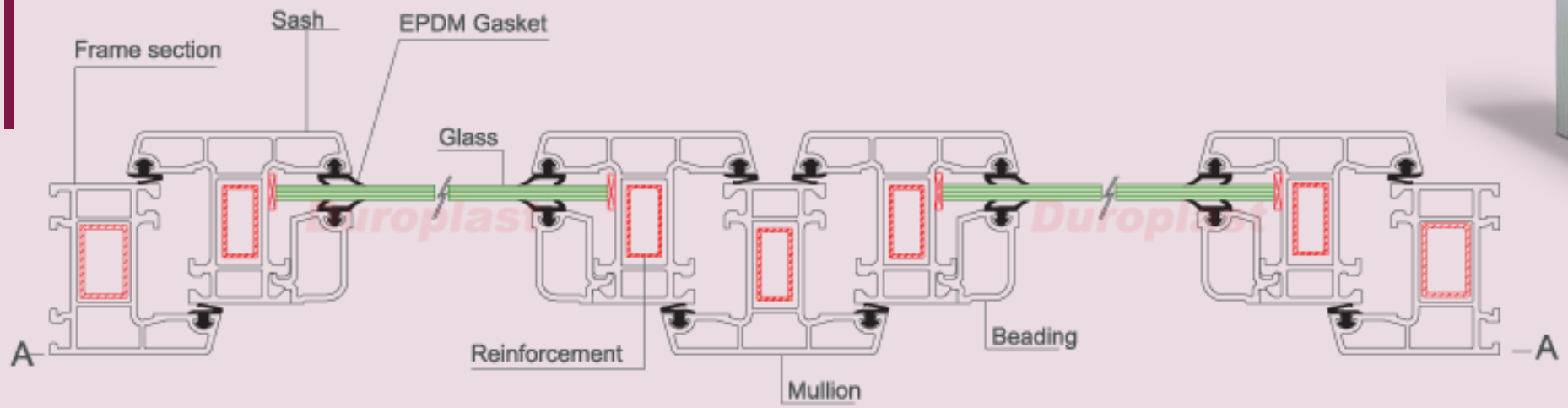
polyethylene terephthalate (PET or PETE) . Most polyesters are thermoplastic, but some are thermoset, depending on their chemical structure. Polyesters are combustible at high temperatures, but tend to shrink away from flames and self-extinguish. Their levels of embodied energy are at the lower end of the range for plastics.

PET is used to make synthetic fibers . Polyester fibers have improved wrinkle resistance, durability, and color retention compared to cotton. They are often spun with natural fibers.

Vinyls

Vinyls are thermoplastics that are strong, durable, and maintenance free. They have good dimensional stability and impact resistance, and are lightweight and tough. Vinyl is manufactured both as rigid and flexible products, and as a transparent fi lm.

The best-known vinyl is **polyvinyl chloride (PVC)**. PVC is strong and durable. It exhibits great versatility in form and adaptability in properties, and its end products range from soft to rigid.



Thermoset Plastics

Thermoset plastics resist higher temperatures and have greater dimensional stability than thermoplastics.

Thermoset plastics undergo a chemical change during processing that hardens them permanently. Consequently, thermoset plastics cannot be softened by heating or remolded.

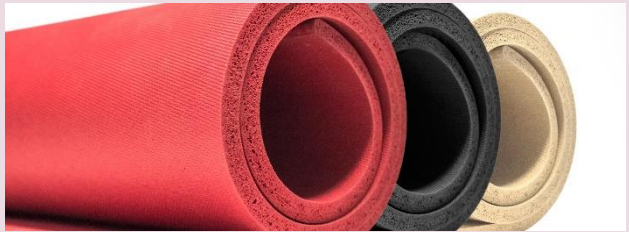
Thermoset plastics include a variety of resins, silicones, and polyesters used in building interiors

Elastomers

Elastomers are long-chain polymers in which the natural helical or zigzag molecular chains are free to straighten when the material is stretched, and recover when the load is removed.

Elastomers are used in flooring, carpet adhesives, coatings (latex paint), textile fiber, and mattresses.

The two main types of elastomers are natural rubber and synthetic rubber



Composite Materials

Composite plastics are formed by blending polymers such as polyethylene, polypropylene, and PVC with natural fibers, including wood chips, hemp, with fine glass Fibers. Fiberglass is lightweight and very strong, and can be easily formed by molding. Fiberglass usually cannot be recycled, but may be ground up and reused in plastic lumber. Fiberglass is used for decorative tiles and panels, as well as architectural elements such as door and window surfaces and surrounds, column covers, domes, or balustrades. It is also used to make mold-resistant gypsum wallboard.

Types of Thermoset Plastics

Name	Description
Epoxy resin (Polyepoxide)	Elastic, chemical and heat resistant. Fiber reinforced plastic, adhesives, solid surfacing, coatings
Melamine formaldehyde (MF) resin	Hard, unmeltable, durable, heat- and stain-resistant, strong, brittle. Decorative laminate finish, textiles, laminated flooring, cabinets, furniture
Silicones (Silicone based)	Heat-resistant, rubbery, water-repellant. Sealants, caulks, water-repellant fabric finishes
Thermoset polyesters	Typically combined with other materials. Alkyd paints, fiberglass reinforced panels, furniture parts
Phenolic formaldehyde (PF) resin	Brittle, strong, hard, resists ignition. Laminate adhesives for laboratory countertops, work surfaces, wall panels, and coatings
Urea-formaldehyde (UF) resin	Strong, flexible, resists ignition. Wood panel product adhesive, decorative laminates, finishes, textiles