Plastic Welding

Part 2: Plastic Basics

We know how.

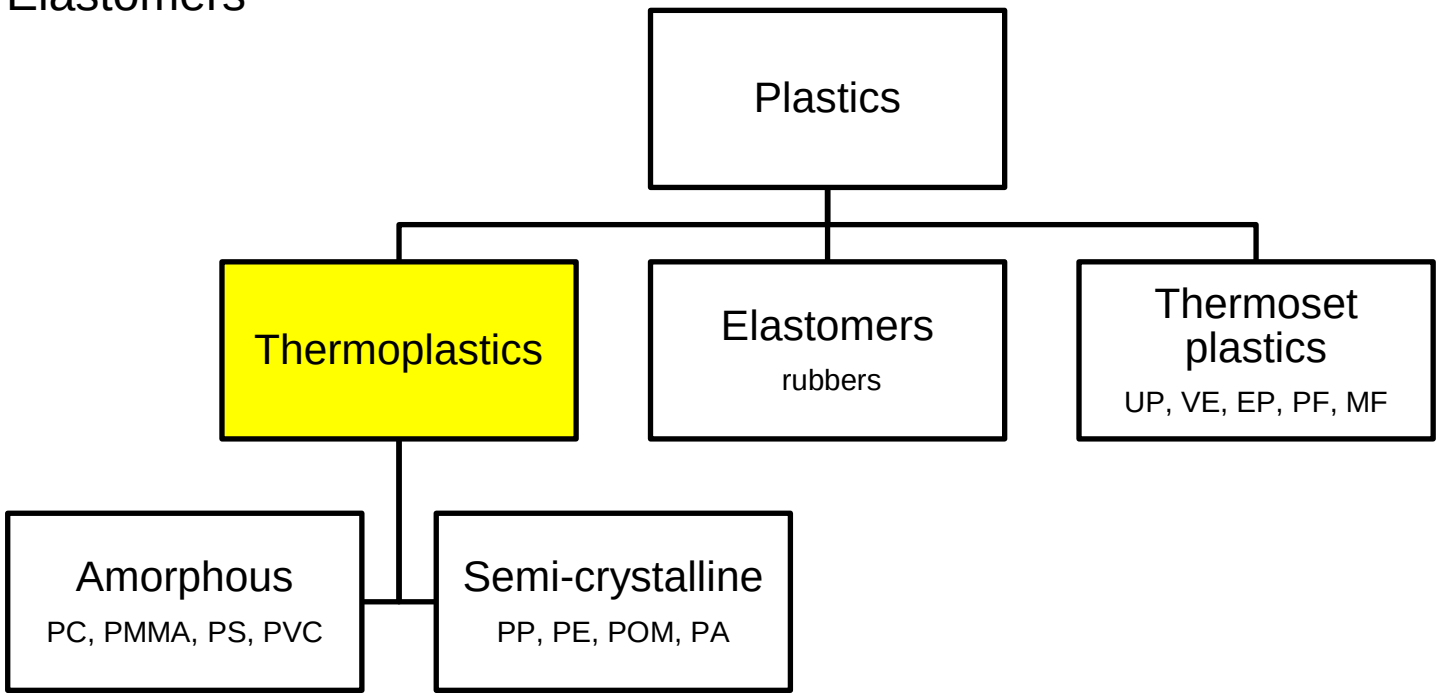
Part 2: Basic Plastics

Plastics are derived from organic products. The materials used in the production of plastics are natural products such as cellulose, coal, natural gas, salt and, of course, crude oil.

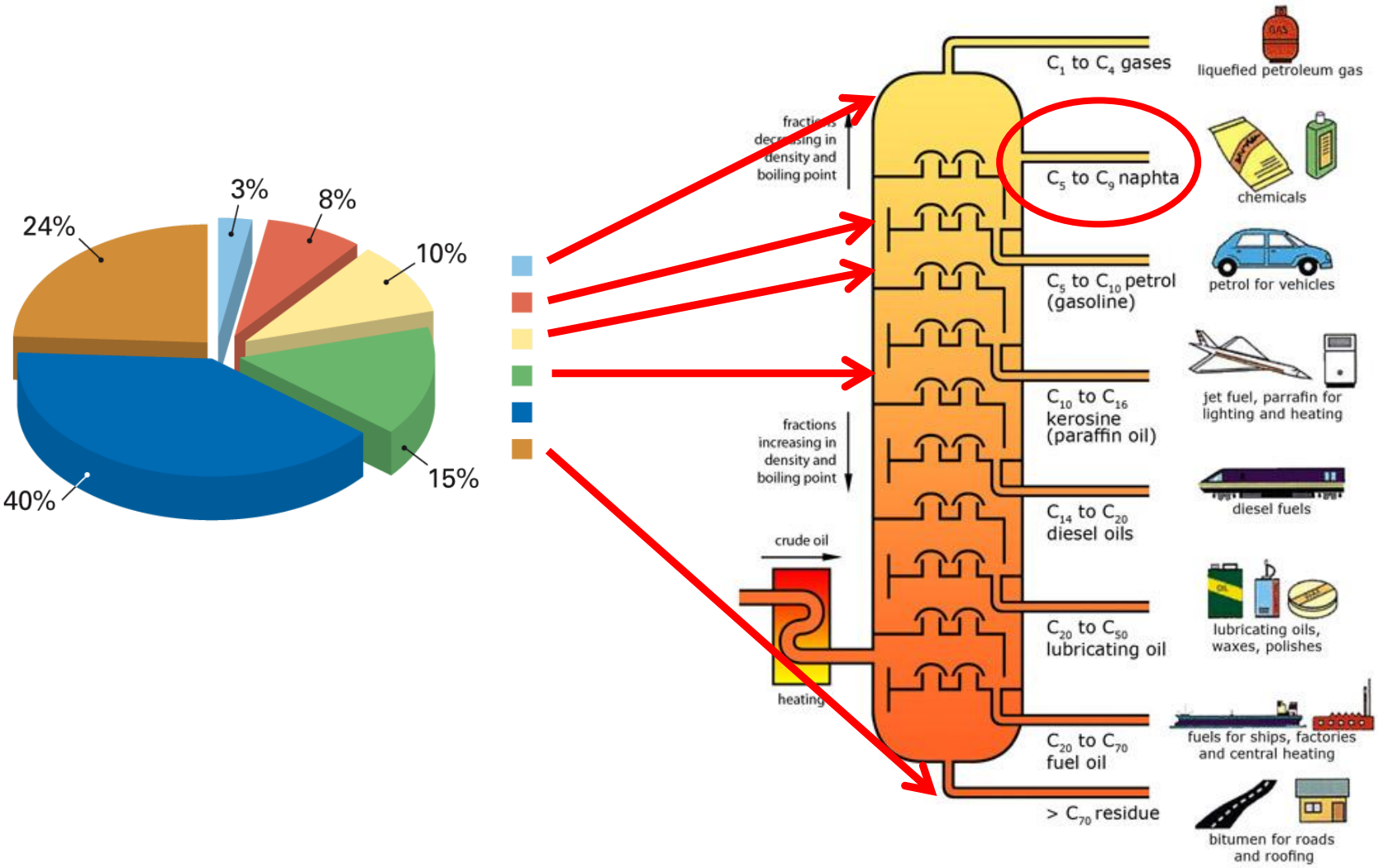
Part 2: Basic Plastics

There are many different types of plastics, and they can be grouped into three main polymer families:

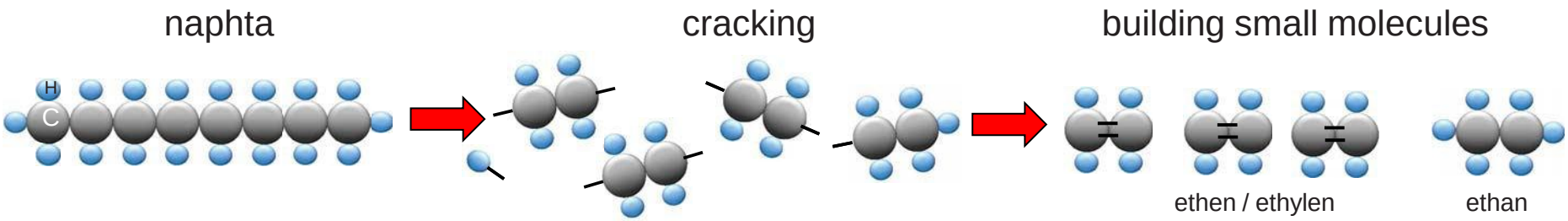
- Thermoplastics (which soften on heating and then harden again on cooling)
- Thermosets (which never soften when they have been molded)
- Elastomers

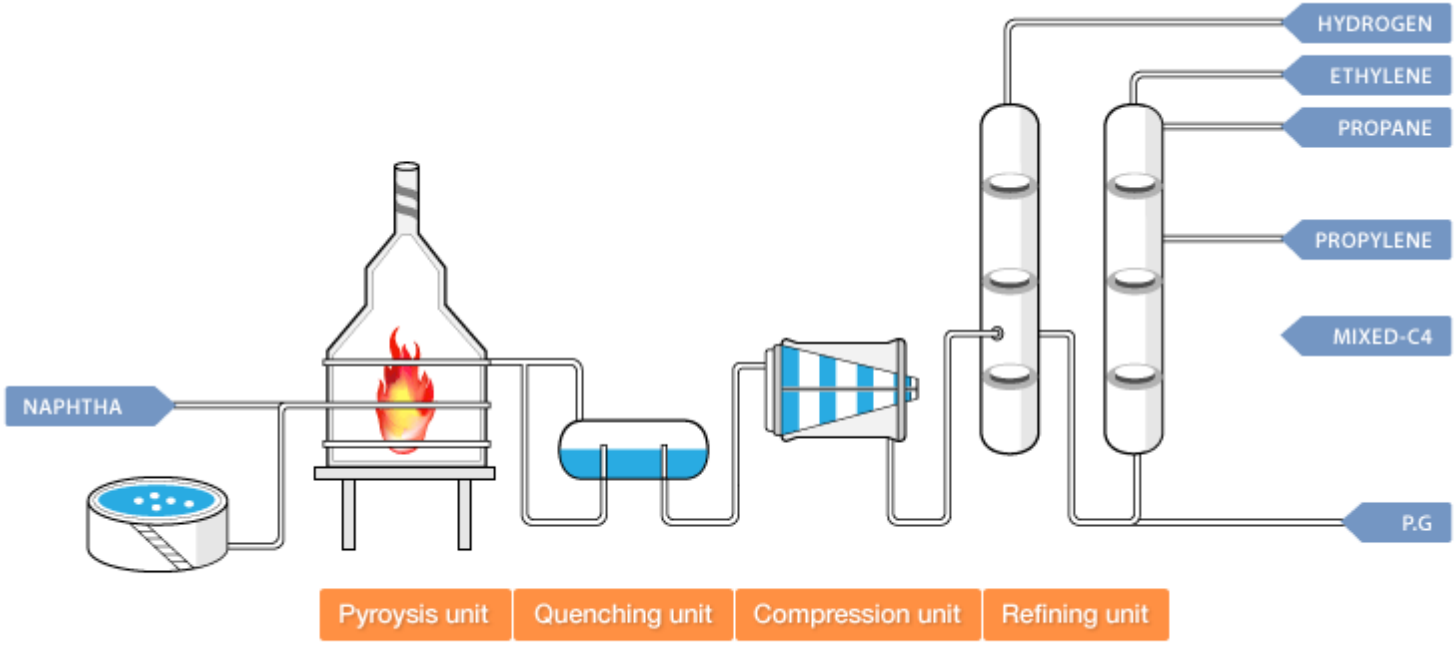


Part 2: Basic Plastics

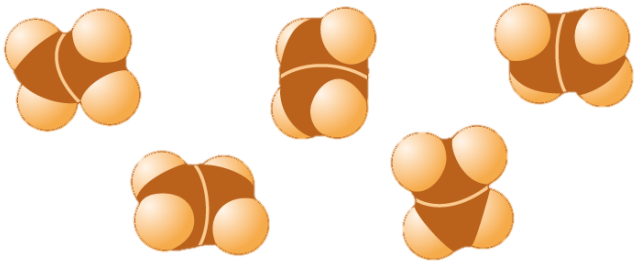


Part 2: Basic Plastics

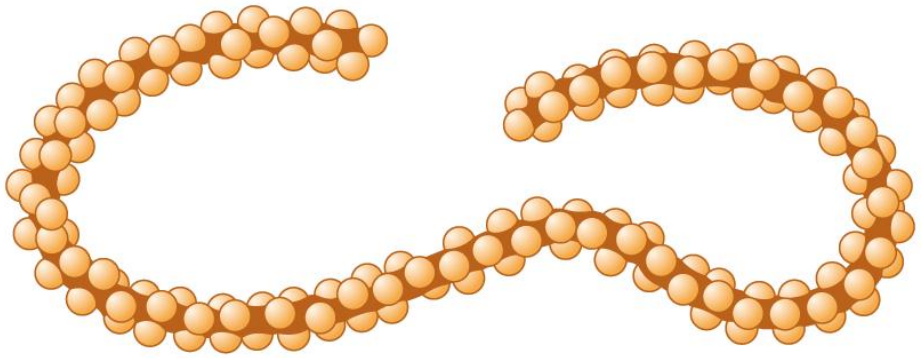




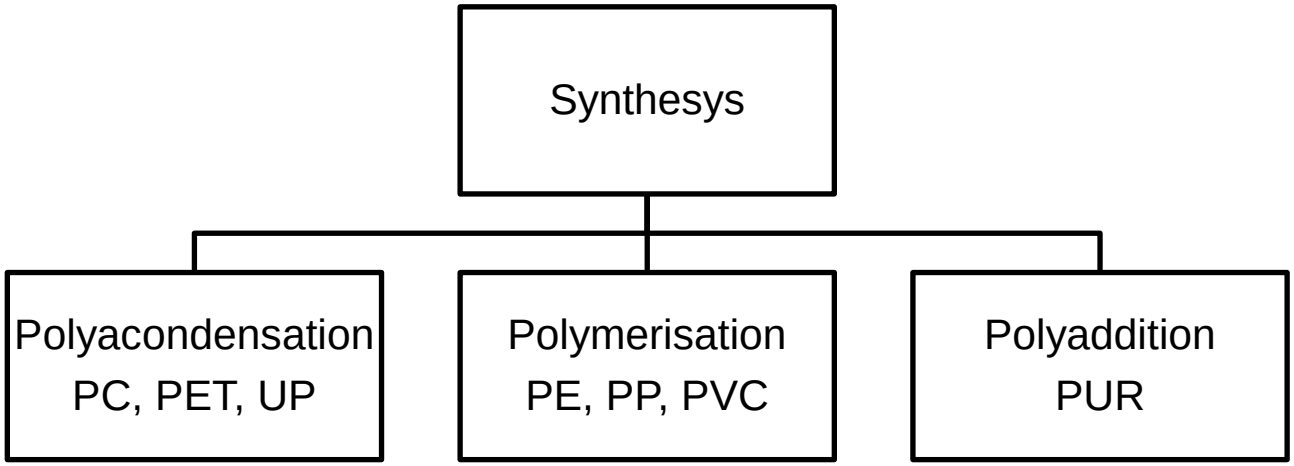
Part 2: Basic Plastics



Monomer



Macromolecule



Part 2: Basic Plastics

usual ingredients

carbon

hydrogen

oxygen

nitrogen

sulfur

chlorine

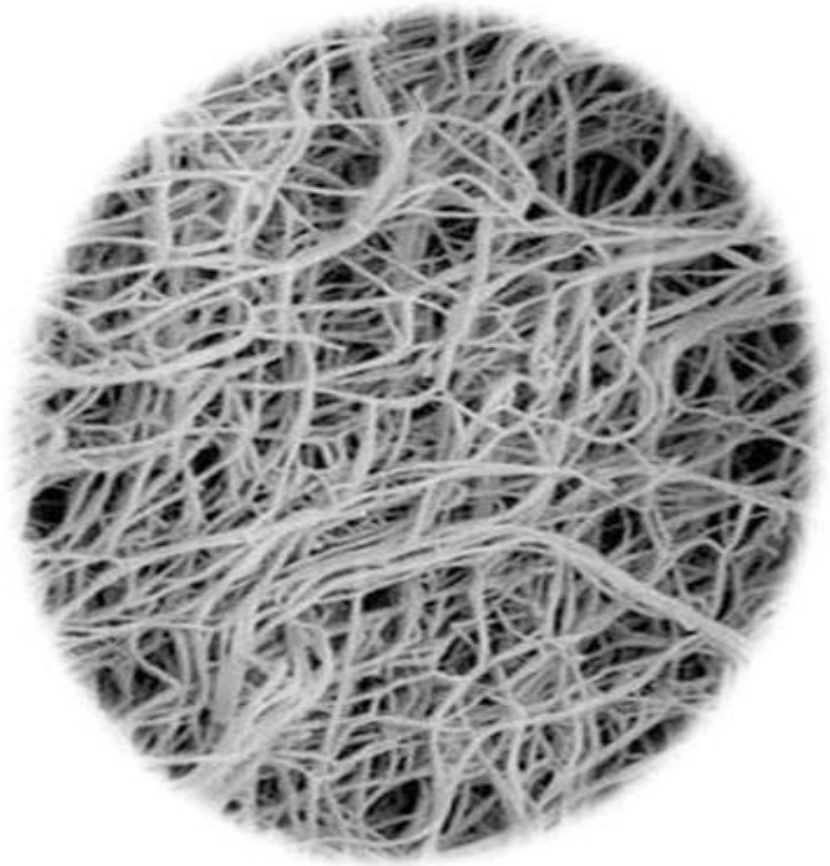
fluorine

silicon

Part 2: Basic Plastics

increasing chain length results in

- Higher resistance of chemicals
- higher resistance of melt flow
- higher strength
- higher toughness



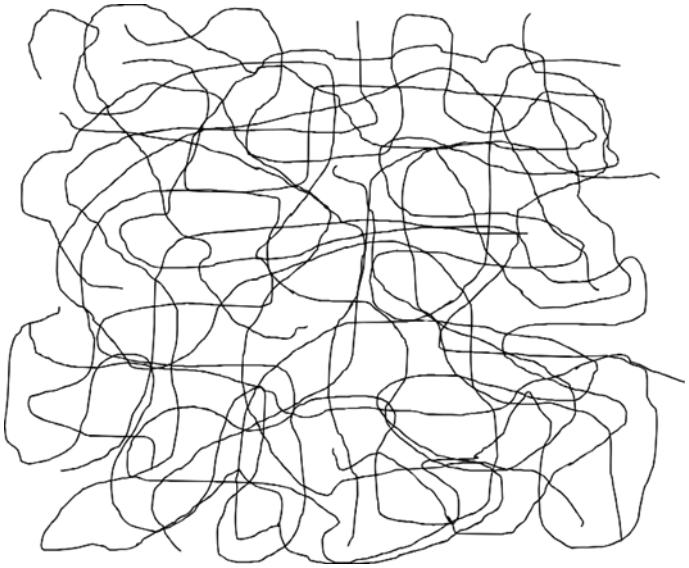
Part 2: Basic Plastics

The properties of plastics include:

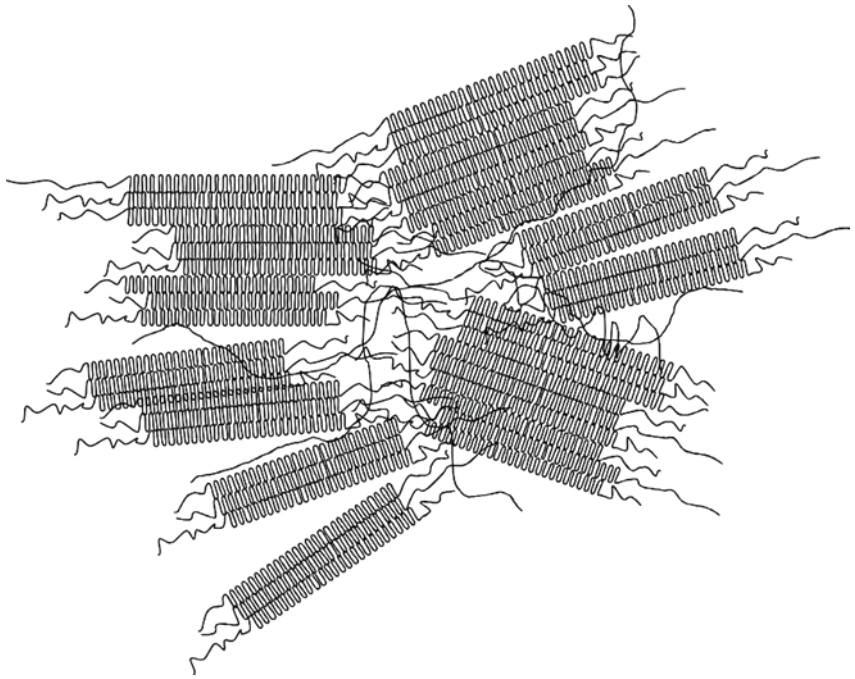
+ low weight and good mechanical properties
+ good electrical insulation
+ excellent resistance to chemicals and weathering
+ low thermal conductivity

– low thermal resistance
– large thermal expansion
– low elastic modulus
– the time dependence of the mechanical property values (creep)
– Permeation (gas permeability)

Structures of plastics



Amorphous
(PS, PVC, PMMA, PC)



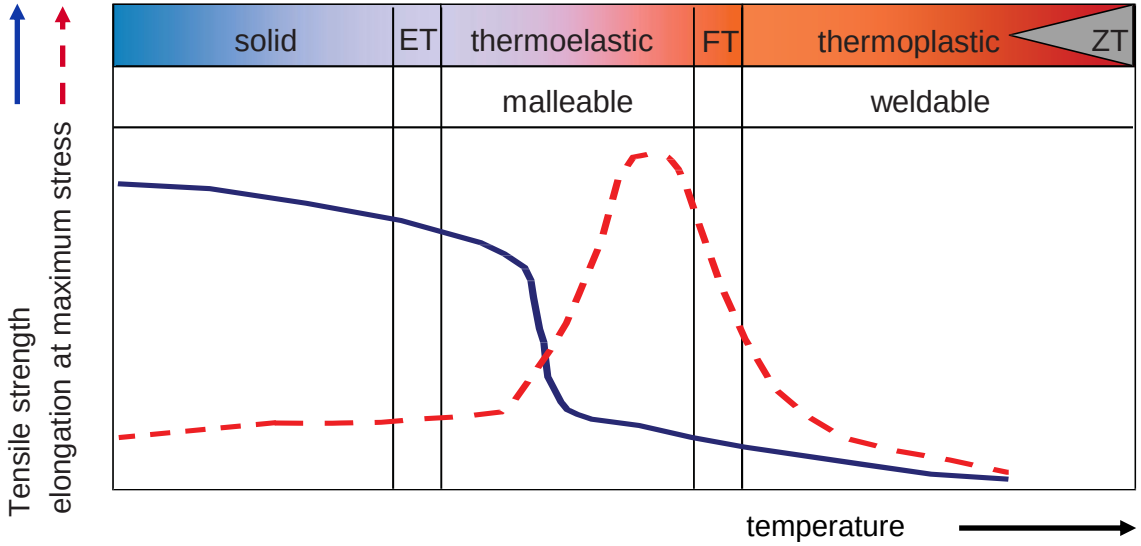
Partially crystalline
(PE, PP, PVDF, PTFE)

Part 2: Basic Plastics

Propetries	amorphous	Partially crystalline
color	transparent	opacity
mecanical	brittle	tough hard
shrinkage	low	high
abrasion	high	low
gliding	low	high
bondability	high	low

Part 2: Basic Plastics

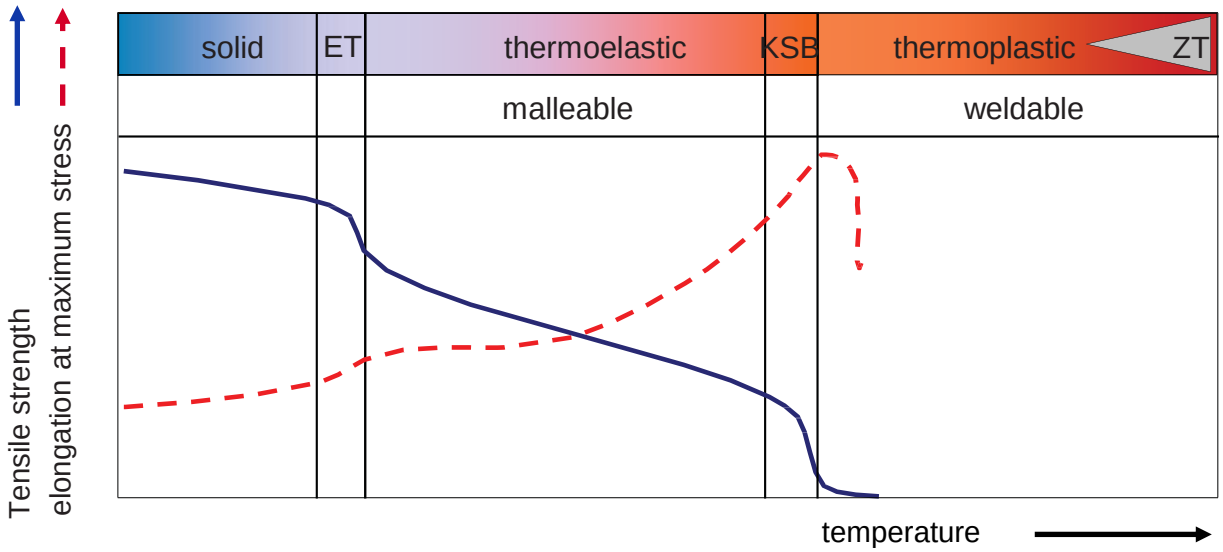
State and processing ranges of PVC-U (amorphous)



ET = softening temperature range
FT = flow temperature range
ZT = decomposition temperature range

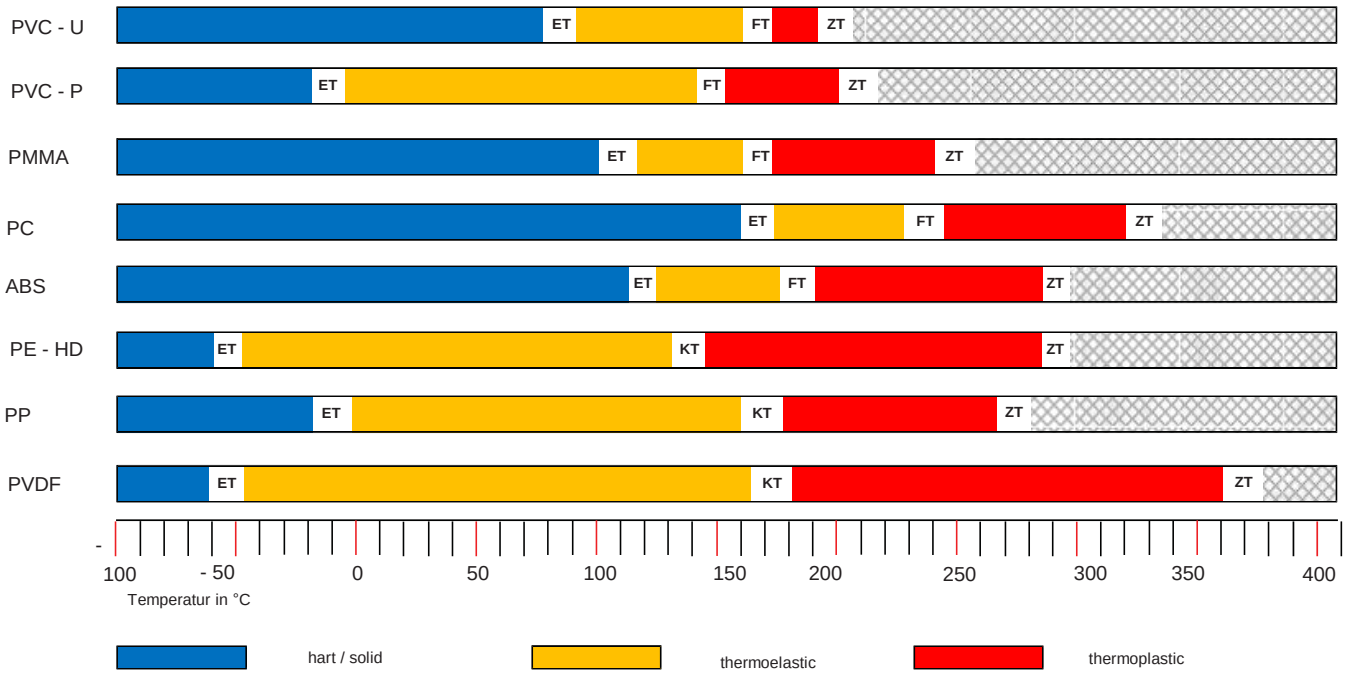
Part 2: Basic Plastics

State and processing ranges of polyethylene (semi crystalline)



ET = softening temperature range
KSB = cristalline melting range
ZT = decomposition temperature range

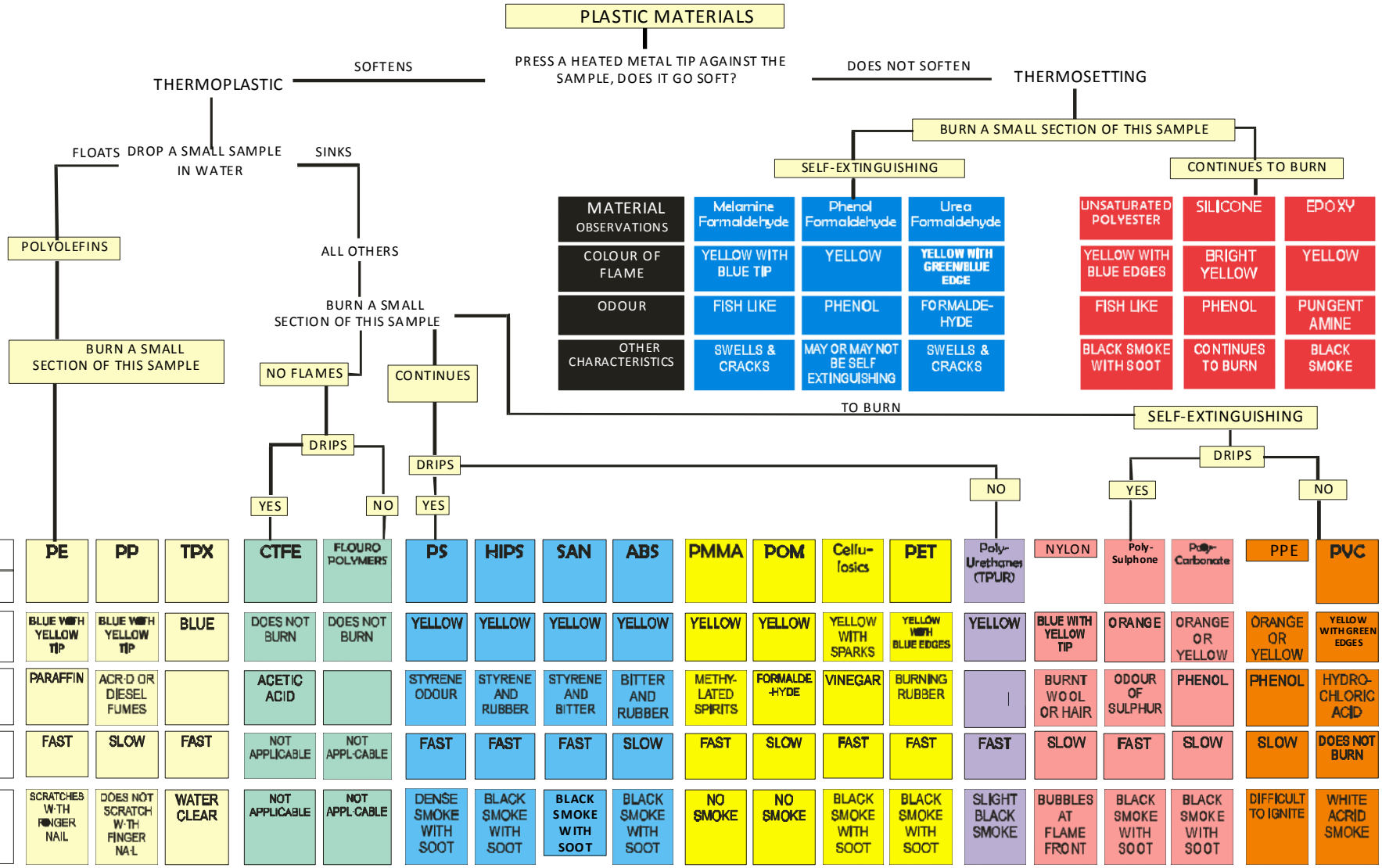
Part 2: Basic Plastics



ET = softening temperature range
FT = flow temperature range
KSB = cristalline melting range
ZT = decomposition temperature range

Part 2: Basic Plastics

PLASTICS IDENTIFICATION FLOW CHART



MATERIAL / Observation	PE	PP	TPX	CTFE	FLOURO POLYMERS	PS	HIPS	SAN	ABS	PMMA	POM	Cellu-losics	PET	Poly-Urethanes (TPUR)	NYLON	Poly-Sulphone	Poly-Carbonate	PPE	PVC
COLOUR OF FLAME	BLUE WITH YELLOW TIP	BLUE WITH YELLOW TIP	BLUE	DOES NOT BURN	DOES NOT BURN	YELLOW	YELLOW	YELLOW	YELLOW	YELLOW	YELLOW	YELLOW WITH SPARKS	YELLOW WITH BLUE EDGES	YELLOW	BLUE WITH YELLOW TIP	ORANGE	ORANGE OR YELLOW	ORANGE OR YELLOW	YELLOW WITH GREEN EDGES
ODOUR	PARAFFIN	ACRID OR DIESEL FUMES		ACETIC ACID		STYRENE ODOUR	STYRENE AND RUBBER	STYRENE AND BITTER	BITTER AND RUBBER	METHY-LATED SPIRITS	FORMALDE-HYDE	VINEGAR	BURNING RUBBER		BURNT WOOL OR HAIR	ODOUR OF SULPHUR	PHENOL	PHENOL	HYDRO-CHLORIC ACID
SPEED OF BURNING	FAST	SLOW	FAST	NOT APPLICABLE	NOT APPLICABLE	FAST	FAST	FAST	SLOW	FAST	SLOW	FAST	FAST	FAST	SLOW	FAST	SLOW	SLOW	DOES NOT BURN
OTHER FEATURES	SCRATCHES WITH FINGER NAIL	DOES NOT SCRATCH WITH FINGER NAIL	WATER CLEAR	NOT APPLICABLE	NOT APPLICABLE	DENSE SMOKE WITH SOOT	BLACK SMOKE WITH SOOT	BLACK SMOKE WITH SOOT	BLACK SMOKE WITH SOOT	NO SMOKE	NO SMOKE	BLACK SMOKE WITH SOOT	BLACK SMOKE WITH SOOT	SLIGHT BLACK SMOKE	BUBBLES AT FLAME FRONT	BLACK SMOKE WITH SOOT	BLACK SMOKE WITH SOOT	DIFFICULT TO IGNITE	WHITE ACRID SMOKE

Part 2: Basic Plastics

Plastic Indentification by Declaration symbol

PET, PETE
(Polyethylene Terephthalate)
- Soft drink, water and salad dressing bottles; peanut butter and jam jars…
- Suitable to store cold or warm drinks. Bad idea for hot drinks.

HDPE
(High-density Polyethylene)
- Water pipes, milk, juice and water bottles; grocery bags, some shampoo / toiletry bottles…

PVC
(Polyvinyl Chloride)
- Not used for food packaging.
- Pipes, cables, furniture, clothes, toys…

LDPE
(Low-density Polyethylene)
- Frozen food bags; squeezable bottles, e.g. honey, mustard; cling films; flexible container lids….

PP
(Polypropylene)
- Reusable microwaveable ware; kitchenware; yogurt containers; microwaveable disposable take-away containers; disposable cups; plates….

PS
(Polystyrene)
- Egg cartons; packing peanuts; disposable cups, plates, trays and cutlery; disposable take-away containers;
  Avoid for food storage!

Other
(often polycarbonate or ABS)
- Beverage bottles; baby milk bottles. compact discs; "unbreakable" glazing; lenses including sunglasses, prescription glasses, automotive headlamps, riot shields, instrument panels…

Part 2: Basic Plastics

Plastic	Characteristics / Properties
ABS (Acrylonitrile-butadiene-styrene)	Rigid, low-cost thermoplastic, easily machined and thermo-formed.
Acetal	Engineering thermoplastic with good strength, wear resistance, and dimensional stability. More dimensionally stable than nylon under wet and humid conditions.
Acrylic	Clear, transparent, strong, break-resistant thermoplastic with excellent chemical resistance and weatherability.
CPVC (Chlorinated PVC)	Thermoplastic with properties similar to PVC, but operated to a 40-60°F higher temperature.
Fiberglass	Thermosetting composite with high strength-to-weight ratio, excellent dielectric properties and unaffected by corrosion.
Nylon	Thermoplastic with excellent impact resistance, ideal for wear applications such as bearings and gears; Self-lubricating under some circumstances
PEEK (Poly-ether-ether-ketone)	Engineering thermoplastic, excellent temperature resistance, suitable for continuous use above 500°F, excellent flexural and tensile properties.
PET (Poly-ethylene-terephthalate)	Dimensionally stable thermoplastic with superior machining characteristics compared to acetal.
Phenolic	Thermosetting family of plastics with minimal thermal expansion, high compressive strength, excellent wear and abrasion resistance and a low coefficient of friction. Used for bearing applications and molded parts.
Polycarbonate	Transparent, tough thermoplastic with high impact strength, excellent chemical resistance and electrical properties, and good dimensional stability.
Polypropylene	Good chemical resistance combined with low moisture absorption and excellent electrical properties. Retains strength up to 250°F.
Polysulfone	Durable thermoplastic, good electrical properties, operates at temperatures in excess of 300°F.
Polyurethane	Thermoplastic, excellent impact and abrasion resistance, resists sunlight and weathering.
PTFE (Poly-tetra-fluoro-ethylene)	Thermoplastic with a low coefficient of friction, withstands heat up to 500°F, inert to chemicals and solvents, self-lubricating with a low thermal expansion rate.
PVC (Poly-vinyl-chloride)	Thermoplastic, resists corrosive solutions and gases both acid and alkaline, good stiffness.
PVDF (Poly-vinyl-idene-fluoride)	Thermoplastic, outstanding chemical resistance, excellent substitute for PVC or polypropylene. Good mechanical strength and dielectric properties.