Plastics Topics – Introduction to thermoplastics

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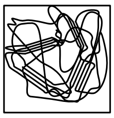
Contents

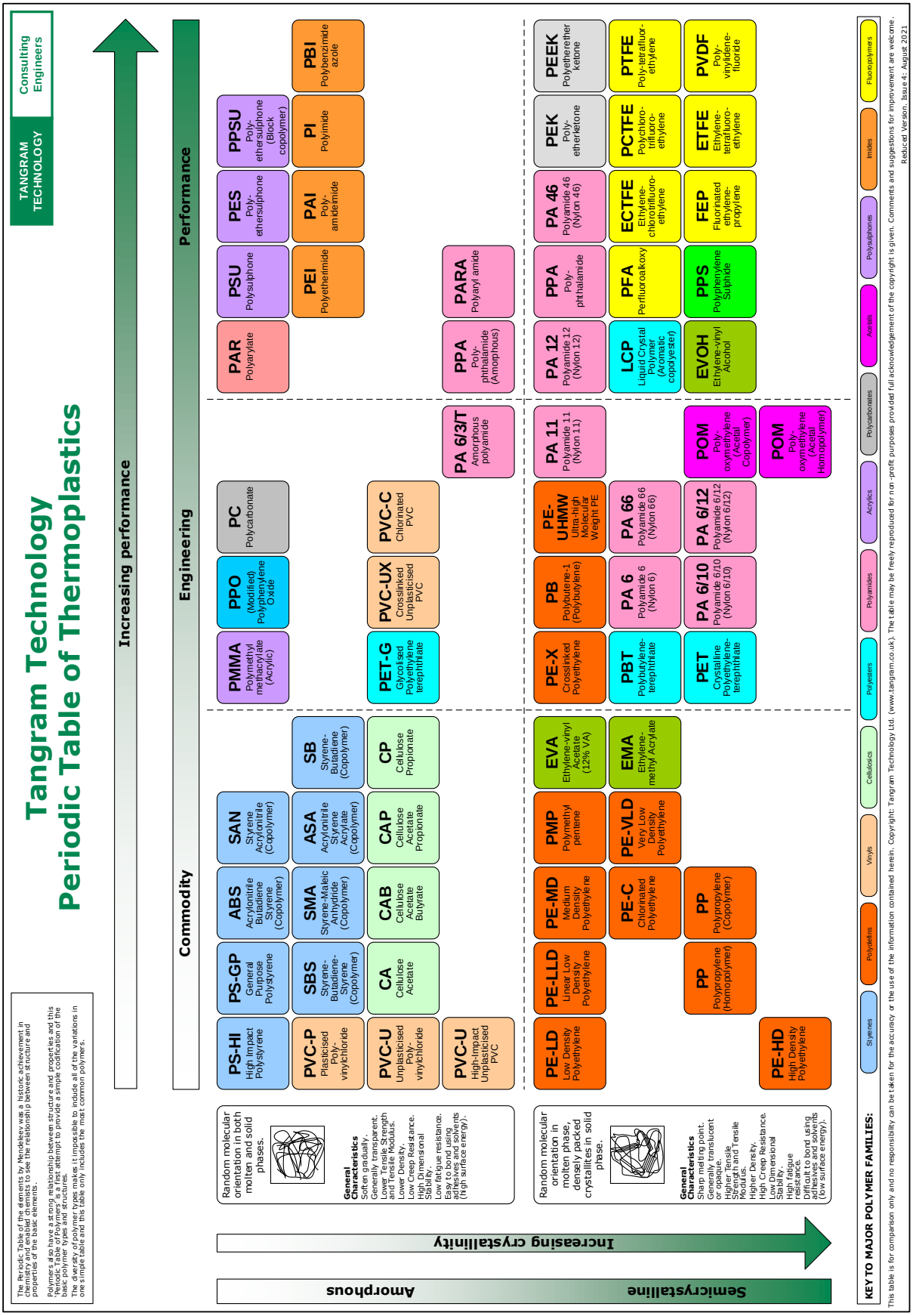
1. A framework for plastics

AMORPHOUS PLASTICS		SEMI-CRYSTALLINE PLASTICS	
AMORPHOUS PLASTICS GENERAL PROPERTIES		**SEMI-CRYSTALLINE PLASTICS GENERAL PROPERTIES**	
Soften over a wide range of temperatures Lower Specific Gravity Lower Tensile Strength and Tensile Modulus Higher Ductility Lower Creep Resistance Tend to be Transparent Higher Dimensional Stability Lower fatigue resistance Higher Surface Appearance Bond well using adhesives and solvents Lower Chemical Resistance and Résistance to Stress Cracking Structural applications only (not for bearing and wear)	 Random molecular orientation in both molten and solid phases.	Distinct & Sharp melting point Higher Specific Gravity Higher Tensile Strength and Tensile Modulus Lower Ductility Higher Creep Resistance Tend to be Translucent or opaque Lower Dimensional Stability Higher fatigue resistance Higher Surface Appearance Difficult to bond using adhesives and solvents Higher Chemical Resistance and Résistance to Stress Cracking Good for bearing and wear, as well as for structural applications	 Random molecular orientation in molten phase but densely packed crystallites in solid phase.
AMORPHOUS PERFORMANCE PLASTICS		**SEMI-CRYSTALLINE PERFORMANCE PLASTICS**	
Key Properties	**Examples**	**Key Properties**	**Examples**
High cost High temperature resistance High strength and good stiffness High impact resistance Good chemical resistance Hot water and steam resistance	Polysulphone (PSU) Polyetherimide (PEI) Polyethersulphone (PES) Polyarylsulphone (PAS)	High cost High temperature resistance High strength Outstanding electrical properties Outstanding chemical resistance Low co-efficient of friction Good toughness	PVDF PTFE ECTFE FEP PFA PPS PEEK
AMORPHOUS ENGINEERING PLASTICS		**SEMI-CRYSTALLINE ENGINEERING PLASTICS**	
Key Properties	**Examples**	**Key Properties**	**Examples**
Moderate cost Moderate temperature resistance Moderate strength and stiffness Good impact resistance Good dimensional stability Typically translucent Good optical qualities	PC Modified PPO Modified PPE Thermoplastic Urethane	Moderate cost Moderate temperature resistance Moderate strength Good impact resistance Good chemical resistance Good bearing and wear properties Low co-efficient of friction Difficult to bond	PA (nylon) POM (Acetal) PET PBT PE-UHMW
AMORPHOUS COMMODITY PLASTICS		**SEMI-CRYSTALLINE COMMODITY PLASTICS**	
Key Properties	**Examples**	**Key Properties**	**Examples**
Low cost Low temperature resistance Low strength and stiffness Good dimensional stability Bond well Typically translucent	PMMA (acrylic) PS ABS PVC PETG CAB	Low cost Low temperature resistance Low strength Good toughness Excellent chemical resistance Near zero moisture absorption Good electrical properties	PE-LD PE-HD PP Polymethylpentene (TPX)

IMIDE MATERIALS	
Key Properties	**EXAMPLES**
Very high cost Excellent high temperature properties Excellent dimensional stability Low co-efficient of friction	PI PAI PBI

Figure 1: A framework for thermoplastics

2. The periodic table of thermoplastics



3. The basic thermoplastics – properties and applications

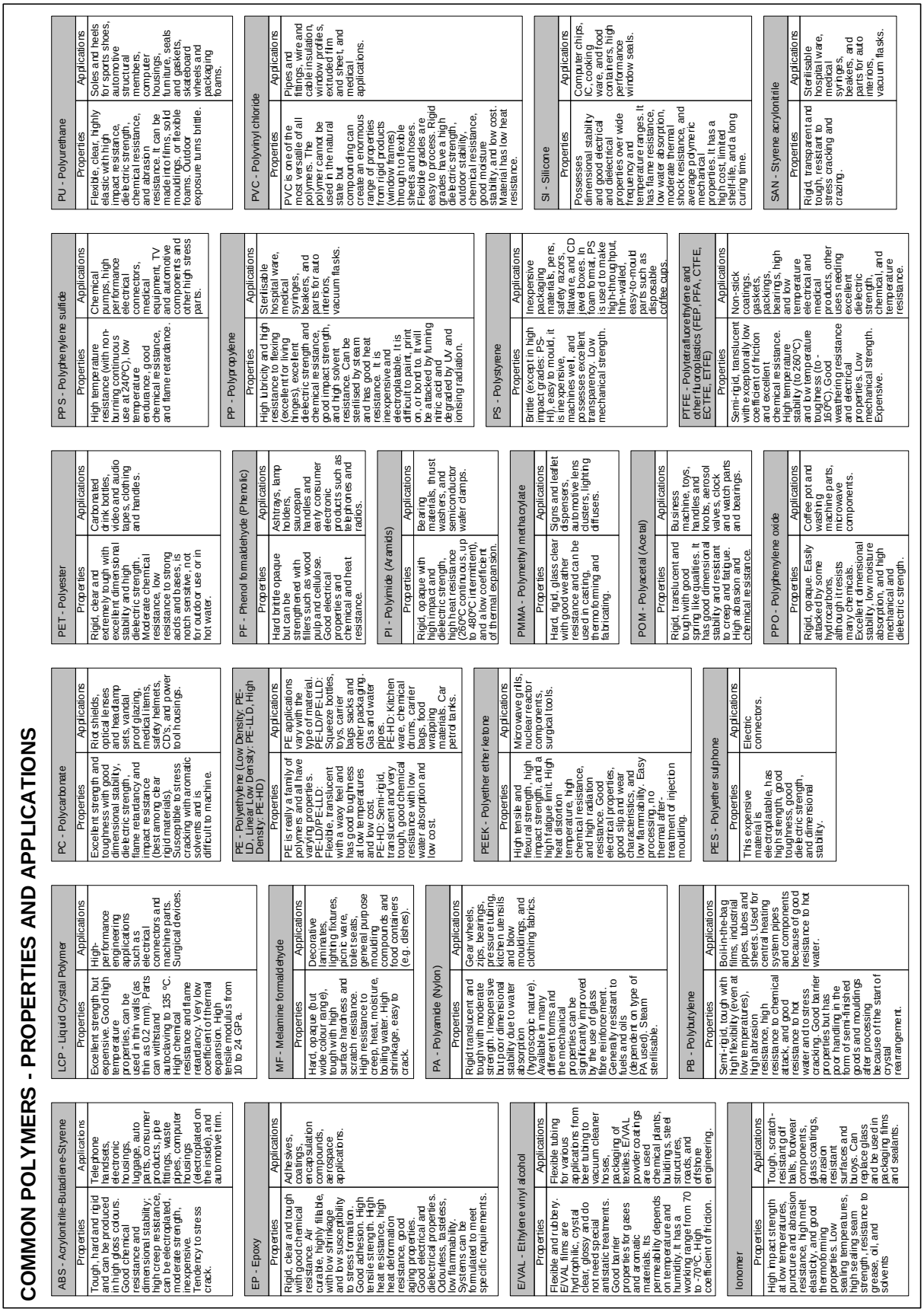


Figure 2: Properties and applications of thermoplastics and thermosets

4. Process selection for thermoplastics

Every processing method has limitations and advantages. Use Table 1 to select the right process for your product.

Process / Feature	Injection Moulding	Extrusion	Blow Moulding	Rotational Moulding	Thermoforming
Equipment Cost	High	High	High	Moderate	Moderate
Tooling Cost	High	Moderate	Moderate	Low	Low
Cycle Time	<1 min	Continuous	<1 min	>3 min	1-3 min
Economic Quantity	>10K	>5Km	>10K	100 - 10K	100 - 10K
Precision	Good	Good	Moderate	Moderate	Low
Wall Thickness Control	Yes	Yes	No	No	No
Open-ended Hollows	Yes	No	Yes	Yes	Yes
Enclosed Hollows	No	No	Yes	Yes	No
Very Small Items	Yes	No	No	No	No
Complicated/ Intricate Shapes	Yes	Yes	Yes	No	No
Large Enclosed Volumes	No	No	Yes	Yes	No
Inserts	Yes	No	No	Yes	No
Moulded-in Holes	Yes	No	No	No	No
Threads	Yes	No	Yes	No	No

Table 1: Processing methods for thermoplastics

5. Materials selection for the process

Not every material is suitable for every process. Use Table 2 to select the best material for the process.

Process / Material	Injection Moulding	Extrusion	Blow Moulding	Rotational Moulding	Thermoforming
ABS	Yes	Yes	No	Yes	Yes
EVA	No	No	No	Yes	No
PA	Yes	Yes	No	Yes	No
PC	Yes	Yes	Yes	No	Yes
PE-LD	Yes	Yes	Yes	Yes	No
PE-HD	Yes	Yes	Yes	Yes	No
PMMA	Yes	Yes	No	No	Yes
POM	Yes	Yes	Yes	No	No
PP	Yes	Yes	Ye	No	Yes
PS / PS-HI	Yes	Yes	Yes	Yes	Yes
PVC-U	Yes	Yes	Yes	Yes	Yes
PVC-P	Yes	Yes	Yes	Yes	Yes
SAN	Yes	Yes	Yes	No	No

Table 2: Materials and processes