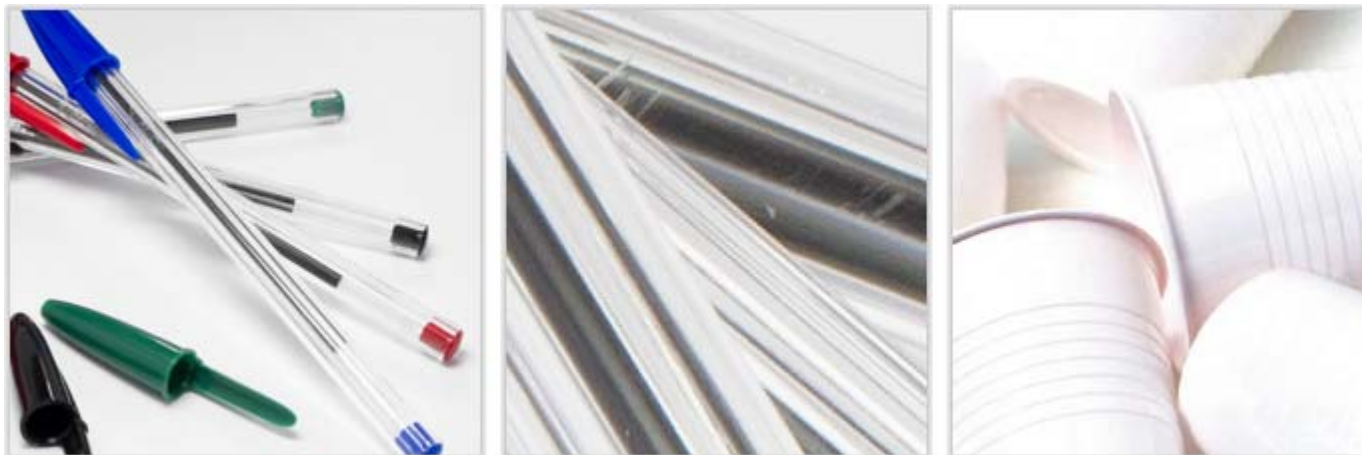


Description

Image



Caption

1. Transparent polystyrene pens. © Carlos Delgado, Kadellar at en.wikipedia - (CC BY-SA 3.0) 2. Close-up of scratches on the material. © Carlos Delgado, Kadellar at en.wikipedia - (CC BY-SA 3.0) 3. Plastic cups. © Chris Lefteri

The material

Polystyrene is an optically clear, cheap, easily molded polymer, familiar as the standard "jewel" CD case. In its simplest form PS is brittle. Its mechanical properties are dramatically improved by blending with polybutadiene, but with a loss of optical transparency. High impact PS (10% polybutadiene) is much stronger even at low temperatures (meaning strength down to -12C). The single largest use of PS is a foam packaging.

Compositional summary

$(\text{CH}(\text{C}_6\text{H}_5)-\text{CH}_2)_n$

General properties

Density	64.9	-	65.5	lb/ft ³
Price	* 0.862	-	1.22	USD/lb
Date first used	1937			

Mechanical properties

Young's modulus	0.174	-	0.377	10 ⁶ psi
Shear modulus	0.0725	-	0.131	10 ⁶ psi
Bulk modulus	0.421	-	0.45	10 ⁶ psi
Poisson's ratio	0.383	-	0.403	
Yield strength (elastic limit)	4.17	-	8.15	ksi
Tensile strength	5.21	-	8.19	ksi
Compressive strength	4.58	-	8.97	ksi
Elongation	1.2	-	3.6	% strain
Hardness - Vickers	8.6	-	16.9	HV
Fatigue strength at 10 ⁷ cycles	2.08	-	3.34	ksi

Fracture toughness	0.637	-	1	ksi.in ^{0.5}
Mechanical loss coefficient (tan delta)	0.012	-	0.0175	

Thermal properties

Glass temperature	165	-	230	°F
Maximum service temperature	170	-	217	°F
Minimum service temperature	-190	-	-99.7	°F
Thermal conductor or insulator?	Good insulator			
Thermal conductivity	0.0699	-	0.0757	BTU.ft/h.ft ² .F
Specific heat capacity	0.404	-	0.42	BTU/lb.°F
Thermal expansion coefficient	50	-	85	µstrain/°F

Electrical properties

Electrical conductor or insulator?	Good insulator			
Electrical resistivity	1e25	-	1e27	µohm.cm
Dielectric constant (relative permittivity)	3	-	3.2	
Dissipation factor (dielectric loss tangent)	0.001	-	0.003	
Dielectric strength (dielectric breakdown)	500	-	574	V/mil

Optical properties

Transparency	Optical Quality			
Refractive index	1.57	-	1.59	

Processability

Castability	1	-	2	
Moldability	4	-	5	
Machinability	3	-	4	
Weldability	5			

Eco properties

Embodied energy, primary production	* 9.98e3	-	1.11e4	kcal/lb
CO2 footprint, primary production	* 3.61	-	3.99	lb/lb
Recycle	✓			

Recycle mark



Supporting information

Design guidelines

PS comes in 3 guises: as the simple material ('general purpose PS'); as the high impact variant, blended with polybutadiene; and as polystyrene foam, the most familiar and cheapest of all polymer foams. All are FDA approved for use as food containers and packaging. General purpose PS is easy to mold. Its extreme clarity, ability to be colored, and high refractive index give it a glass-like sparkle, but it is brittle and cracks easily (think of CD cases). It is used when the optical attractiveness and the low cost are sought, and the mechanical loading is light: cosmetic compacts, transparent but disposable glasses, cassettes of all kinds. Medium and high impact polystyrenes trade their optical for their mechanical properties. Medium impact PS, translucent, appears in electrical switch gears and circuit breakers, coat hangers and combs. High impact PS - a blend of PPO and PS, is opaque, but is tough and copes better with low temperatures than most plastics; it is found in interiors of refrigerators and freezers, and in food trays such as those for margarine and yogurt. Other styrene blends, like Kraton, have low tensile strength and higher elongation than SBR or natural rubber. PS can be foamed to a very low density (roughly 1/3 of all polystyrene in foamed). These foams have low thermal conduction and are cheap, and so are used for house insulation, jackets for water boilers, insulation for disposable cups. They crush at loads that do not cause injury to delicate objects (such as TV sets or to the human body), making them good for packaging.

Technical notes

Polystyrene, PS, is - like PE and PP - a member of the polyolefin family of moldable thermoplastics. In place of one of the H-atoms of the polyethylene it has a C₆H₅ - benzene ring. This makes for a lumpy molecule which does not crystallize, and the resulting material is transparent with a high refractive index. The benzene ring absorbs UV light, exploited in the PS screening of fluorescent lights, but also causing the polymer to discolor in sunlight. All grades of PS have excellent electrical resistance and dielectric strength, exploited in switchgear.

Typical uses

Toys; light diffusers; lenses and mirrors; beakers; cutlery; general household appliances; video/audio cassette cases; electronic housings; refrigerator liners.

Tradenames

Aim, Bapolan, Comalloy, Dylite, Lastirol, NSC, Polystyrol, Styron, Styropor, Vestyron

Links

Reference

ProcessUniverse

Producers