Ethylene vinyl acetate (EVA)

Description

Image

Caption

1. Slippers. © Zhangzhou Yongxin Trade Co. 2. Running shoes. © Adidas

The material

Ethylene-Vinyl-Acetate elastomers (EVA) are built around polyethylene. They are soft, flexible and tough, and retain these properties down to -60 C. Fillers improve both hardness and stiffness, but with some degradation of other properties. EVAs blend well with PE because of their chemical similarity. EVA is available in pastel or deep hues; it has good clarity and gloss. It has good barrier properties, little or no odor, is UV resistance and FDA-approval for direct food contact. The toughness and flexibility is retained even at low temperatures and it has good stress-crack resistance and good chemical resistance. EVA can be processed by most normal thermoplastic processes: co-extrusion for films, blow molding, rotational molding, injection molding and transfer molding.

Compositional summary

(CH2)n-(CH2-CHR)m

General properties

Density	59	-	59.6	lb/ft^3
Price	* 1.04	-	1.15	USD/lb
Date first used	1972			

Mechanical properties

Young's modulus	0.00145	-	0.0058	10^6 psi
Shear modulus	0.00116	-	0.00145	10^6 psi
Bulk modulus	* 0.189	-	0.203	10^6 psi
Poisson's ratio	* 0.47	-	0.49	
Yield strength (elastic limit)	1.74	-	2.61	ksi
Tensile strength	2.32	-	2.9	ksi
Compressive strength	1.91	-	2.87	ksi
Elongation	730	-	770	% strain
Fatigue strength at 10^7 cycles	* 1.74	-	1.86	ksi

Fracture toughness	* 0.455	-	0.637	ksi.in^0.5
Mechanical loss coefficient (tan delta)	* 0.34	-	0.83	

Thermal properties

Glass temperature	* -99.7	-	-9.67	°F
Maximum service temperature	116	-	125	°F
Minimum service temperature	* -190	-	-99.7	°F
Thermal conductor or insulator?	Good insulator			
Thermal conductivity	0.173	-	0.231	BTU.ft/h.ft^2.F
Specific heat capacity	* 0.478	-	0.525	BTU/lb.°F
Thermal expansion coefficient	88.9	-	106	µstrain/°F

Electrical properties

Electrical conductor or insulator?	Good insulator			
Electrical resistivity	* 3.16e21	-	1e22	µohm.cm
Dielectric constant (relative permittivity)	2.9	-	2.95	
Dissipation factor (dielectric loss tangent)	0.005	-	0.022	
Dielectric strength (dielectric breakdown)	673	-	686	V/mil

Optical properties

Transparency	Translucent			
Refractive index	1.48	-	1.49	

Processability

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

Durability: water and aqueous solutions

Water (fresh)	Acceptable
Water (salt)	Acceptable
Soils, acidic (peat)	Unacceptable
Soils, alkaline (clay)	Excellent
Wine	Excellent

Durability: acids

Acetic acid (10%)	Unacceptable
Acetic acid (glacial)	Unacceptable
Citric acid (10%)	Acceptable
Hydrochloric acid (10%)	Unacceptable
Hydrochloric acid (36%)	

	Unacceptable
Hydrofluoric acid (40%)	Unacceptable
Nitric acid (10%)	Unacceptable
Nitric acid (70%)	Unacceptable
Phosphoric acid (10%)	Excellent
Phosphoric acid (85%)	Excellent
Sulfuric acid (10%)	Unacceptable
Sulfuric acid (70%)	Unacceptable

Durability: alkalis

Sodium hydroxide (10%)	Excellent
Sodium hydroxide (60%)	Limited use

Durability: fuels, oils and solvents

Amyl acetate	Unacceptable
Benzene	Unacceptable
Carbon tetrachloride	Unacceptable
Chloroform	Unacceptable
Crude oil	Unacceptable
Diesel oil	Acceptable
Lubricating oil	Excellent
Paraffin oil (kerosene)	Acceptable
Petrol (gasoline)	Limited use
Silicone fluids	Excellent
Toluene	Unacceptable
Turpentine	Excellent
Vegetable oils (general)	Unacceptable
White spirit	Unacceptable

Durability: alcohols, aldehydes, ketones

Acetaldehyde	Limited use
Acetone	Unacceptable
Ethyl alcohol (ethanol)	Unacceptable
Ethylene glycol	Excellent
Formaldehyde (40%)	Acceptable
Glycerol	Acceptable
Methyl alcohol (methanol)	Unacceptable

Durability: halogens and gases

Chlorine gas (dry)	Unacceptable
Fluorine (gas)	Unacceptable

O2 (oxygen gas)	Unacceptable
Sulfur dioxide (gas)	Acceptable

Durability: built environments

Industrial atmosphere	Excellent
Rural atmosphere	Excellent
Marine atmosphere	Excellent
UV radiation (sunlight)	Fair

Durability: flammability

Flammability	Highly flammable

Durability: thermal environments

Tolerance to cryogenic temperatures	Unacceptable
Tolerance up to 150 C (302 F)	Acceptable
Tolerance up to 250 C (482 F)	Unacceptable
Tolerance up to 450 C (842 F)	Unacceptable
Tolerance up to 850 C (1562 F)	Unacceptable
Tolerance above 850 C (1562 F)	Unacceptable

Primary material production: energy, CO2 and water

Embodied energy, primary production	* 8.13e3	-	8.97e3	kcal/lb
CO2 footprint, primary production	* 2	-	2.21	lb/lb
Water usage	* 0.319	-	0.352	gal(US)/lb
Eco-indicator 99	268			millipoints/kg

Material processing: energy

Polymer extrusion energy	* 632	-	696	kcal/lb
Polymer molding energy	* 1.6e3	-	1.78e3	kcal/lb
Coarse machining energy (per unit wt removed)	* 78	-	86.2	kcal/lb
Fine machining energy (per unit wt removed)	* 316	-	350	kcal/lb
Grinding energy (per unit wt removed)	* 582	-	644	kcal/lb

Material processing: CO2 footprint

Polymer extrusion CO2	* 0.466	-	0.514	lb/lb
Polymer molding CO2	* 1.19	-	1.31	lb/lb
Coarse machining CO2 (per unit wt removed)	* 0.054	-	0.0597	lb/lb
Fine machining CO2 (per unit wt removed)	* 0.219	-	0.242	lb/lb
Grinding CO2 (per unit wt removed)	* 0.403	-	0.445	lb/lb

Material recycling: energy, CO2 and recycle fraction

Recycle	✖

Embodied energy, recycling	* 4.84e3	-	5.36e3	kcal/lb
CO2 footprint, recycling	* 3.52	-	3.89	lb/lb
Recycle fraction in current supply	0.1			%
Downcycle	✓			
Combust for energy recovery	✓			
Heat of combustion (net)	* 4.25e3	-	4.47e3	kcal/lb
Combustion CO2	* 2.82	-	2.97	lb/lb
Landfill	✓			
Biodegrade	✗			
Toxicity rating	Non-toxic			
A renewable resource?	✗			

Supporting information

Design guidelines

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Typical uses

Medical tubes, milk packaging, beer dispensing equipment, bags, shrink film, deep freeze bags, co-extruded and laminated film, closures, ice trays, gaskets, gloves, cable insulation, inflatable parts, running shoes.

Links

Reference

ProcessUniverse

Producers