

## 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

$(CH_2)_n-(CH_2-CHR)_m$

## General properties

Density	945	-	955	kg/m <sup>3</sup>
Price	* 2.3	-	2.53	USD/kg
Date first used	1972			

## Mechanical properties

Young's modulus	0.01	-	0.04	GPa
Shear modulus	0.008	-	0.01	GPa
Bulk modulus	* 1.3	-	1.4	GPa
Poisson's ratio	* 0.47	-	0.49	
Yield strength (elastic limit)	12	-	18	MPa
Tensile strength	16	-	20	MPa
Compressive strength	13.2	-	19.8	MPa
Elongation	730	-	770	% strain
Fatigue strength at 10 <sup>7</sup> cycles	* 12	-	12.8	MPa

Fracture toughness	* 0.5	-	0.7	MPa.m <sup>0.5</sup>
Mechanical loss coefficient (tan delta)	* 0.34	-	0.83	

### Thermal properties

Glass temperature	* -73.2	-	-23.2	°C
Maximum service temperature	46.9	-	51.9	°C
Minimum service temperature	* -123	-	-73.2	°C
Thermal conductor or insulator?	Good insulator			
Thermal conductivity	0.3	-	0.4	W/m.°C
Specific heat capacity	* 2e3	-	2.2e3	J/kg.°C
Thermal expansion coefficient	160	-	190	µstrain/°C

### 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)	26.5	-	27	1000000 V/m

### 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	* 75	-	82.8	MJ/kg
CO2 footprint, primary production	* 2	-	2.21	kg/kg
Water usage	* 2.66	-	2.94	l/kg
Eco-indicator 99	268			millipoints/kg

### **Material processing: energy**

Polymer extrusion energy	* 5.83	-	6.42	MJ/kg
Polymer molding energy	* 14.8	-	16.4	MJ/kg
Coarse machining energy (per unit wt removed)	* 0.72	-	0.796	MJ/kg
Fine machining energy (per unit wt removed)	* 2.92	-	3.23	MJ/kg
Grinding energy (per unit wt removed)	* 5.37	-	5.94	MJ/kg

### **Material processing: CO2 footprint**

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

### **Material recycling: energy, CO2 and recycle fraction**

Recycle	✗
---------	---

Embodied energy, recycling	* 44.7	-	49.5	MJ/kg
CO2 footprint, recycling	* 3.52	-	3.89	kg/kg
Recycle fraction in current supply	0.1			%
Downcycle	✓			
Combust for energy recovery	✓			
Heat of combustion (net)	* 39.2	-	41.2	MJ/kg
Combustion CO2	* 2.82	-	2.97	kg/kg
Landfill	✓			
Biodegrade	✗			
Toxicity rating	Non-toxic			
A renewable resource?	✗			

## Supporting information

### Design guidelines

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.

### 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