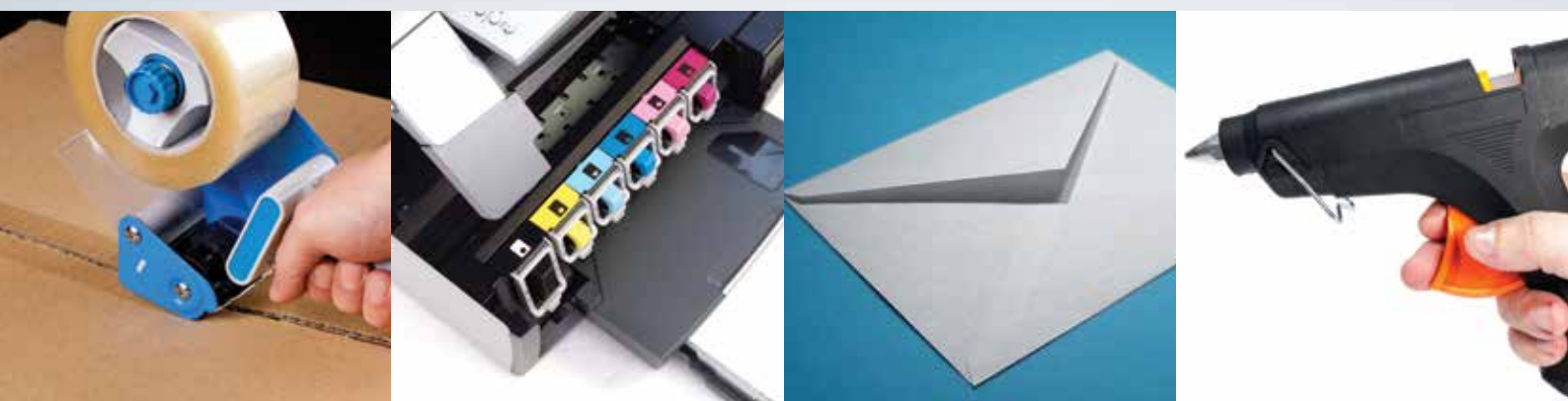


PVP/VA

Polyvinylpyrrolidone/Vinyl Acetate copolymers



Intermediates

Solvents

Monomers

Polymers

Specialty Chemicals



ASHLAND

With good chemistry great things happen.™

Film formers for aerosol, aqueous and organic solvent systems

Ashland offers formulators a series of vinylpyrrolidone/vinyl acetate copolymers. Members of the PVP/VA copolymer series serve as primary film formers in a variety of products demanding different degrees of water resistance. These copolymers feature specific affinity for hair, skin and smooth surfaces such as wood, glass, paper, and metal, yet do not require solvents for removal.

The advantages of using PVP/VA copolymers as film formers are:

- film flexibility
- good adhesion
- water remoistenability
- hardness

These properties make PVP/VA copolymers suitable for a variety of industrial, personal care, and pharmaceutical products. The major industrial applications are in hot melt adhesives, photoresist binders and coatings for inkjet media paper, plastic film and other substrates.

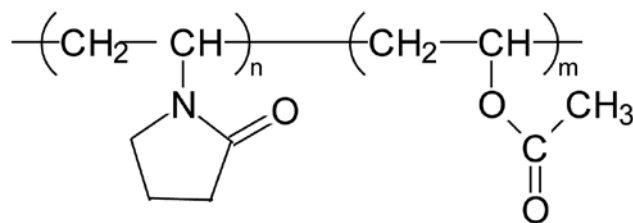
The PVP/VA product line consists of thermoplastic copolymers with the following Tg properties as a function of vinylpyrrolidone (VP) content:

Wt% VP	Tg, °C
70	109
60	105
50	73
30	55



PVP/VA (Poly(Vinyl Pyrrolidone/Vinyl Acetate) Property Chart

- Linear, random copolymers
- Increasing vinyl acetate content - increasing hydrophobicity, decreasing hygroscopicity, decreasing Tg
- Hydrophilic, transparent, flexible thermoplastic, oxygen permeable films which adhere to glass, plastics and metals
- Soluble in alcohols, esters, and ketones, insoluble in ethers and aliphatic hydrocarbons. Soluble in water when VP content greater than 50%
- Adhesive and cohesive properties
- E = ethanol (EtOH), I = isopropanol, W = water, S = solid



Property	E-335	E-535	E-635	E-735	I-335	I-535	I-735	W-635	W-735	S-630
Appearance	Clear viscous liquid	Clear viscous liquid	Clear viscous liquid	Clear viscous liquid	Clear viscous liquid	Clear viscous liquid	Clear viscous liquid	Aqueous Viscous Liquid	Aqueous Viscous Liquid	White Powder
VP/VA ratio	30 / 70	50 / 50	60 / 40	70 / 30	35 / 65	50 / 50	70 / 30	60 / 40	70 / 30	60 / 40
Color (APHA) - as is	60 max.	100 max.	100 max.	150 max.	40 max.	60 max.	80 max.	20 max. ^a	80 max. ^a	60 max. ^b
K-Value (1% in EtOH)	25 - 35	30 - 50	30 - 45	35 - 50	20 - 30	25 - 35	28 - 36	26 - 34	25 - 34	30 - 50
% Moisture	0.5 max.	0.5 max.	0.5 max.	0.5 max.	0.5 max.	0.5 max.	0.5 max.	48 - 52	48 - 52	5 max.
% Solids	48 - 52	48 - 52	48 - 52	48 - 52	48 - 52	48 - 52	48 - 52	48 - 52	48 - 52	95 - 100
% Nitrogen	3.5 - 4.5	5.8 - 6.8	7.0 - 8.0	7.5 - 9.4	3.9 - 4.9	6.0 - 6.9	8.0 - 8.9	7.0 - 8.0	8.0 - 9.0	7.5 - 8.5
% Ash	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.3	< 0.3	< 0.01
M _w (PEO standards)	28,800	36,700	38,200	56,700	12,700	19,500	22,300	51,000	27,300	51,000
Polydispersity (M _w /M _n)	5.05	6.0	-----	6.8	3.5	4.7	4.9	2.4	-----	4.7
Intrinsic Viscosity [η] @ 25°C (dl/g)	0.265	0.363	0.330	0.429	0.176	0.222	0.261	---	0.265	0.424
Brookfield Viscosity, cps ^c	2000	3000	3600	11400	1000	2800	5600	1800	2600	670 ^d
Specific Gravity @ 25°C	0.945 - 0.965				0.945 - 0.965			1.113	1.110	1.081
Tg (°C)	69	96	106	117	71	89	108	99	114	110
Cloud Point (°C, 5% aq.)	< 0°C ^e	< 0°C ^e	12	58	12	10	19	68	66	16.1
Film Pencil Hardness	4H	4H	no data	3H	H	4H	3H	no data	no data	no data
Film Adhesivity ^f	85.2	51.8	no data	54.0	94.8	70.4	117.2	no data	no data	no data
Saponification Number (mg KOH/g) - as is	204	151	126	95	201	160	112	131	92	241

^a 10% Solids ^b 5% solids in EtOH ^c DV-II, Spindle RV #7, 20 rpm, 22-23°C ^d 38% solids @ 30°C in H₂O ^e Cloudy to 0°C ^f IMASS Slip/Peel Tester - Force (g) to Separate Parafilm
 NOTE: These data are typical of current production, but are not necessarily specifications.

The PVP/VA E and I copolymer Series

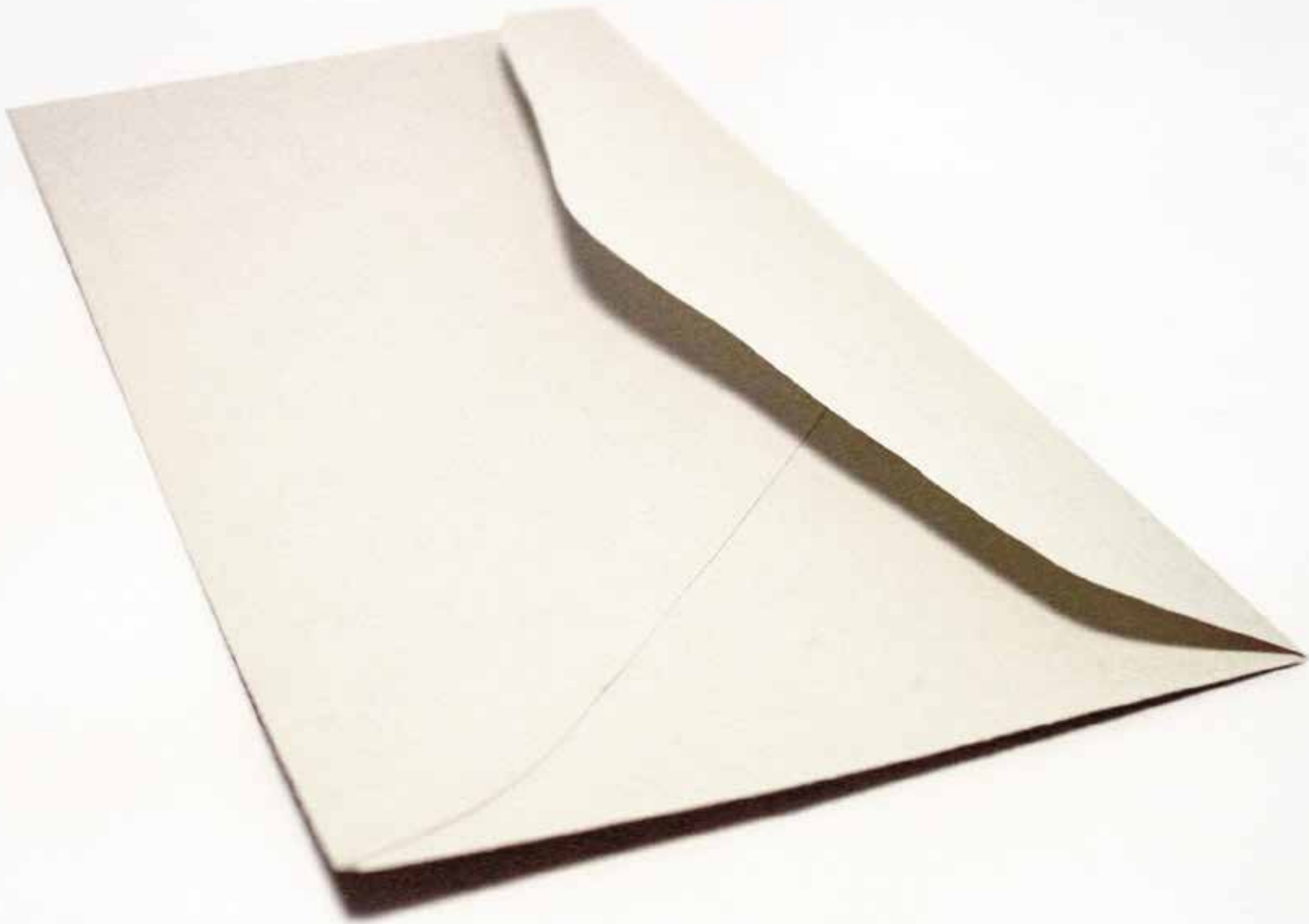
To fit many application areas, the E and I series of PVP/VA copolymers are available as 50% solutions in ethanol and in isopropanol², respectively. There are four distinct copolymers in the E group: E-335, E-535, E-635, E-735, and three in the I group: I-335, I-535, I-735. Each differs in monomer ratio and, therefore, in properties - water sensitivity, viscosity, softening point, etc. This affords formulators considerable flexibility in creating new products for specific applications. The transparent films formed by all of these copolymers are characterized by adhesion, luster, hardness and water rewettability. Good compatibility with many modifiers and plasticizers permits wide freedom in formulation and broadens the range of hygroscopicity, film flexibility, and abrasion resistance. Unmodified copolymers having the lower ratios of vinylpyrrolidone to vinyl acetate exhibit more moisture resistance than products with high ratios.

The PVP/VA S copolymer

PVP/VA S-630 copolymer, a white, odorless powder, is also available at a 60/40 VP/VA weight ratio. It is a high molecular weight, solvent and water soluble copolymer exhibiting a minimum critical solution temperature of approximately 70°C. Films cast from solutions are glossy, translucent and rewettable by water.

The PVP/VA W copolymers S

PVP/VA W-735 copolymer is a 70/30 copolymer of PVP and vinyl acetate supplied as a 50% solution in water. PVP/VA W-635 copolymer is a 60/40 copolymer also supplied as a 50% aqueous solution.



²No alcohol permit from the U.S. Treasury Department is necessary for the use of the I-series.

Compatibility

SOLVENTS: The PVP/VA E and I series of copolymers are soluble in a number of polar and nonpolar solvents, as illustrated below:

Solubility in Organic Solvents

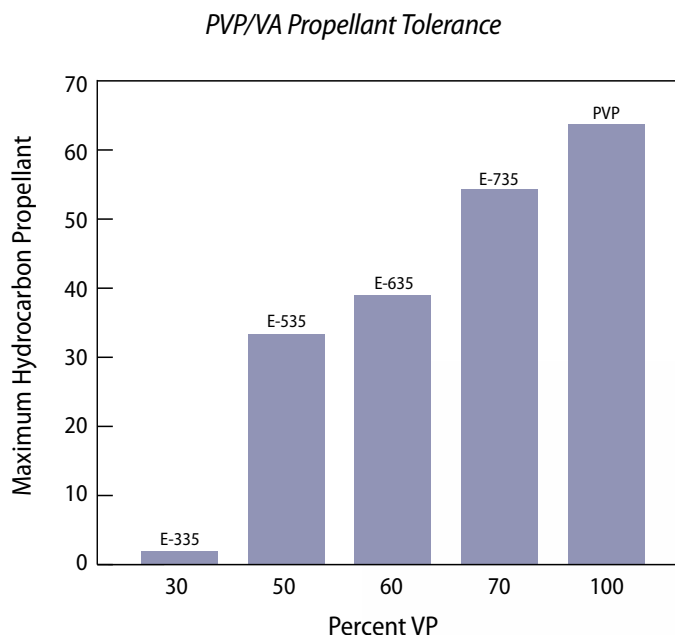
		PVP/VA E- or I-Series (10% solids content**)
Alcohols	Methanol	S
	Ethanol	S
	Isopropanol	S
	sec. Butanol	S
	Benzyl alcohol	S
	1,4 Butanediol	S
	Propylene glycol	S
	Glycerine	-
Ether Alcohols	Diethylene glycol	S
	Butyl Cellosolve* (Dow)	S
	Methyl Cellosolve* (Dow)	-
	Methyl Carbitol* (Dow)	-
Ketone Alcohol	Diacetone alcohol	S
Ethers	Dioxane	S
	Tetrahydrofuran	S
Ketones	Acetone	S
	Methyl isobutyl ketone	S
Lactone	Butyrolactone	S
Amine	Triethanolamine	S
Esters	Ethyl Acetate (95%-98%)	S
	sec. Butyl acetate	S
	Methyl Cellusolve* acetate (Dow)	S
Chlorinated Hydrocarbons	Carbon tetrachloride	S
	Methylene chloride	S
	Tetrachloroethylene	S
	1.1.1 - Trichlorethane	-
Aromatic Hydrocarbons	Benzene	S
	Toluene	S
	Xylene	S
Nitroparaffin	Nitroethane	S
Lactams	Methylpyrrolidone	S
	2-Pyrrolidone	S

**Mixtures of 20 parts copolymer with 80 parts solvent (I.E., 10% solids content)

s =soluble

VA (vinyl acetate) is a more hydrophobic molecule than VP (vinylpyrrolidone). Thus increasing VA content of the copolymer causes an increase in hydrophobicity and consequently a decrease in water solubility and hygroscopicity relative to the VP homopolymer.

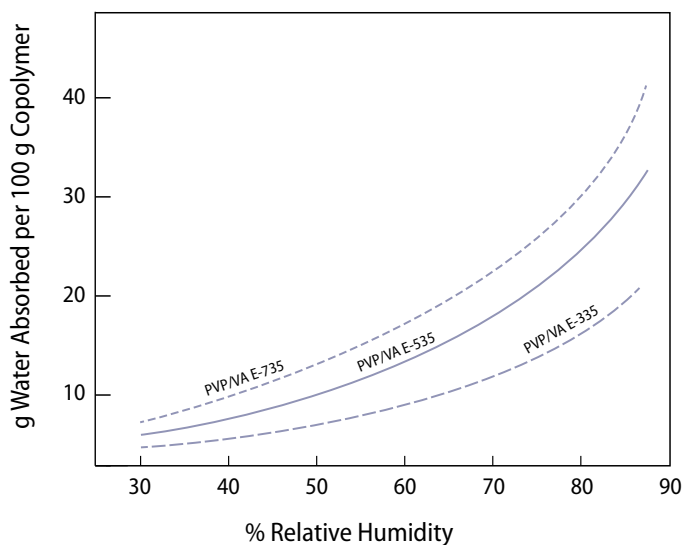
Propellents: PVP/VA copolymers are compatible with most of the common hydrocarbon propellants used in spray formulations. The propellant tolerance of PVP/VA E copolymers is reflected in the following bar graph:



Plasticizers and Polymers: Most PVP/VA copolymers are compatible with a variety of nonionic and cationic polymers. Compatibility with anionic copolymers can be achieved through neutralization prior to mixing.

Hygroscopicity of Films: The inherent water sensitivity of PVP/VA copolymer films varies with the monomer ratio. Typical data are shown below for PVP/VA E-735 copolymer, PVP/VA E-535 copolymer and PVP/VA E-335 copolymer. In general, PVP/VA copolymer is less hygroscopic than PVP.

*Relative Hygroscopicity (at equilibrium)
of PVP/VA copolymer Films*



Air Permeability: PVP/VA copolymer films are permeable to air and oxygen, an advantage in many applications, e.g., spray bandages and protective coatings for plants.



PVP/VA applications and markets

PVP/VA copolymers are widely used for their excellent film forming properties in the following applications and markets:

- Coatings on paper, film, other substrates
- Water remoistenable adhesives
- Water soluble adhesives
- Decorative and protective coatings
- Photoresist/solder mask binders
- Bioadhesives
- Protective masks

In hot melt adhesives, PVP/VA copolymers are used in a variety of water remoistenable or water removable adhesives as listed below. Here they offer the formulators performance advantages in film flexibility, adhesiveness and water remoistenability.

Water Remoistenable Adhesives

	<u>PVP/VA copolymer type</u>
• Solvent based formulations	E and I Series
• Hot Melt	S-630
• Hot Melt, pressure sensitive, repulpable	S-630

Water Soluble Adhesives

• Label adhesive for beverage bottles	S-630, E and I Series
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PVP/VA copolymers are also used in coatings for ink-jet media including paper, plastic films and other substrates to enhance dye receptivity. PVP/VA S-630 copolymer is used as a binder to allow the aqueous processing of photoresists.

Storage and handling

PVP/VA copolymers are stable for at least one year under normal conditions of storage but strict precautions should be taken to avoid moisture pickup. The E and I series have flash points in the range of 50-55°F (10-13°C) and are classified as flammable (DOT Flammable) materials. For safety reasons and to prevent moisture pickup due to drum breathing with changes in temperature, store in a dry place below 100°F (38°C) and repack or use in explosion- proof facilities.



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