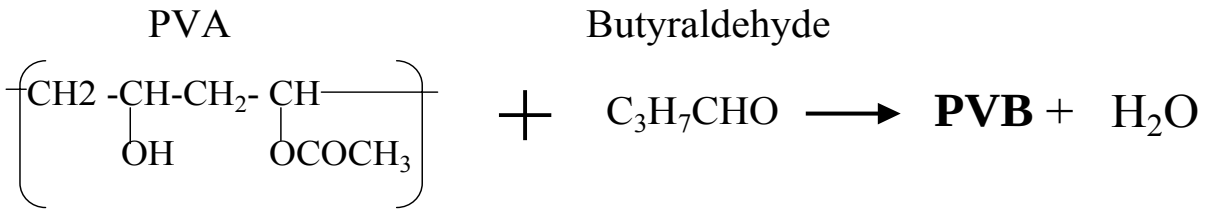
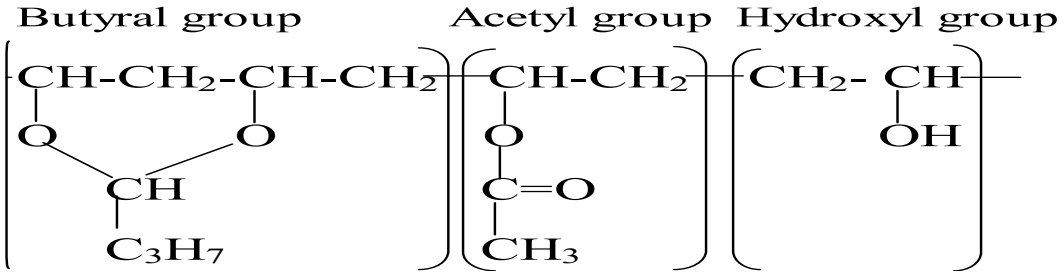
Introduction

CCP Polyvinyl Butyral resin, known as PVB, is a thermoplastic resin, which is soluble in most organic solvents. PVB has been extensively used in the applications of wash primers, metal coating, paints, adhesives, toner, printing ink and ceramic binders. CCP PVB is manufactured from the condensation reaction of PVA and n-butyraldehyde, refer to the formula shown below.



In the structure of PVB resin, there are three functional groups: butyral, hydroxyl and acetyl group. The physical properties of PVB resin can be adjusted by controlling the molecular structure of PVB. The molecular structure of PVB is shown below.



These three functional groups make PVB a resin with many distinguished features and excellent properties in numerous applications. The relationship of molecular weight, functional groups and its physical and chemical properties are summarized as follows.

Table 1. Molecular Weight, Functional Groups and Physical / Chemical Properties

Item	Physical or chemical properties
Degree of polymerization	Film toughness, Softening point, Adhesiveness, Solution viscosity
Acetyl group content (residual acetate group)	Tg, glass transition temperature, Solution viscosity
Butyral group content	Flexibility, Compatibility with other resins, Water resistance, Solubility in non-polar solvents
Hydroxyl group (OH group) content	Adhesiveness, Reaction with thermosetting resins Solubility in polar solvents

Physical properties of PVB resin are listed in table as follows.

Table 2. Physical Properties of PVB

Item	Property
Appearance	White granular or powder
Specific gravity	1.1
Bulk density	0.25~0.35 for powder grade; 0.4~0.5 for granular grade
Glass transition temperature	50~95℃

The combination of properties makes PVB unique in many applications. Some of these that are important in industrial applications are:

- PVB resin has a strong adhesion to glass, metal, plastic, leather and wood.
- PVB resin is an excellent film-former, and the film is remarkable tough and flexible.
- PVB resin is odorless and non-toxic to human and animals.
- The thermal and mechanical properties vary with the degree of polymerization.
- PVB is reactive with many kinds of resin to form cross-linking, such as phenolic resin, epoxy resin, urethane resin, urea resin and melamine resin.
- PVB resin can be blended with nitrocellulose and ketone resin to increase its hardness.
- The thermoforming and coating characteristics of PVB are excellent. And combining with plasticizers and other resins can modify them.
- PVB is compatible with phthalate ester, phosphate ester, fatty ester, glycol derivatives and many other plasticizers.

CCP has developed a number of grades of PVB, differ with their molecular weight and molecular structure to meet the demands of customers. If customers need special grade, we would be delighted to develop new grade for them.

Information contained in this booklet is based on our knowledge. Recommendation and statement are for information purpose only, and are presented without guarantee and responsibility on our parts. They are not intended as a recommendation for any use, which would violate any patent rights.

Grades and Specifications

Grade	Butyral wt%	Hydroxyl wt%	Acetyl wt%	Viscosity cps	Free Acid wt%	Volatile wt%
Grades for Wash Primer, Paint, Ceramic Binder, Coating, Adhesive						
B17HX	75~82	18~22	<3	60~100[1]	<0.05	<3
B08HX	76~82	18~21	< 3	110~180[2]	< 0.05	< 3
B06HX	76~82	18~21	<3	70~100[2]	<0.05	< 3
B05HX	76~82	18~21	<3	40~70[2]	<0.05	< 3
B08SY	81~86	11~14	<5	100~160[2]	<0.05	< 3
B06SY	81~86	11~14	<5	30~80[2]	<0.05	< 3
B05SY	81~86	11~14	<5	10~30[2]	<0.05	< 3
Grades for Copper Foil and Printed Circuit Board						
B12TX	-----	14~18	< 2	150~220[3]	< 0.05	< 3
B11TX	-----	14~18	< 2	100~150[3]	< 0.05	< 3
B10TX	-----	14~18	< 2	60~100[3]	< 0.05	< 3
Grade for Film of Safety Glass						
B1776	-----	18.5~20.5	< 2	60~150[1]	< 0.05	< 3
Grade for Printing Ink						
B03HX	76~82	18~21	< 3	10~30[2]	< 0.05	< 3

Remark: Measurement of Viscosity

[1]Solution Viscosity was determined in 5% by weight in 95% ethanol, at 20℃, using Brookfield viscometer.

[2]Solution Viscosity was determined in 10% by weight in at 20℃, toluene/ethanol 1/1, using Brookfield viscometer.

[3]Solution Viscosity was determined in 5% by weight in toluene/ethanol 1/1, at 20℃, using Brookfield viscometer.

P.S. Should customer need special grades, which are not listed, CCP will be delighted to discuss with them.

Solubility of CCP PVB

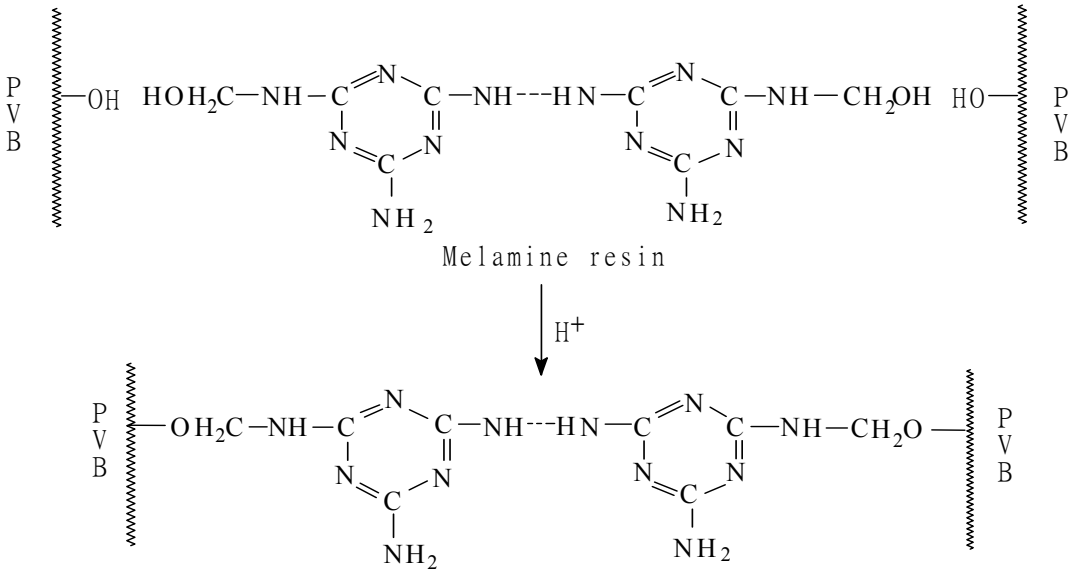
PVB resin is soluble in most organic solvents. The viscosity of PVB solution depends on the concentration of resin, temperature of solution and the solvents employed. PVB resin is most soluble in a mixed solvent system such as ethanol/ toluene, methanol/ methyl ethyl ketone, etc.

Solvent		**B17HX**	**B08HX**	**B05HX B06HX**	**B03HG B03HX**	**B08SY B06SY B05SY**	**B10TX B11TX B12TX**
Alcohol	**Methanol**	S	S	S	S	S	S
	Ethanol	S	S	S	S	S	S
	N-Propanol	S	S	S	S	S	S
	I-Propanol	S	S	S	S	S	PS
	N-Butanol	S	S	S	S	S	S
	N-Octanol	S	S	S	S	S	S
	Ethylene glycol	S	S	S	S	S	S
Ketone	**Acetone**	I	PS	S	S	S	S
	Methyl ethyl ketone	S	S	S	S	S	S
	Methyl isobutyl ketone	PS	PS	PS	PS	PS	I
	Cyclohexanone	S	S	S	S	S	S
Ester	**Methyl acetate**	PS	PS	PS	PS	S	PS
	Ethyl acetate	PS	PS	PS	PS	S	PS
	Isopropyl acetate	I	I	I	I	S	I
	N-Butyl acetate	PS	PS	PS	PS	S	PS
Ether	**Ethyl ether**	I	I	I	I	I	I
	Dioxane	S	S	S	S	S	S
	Tetrahydrofuran	S	S	S	S	S	S
Cellosolve	**Methyl cellosolve**	S	S	S	S	S	S
	Ethyl cellosolve	S	S	S	S	S	S
	Butyl cellosolve	S	S	S	S	S	S
Hydrocarbons	**Aliphatic**	I	I	I	I	I	I
	Aromatic	I	I	I	I	S	I

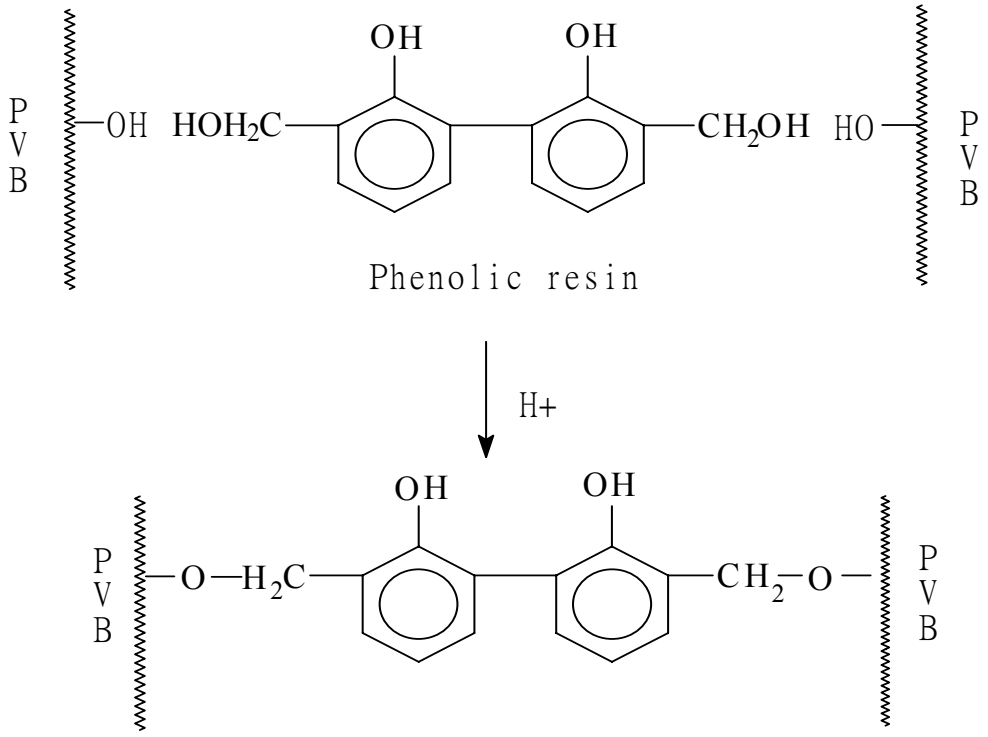
Remark: S: soluble; PS: partly soluble ; I: insoluble.

Chemical Properties of CCP PVB

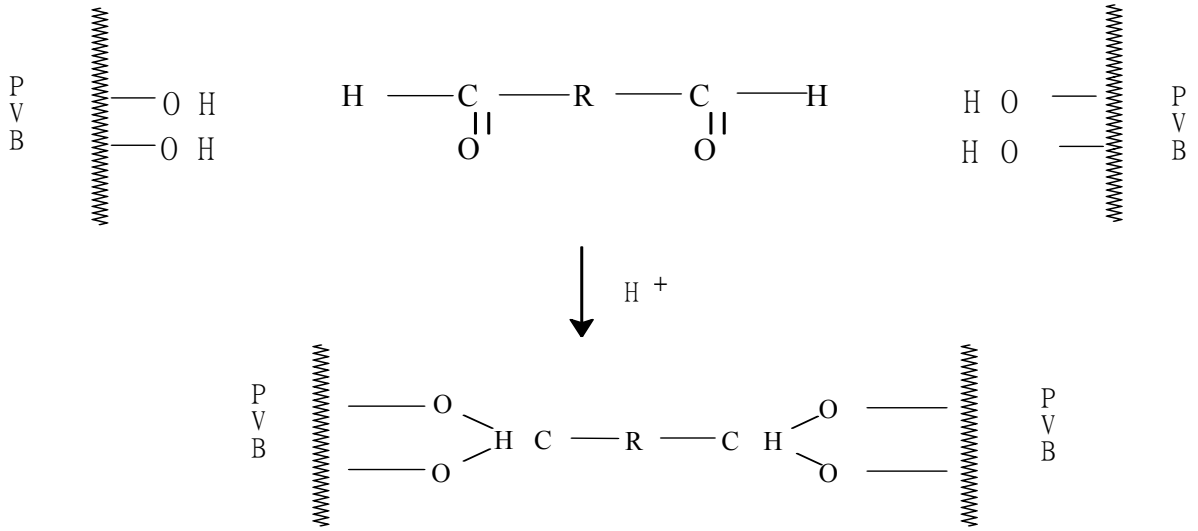
- Reaction with melamine



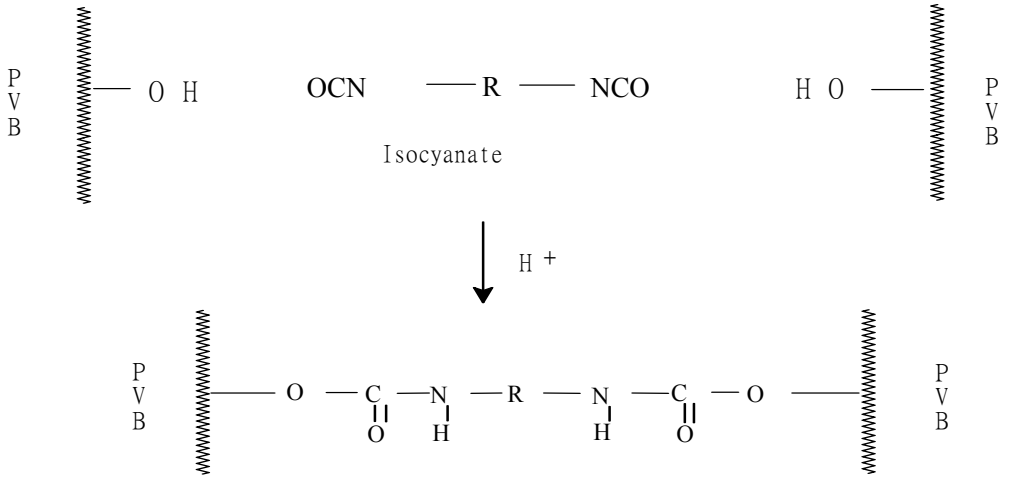
- Reaction with phenolic



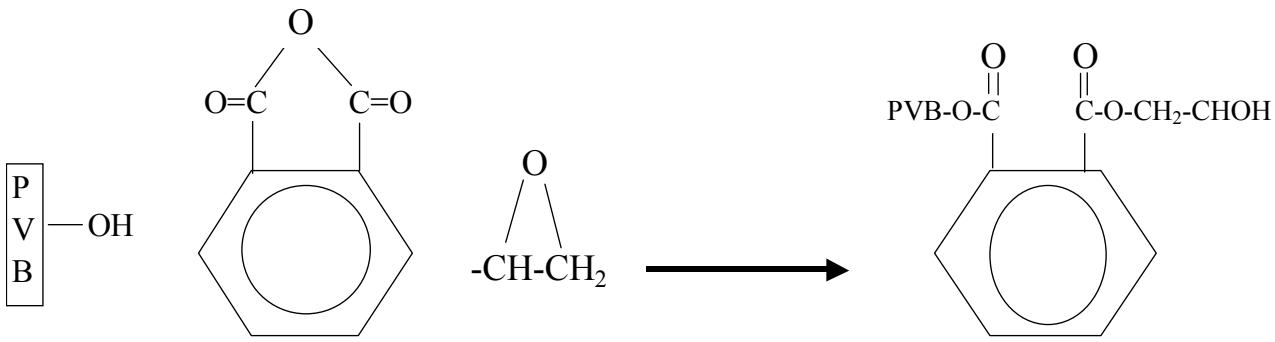
- Reaction with di-aldehyde



- Reaction with isocyanates



- Reaction with Epoxy (Cure with anhydride)



PVB Anhydride Epoxy

Applications of CCP PVB

Typical applications of CCP PVB are:

- Wash Primer
- Foil Coating
- Wood Paint
- Leather Paint
- Stoving Paint
- Powdery Paint
- Adhesive
- Printing Ink
- Ceramic Binder
- Transfer Paper
- Textile Coating
- Printed-Circuit Board Adhesive

● Wash primer

The best-known PVB resin application for metal paints is "wash primer". It is widely used on a variety of metal structures, such as storage tank, ship, airplane, bridge, dam lock, electronic appliances and etc. Wash primer is more effective than other corrosion inhibiting materials. They offer several means of corrosion prevention in a single treatment. These anticorrosive primers apply easier, adhere better and dry faster than conventional materials. The good anchoring of the wash primer to metal is brought by a synthetic resin/ pigment/ phosphoric acid/ metal complex. Both B05HX and B08HX are suitable for this application. High solid content, low viscosity solutions can be produced with B05HX. B08HX, on the other hand, has a higher degree of polymerization than B05HX. Hence, solutions viscosity of B08HX is higher than that of B05HX. These films have low water absorption and good weather resistance.

● One-Pack Primers

In the content of one-pack primer, there is less amount of phosphoric acid. Then it can be kept longer, and can be used for dipping and other special purposes.

Example: Starting formulation for one-pack primer:

Solution A	B05HX Ethanol	10~12% 60~65%
Solution B	Phosphoric acid(85%) Acetone	1~1.2% 9~10%
Solution C	Chromic acid Distilled water	0.5% 0.8~1.0%
Dilutent	N-butanol	12~20%

Preparation of one-pack primer:

Prepare solution **A**, solution **B**, solution **C** separately. Then solution **C** is slowly poured into solution **B** while the latter is being stirred. Let the mixture of solution B and C be poured into solution A while the latter is at 50℃ and under agitating. Keep stirring for 25 minutes at 45-50℃. Then cool it to 35℃ and the dilutent n-butanol is added. The mixture is ready for use after cooling to room temperature.

● Two-pack primers

A two-pack primer consists of two solutions, which must be stored separately. Normally they are mixed in the ratio 80/20 before application. In general, two-pack primers have a better performance in adhesion to substrate, water

resistance and weather resistance than one-pack primers. The phenolic modified wash primer is developed to improve the durability of the wash primer.

Example: Two-pack primer

Solution A		Solution B	
B05HX or B-08MX	7~8%	Phosphoric acid	3~4%
Basic zinc chromate pigment	6~8%	Distilled water	3~4%
Talc	1~1.5%	Isopropanol（99%）	12~14%
Isopropanol(99%)	45~50%		20.0%
Toluene	10~15%		
	80%		

Example: Phenolic modified two-pack primer

Solution A		Solution B	
B-05HX/B-08MX	7~8%	Phosphoric acid	3~4%
Phenolic resin	2~3%	Distilled water	3~4%
Basic zinc chromate pigment	6~8%	Isopropanol(99%)	12~14%
Talc	1~1.5%		20.0%
Isopropanol（99%）	45~50%		
Toluene	10~15%		
	80.0%		

Preparation of solution A：

Dissolve PVB in the stated solvents. This solution is ball-milled, together with the zinc chromate and talc, for 24~36 hours, depending on the efficiency of the mill. Only ceramic mills with porcelain balls should be used. Because the abraded iron will react with phosphoric acid, and the adhesion of wash primer will be reduced.

Preparation of solution B：

The amount of phosphoric acid is mixed with the specified amount of water, and then the isopropanol is added.

Storage and use of the wash primer：

Solution **A** can be stored in containers lined with high quality stoving paints, but solution **B** only in glass, ceramic or polyethylene containers. When using the wash primer, solution **B** is slowly poured into solution **A**, while the latter is being stirred. The mixture is ready for use after maturing for about half an hour. The mixed primer has pot-life about eight hours.

● Foil Coatings

To coat a metal foil (e.g. aluminum, brass, tin, lead, iron) with PVB solution, the foil strength and moisture-proofness is increased, and so its printability. The adhesion of the coating can be improved by stoving it at temperature up to about 140℃. B05HX and B08HX can be used for foil coating.

Example: Foil coating

B-05HX or B-08MX	9~10%
Ethanol	40~50%
Butyl cellosolve	2~6%
Toluene	40~50%
Pigment	0.5~1%

● Wood Paints

PVB is widely used as a component of wood sealers and finishes. It confers toughness, flexibility, impact resistance to the film and enables the coating to maintain adhesion under the wide variety of condition. Combinations of PVB with phenolic resins, shellac and nitrocellulose are used commonly for wood coatings. Knot sealer is a barrier to bleeding of terpenaceous matter from knots, heart wood and rosin ducts. The system consists of a combination of PVB and phenolic resin. B05HX and B08HX can be used in this application.

● Leather Paints

PVB in combination with nitrocellulose and plasticizer have been used as paint for leather. This coating of paint has excellent adhesion, elongation, and crack-prevention properties. B08SY, B06SY and B05SY can be used for leather paints. Representative formulation for leather paint：

PVB B08SY	3~4%
Nitrocellulose	8~12%
Plasticizer	5~8%
N-Butyl acetate	50~60%
N-Butanol	15~25%

● Stoving Paints

Combination of PVB with hardening resins like phenolic, melamine and urea resin are suitable for stoving paints. As an example of stoved film of phenolic resin, it is brittle and has poor levelling. But by adding 5~25% of PVB to the phenolic resin solid, it produces coatings with good flexibility, good leveling, free from pinholes and good alkali resistance. B05HX and B03HX series can be used in this application.

● Powdery Paints

For powdery paints, PVB is blended with epoxy resins. It is effective in edge covering and in preventing from pulverization. B-05HX and B-03HX can be used for powdery paints.

● Adhesives

A mixture of PVB and phenolic resin may be used for bonding metal, glass, leather, wood, cloth, paper and other materials. After the solvent has been completely removed at room temperature or at a low bake, the surfaces are heated

and pressed together. The curing time and temperature will depend on the material being bounded. For most applications, a treatment of 160℃ for 15 to 30 minutes is suitable.
B05HX, B08HX and B17HX are suitable to use according to the bonded materials and operation condition.

● Printed-Circuit Board Adhesives

The most important qualification of printed-circuit board adhesives are peel strength, blister resistance and dielectric properties. A mixture of PVB and phenolic resin has good properties of these. Thus they can be used in joining the pre-pregs of phenolic laminate with copper foil. B-10TX, B-11TX and B-12TX（or granular type PVB）are being used for bonding of printed-circuit board.

Example: Printed-circuit board adhesive

PVB B-10TX, B-11TX	8~12%
Phenolic resin	8~12%
Methyl ethyl ketone	40~45%
Xylene	10~20%
Methanol	15~25%
Epoxy resin	2-3%

● Electrostatic Copier Toners

A toner or developer for xerographic images uses PVB as a binder. For example, it can be composed of about 5% pigment dispersed in PVB with a copolymer of styrene-methylacrylate ester. A typical formulation contains:

PVB B-05HX	25%
Carbon black	5%
Styrene polymer	70%

These materials are mixed and milled to a particle size of 2~5 μ.

● Printing Inks

PVB is used in manufacturing ink for gravure, letterpress and flexorgraphic printing. PVB offers good flexibility, adhesion and toughness. B03HX, B05HX, and B08HX can be used for printing inks.

● Hot-melt Adhesives

By fusing PVB with plasticizer and fluxing-extending resins, hot-melt adhesives are obtained which provide a tough, clear film with good adhesive strength. B05HX can be used for hot-melt adhesives.

● Ceramic Binders

In the development of ceramic electronic component, PVB is used as the binder to give green strength to the ceramic powder. B05HX, B08HX, B08SY and B05SY can be used for ceramic binders.

● Transfer Paper for Textile

B08HX, B05HX and B03HX can be used to make the printing ink of transfer paper for textile.

● Textile Coating, Printings and Yarn Sizing Agents

B05HX, B08HX and B-17HX can be used for textile coatings, textile printings and textile yarn sizing agents.

Analytical Methods for CCP PVB

Procedures listed here describe the methods for determining the general properties of CCP PVB including content of moisture, vinyl acetate, vinyl alcohol and vinyl butyral.

● Moisture content

Principle: The method is based on determining the loss on drying at 105℃

Procedure: Weigh 2 g of sample to Alumiun foil dish and let it be dried in an oven at 105 ±2℃ for 2hr . Remove the dish from the oven, leave it to cool in a desiccator and weigh the dish.

Calculation: R＝(S-W) / S *100

Where R: Volatile content (wt%), S:Weight of the sample (g), W:Weight of dried sample (g)

● Vinyl acetate content

Principle: The vinyl acetate group in poly vinyl butyral is saponified with an excess of sodium hydroxide, which is then determined by titration with hydrochloric acid.

Instruments

1) Erlenmeyer flask with 250 ml, stirred

2) Burette, 50 ml burette, minimum scale value 0.1 ml

3) Pipette, 10 ml whole pipette

4) Measuring cylinder

5) Chemical balance analytical balance, precision 0.001g

Procedure

Weigh 0.8 g of the sample in the Erlenmeyer flask with stopper. Add 50 ml of ethyl alcohol to dissolve. Add 10 ml of the N/10 sodium hydroxide solution slowly while stirring for 2 hrs. Titrate excessive sodium hydroxide with the N/10 hydrochloric acid solution by using the phenolphthalein as an indicator until the pink color disappear, and take "a" ml of the titration amount. Separately carry out a blank test. Take "b" ml of the titration amount of the N/10 hydrochloride acid consumed in test.

Calculation $V_{AC} = 86.09 * (b - a) * F / (S * P)$

Where V_{AC}:Vinyl acetate (wt%), S: Mass of specimen (g)

P: Pure component (%) , F:Factor of N/10 hydrochloride acid solution

● Vinyl alcohol content

Principle: Comparable to JIS K 6728

Reagents:

1) N/2 sodium hydroxide solution

2) Pyridine -acetic anhydride mix solution: Mix 8ml of acetic anhydride and 92 ml of pyridine well to prepare this solution, store in a brown bottle, and never use the solution which has lapsed seven days after preparation.

3) Phenolphthalein 1% solution

4) Dichloroethane 1,2 – dichloroethane

Procedure

Weigh 0.4 g of the sample in the Erlenmeyer flask with stopper. Add 10 ml of the pyridine- acetic anhydride mixed solution to dissolve, and heat slowly while stirring in the heat plate(set 120℃) to which the cooler is attached for 120 min. After cooling , add 20 ml of dichloroethane and shake well , further add 50 ml of pure water , plug it with a stopper , shake violently , leave it alone for 30 min. Titrate the generated acetic acid with the N/2 sodium hydroxide solution by using the phenolphthalein as the indicator while shaking violently until it presents pale pink color , and take "a" ml of this titration amount. Separately ,carry out a blank test , take "b" ml of the titration amount of N/2 sodium hydroxide solution consumed in the test.

Calculation $V_A = 2.2 * (b-a) * F / (S * P) * 100$

Where V_A : Vinyl alcohol (wt%); S: Mass of specimen(g); P: Pure component (wt%)

● Vinyl butyral content

Principle : The method is based on PVB composition is equal to 100

Caculation : Vinyl butyral (wt%) ＝ 100 － vinyl acetate (wt%) － vinyl alcohol (wt%)

MATERIAL SAFETY DATA SHEET

SECTION 1 Chemical Product and Manufacturer's Identification

Chemical Name and Synonyms	Polyvinyl Butyral (PVB)
Trade Name	B17HX, B12TX, B11TX, B10TX, B08HX, B08SY, B06HX, B05HX, B05SY, B03HX, B1776, B1776G, B1776K, B1776T
Chemical Family	polymer, synthetic resin
Chemical Formula	[$-C_8H_{14}O_2-$]l [$-CH_2CHOH-$]n [$CH_2CHOOCCH_3$]m
Supplier Information	Chang Chun Petrochemical Co., Ltd 301 Songkiang Road, 7th Fl., Taipei, Taiwan, 10477 Tel: 886-2-25038131, 886-2-25001800 Fax: 886-2-25033378
Emergency Contact	Guo Don Lin, Senior Manager Ming Jyh Yang, Manager Tel: 886-37-320673, ext 237, 222 Fax: 886-37-355591

SECTION 2 Composition / Information on Ingredients

Ingredient	CAS No	Percent
Polyvinyl Butyral	64148-65-2	> 97%
Butyraldehyde	0123-72-8	< 1%
Water	7732-18-5	<2%

SECTION 3 Hazards Identification

Emergency Overview CAUTION! MAY FORM COMBUSTIBLE DUST CONCENTRATIONS IN AIR. NUISANCE DUST. MAY CAUSE EYE IRRITATION.

Potential Health Effects

Inhalation:	Dust may be formed under certain conditions of use. Treat as a nuisance dust.
Ingestion:	Not expected to be a health hazard via ingestion.

Skin Contact:	Not expected to be a health hazard from skin exposure.
Eye Contact:	Moderate irritating to eyes. Dust may cause eye irritation as would any foreign material.

SECTION 4. First Aid Measures

Inhalation:	Immediately first is not likely to be required. If symptoms develop, remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:	Not expected to require first aid measures.
Skin Contact:	Wash exposed area with soap and water. Immediately first is not likely to be required.
Eye Contact:	Wash thoroughly with running water. Get medical advice if irritation develops.

SECTION 5 Fire Fighting Measures

Fire: Fire is possible at elevated temperatures or by contact with an ignition source.
Explosion: Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.
Fire Extinguishing Media: Water spray, dry chemical, alcohol foam or carbon dioxide.
Special Information: In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

SECTION 6. Accidental Release Measures

Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Flush spill area with water.

SECTION 7. Handling and Storage

Handling

Keep in a tightly closed container, stored in a cool, dry, well ventilated area. Separate from incompatibilities. Avoid dust formation and control ignition sources. Employ grounding, venting and explosion relief provisions in accord with accepted engineering practices in any process capable of generating dust and/or static electricity.

Storage

Keep in a tightly closed container, stored in a cool, dry, well ventilated area.

Stable under normal conditions of handling.

SECTION 8. Exposure Controls/Personal Protection

Airborne Exposure Limits

OSHA Permissible Exposure Limit (PEL):
15 mg/m^3 total dust , 5 mg/m^3 respirable fraction for nuisance dusts.
ACGIH Threshold Limit Value (TLV):
10 mg/m3 total dust containing no asbestos and < 1% crystalline silica for Particulates Not Otherwise Classified (PNOC).

Ventilation System: A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred ..

Personal Respirators: If the exposure limit is exceeded, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest.

Eye Protection: Ware chemical safety goggles. Have eye flushing equipment available.

Skin Protection: Wear protective gloves and clean body-covering clothing.

SECTION 9. Physical and Chemical Properties

Appearance:	White granule or powder
Odor:	Characteristic
Solubility:	Insoluble in water
Bulk Density	0.25~0.35
Melting Point:	110~250℃

SECTION 10. Stability and Reactivity

Stability: Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products: Complete combustion will emit carbon dioxide and water when heated to decomposition. Incomplete combustion gives in addition carbon monoxide and oxidation products, including organic acids, aldehydes and alcohol.
Hazardous Polymerization: Will not occur.
Incompatibilities: Strong oxidizing agent.
Conditions to Avoid: Heat, flame, ignition sources, dusting and incompatibles.

SECTION 11. Toxicological Information

Oral LD50, rat : > 10,000 mg/kg. Practically nontoxic following oral administration. Dermal LD50, rabbit: > 7940 mg/Kg. Practically nontoxic after skin application in animal studies. Eye irritation, rabbit: Slightly irritation to eyes (rabbit)., 24h. Skin irritation, rabbit: Slightly irritation to skin (rabbit)., 24h. Mutagenicity: The active ingrident generally produced no genetic changes in standard tests using baterial and yeast cells.

SECTION 12. Ecological Information

Environmental Fate: No information available
Environmental Toxicity: No information available.

SECTION 13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Dispose of as a non-hazardous solid waste.

SECTION 14. Transport Information

This product is not classified as dangerous goods according to the international regulations for transport by land, inland waterway, sea and air.

SECTION 15. Regulatory Information

Chemical Inventory Status

Ingredient\Area	TSCA	EC	Japan	Australia
Butyraldehyde (0123-72-8)	Yes	Yes	Yes	Yes
Polyvinyl Butyral (64148-65-2)	Yes	Yes	Yes	Yes

SECTION 16. Other Information

NFPA Ratings: Health: 1, Flammability: 1, Reactivity: 0
HMIS Ratings: Health: 1, Flammability: 1, Reactivity: 0
Label Hazard Warning: CAUTION! MAY FORM NUISANCE DUST.

Disclaimer:

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