ThreeBond
TECHNICAL NEWS

Three Bond Technical News
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Instant Adhesives
(Cyanoacrylate Adhesives)

Introduction

Instant adhesives (cyanoacrylate adhesives) are one-part solvent-free adhesives that cure immediately at room temperature and offer strong bonding strength.

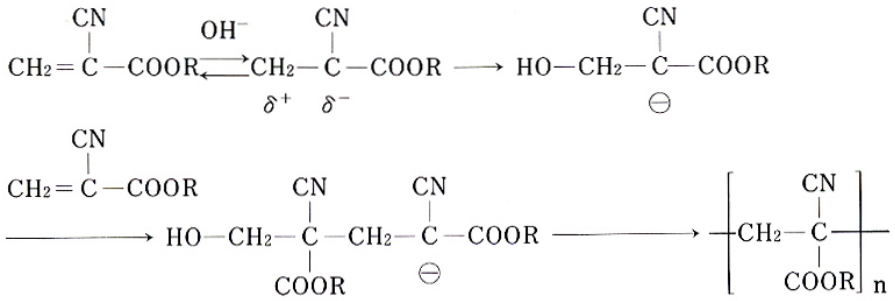
Instant adhesive was first developed in 1949 by Alan E. Ardis at Goodrich Company in the U.S., and was later developed into a product by F. B. Joyner and G. F. Hawkins at Eastman Company and marketed as Eastman 910 in 1959. Since then, various adhesive manufacturers around the world have improved and modified methods of synthesizing the main components, monomer. Due to the unique characteristics that distinguish these adhesives from other types, instant adhesives are currently used in a wide range of applications, both in industry and in the home.

This issue will describe the reaction mechanism of these unique instant adhesives and the advantages and disadvantages stemming from their properties. This issue will also introduce the ThreeBond 1700 series and discuss the present and future of instant adhesives.

Contents

1. The reaction mechanism of instant adhesives

The chemical reaction that causes curing of instant adhesives is referred to as anion polymerization. In other words, a substance containing anions causes a reaction to progress rapidly, with polymerization and curing taking place within seconds. Representative examples of chemical groups that have negative ions (anions) are water (H-OH), methanol (CH_3OH), and caustic soda (NaOH). The OH-group within the molecular structures of these groups acts upon the cyanoacrylate, and, through the chemical reactions illustrated below, induces polymerization and curing.



R: Methyl group ($-CH_3$), ethyl group ($-C_2H_5$), alkyl groups, etc.

2. Instant adhesives-ThreeBond 1700 (TB 1700) series

2-1. Classification of TB 1700 series

Types	Purpose	TB Grade	Viscosity (cP)	Remarks
ThreeBond 1700 series	Multi-purpose type	1701	3	Methyl cyanoacrylate For bonding metals, rubber, and plastics
		1702	35	
		1703	100	
		1741	2	Ethyl cyanoacrylate For bonding metals, rubber, and plastics
		1743	100	
		1745	500	
		1747	2,000	
		1713	100	Slow-curing type
	Heat-resistant type	1751	3	High heat-resistant type
		1753	80	
	Impact-resistant type	1781	3	High peeling strength, impact-resistant type
		1782	80	
		1783	1,000	
	Woodwork type	1785B	3	For bonding porous substrate materials such as wood and balsa
		1786	150	
		1787	1,100	
	Low-odor low blooming type	1721	10	Low-odor, low-blooming type
	Gel type	1739	Gel form	In gel form to permit use on ceilings and vertical surfaces
	Peeler	1795	1	For cleaning blooming and excess adhesive
	Curing accelerators	1796	1	For curing thick coats of adhesives such as in hardfacing
	Adhesive primers for hard-to-bond surfaces	1797	1	Allows bonding of PE and PP when used together with instant adhesives

* In addition to the standard products listed above, specialized products are available in a variety of different viscosities, colors, etc.

2-2. Characteristics of the TB 1700 series

The TB 1700 series has the following characteristics.

(1) Instant bonding - a strong bond is formed within five seconds to three minutes.
(2) Easy-to-use - Since it is a one-part formulation, there is no need to mix with a curing agent. Neither pressurization nor heating is required.
(3) Strong bonds are formed at room temperature.
(4) Extremely small amounts are required-due to its low viscosity, it spreads well and extends into corners, reducing required application amounts by half relative to other adhesives.
(5) The bonded part is clear and colorless, resulting in a neat finish.
(6) Since it is solvent-free, virtually no shrinkage occurs during curing.
(7) Promotes rationalization and efficiency in work procedures

3. Advantages and disadvantages of instant adhesives

Instant adhesive products that are popularly used today are either methyl cyanoacrylates or ethyl cyanoacrylates; 90% of them are the latter. Advantages and disadvantages common to these two representative instant adhesives are given below.

Advantages	Disadvantages
1) Instant bonding	1) Low heat resistance
2) Curing at room temperature	2) Low impact resistance
3) One-part catalyst-free formulation	3) Low elasticity
4) High bonding strength	4) Only applicable in small-clearance applications
5) High electric insulation capacity	5) Unsuitable for bonding large surfaces at once
6) High chemical resistance	6) Irritating odor and causes blooming
7) Requires small volumes	7) Bonds well with skin, so care is required in handling
	8) Requires caution in storage and management

ThreeBond 1739 Instant extra-strength adhesive (gel-type)

4. Examples of main applications of instant adhesives

Below are examples of applications in various fields of industry.

Fields	Parts	Substrate materials
Electrical instruments	Tape recorder buttons	ABS + Chromated metal parts
	Buttons on Irons	Duracon + Aluminum
	Buttons on CD/DVD players	Zinc + Brass
	Rod antenna accessories	ABS + Chromium plating
	Capstans	Brass + Stainless steel
	Magnetic heads	Permalloy + Iron
	Fuse casings	Polyester + Polycarbonate
	Calculators	Urethane rubber + Polyacetal
	Gaskets in CRTs	Neoprene + Neoprene
	Gaskets in vacuum cleaners	Neoprene + ABS
	Rubber vibration isolators in washing machines	Neoprene + SBR
Automobiles	Spark-plug lead covers	Neoprene + Soft PVC
	Dashboard leather	Urethane foam + Soft PVC
	Door edge guards	Soft PVC + Soft PVC
	Door handle parts	Neoprene + Unichrome plating
	Distributor gaskets	Neoprene + Phenol
	Rubber on window frames	EPT + EPT
	Cushion absorbers	Neoprene + Unichrome plating
	Washer nozzles	Neoprene + ABS
	Mud flaps	Natural rubber + Natural rubber
	Tail lamp decorations	Neoprene + Chromium plating
Precision instruments	Camera viewfinders	Glass + Iron
	Printer wiring	ABS + Aluminum
	Camera shutters	Stainless steel + Aluminum
	Camera tripods	ABS + Aluminum
	Strain gauges	Polyimide+ Iron
	Sewing machine parts	ABS + SPC copper
Musical instruments	Pianica keyboards	ABS + Aluminum
	Guitar bridges	Rosewood + Urethane-coated board
	Banjo drums	ABS + Plywood
	Moving piano parts	Maple + Maple
	Flutes	ABS + Chrome plating
Others	Packing rubber in Hume pipes	Synthetic rubber + Synthetic rubber
	Blood pressure meters	Neoprene + Neoprene
	Frangible disks in fire extinguishers	Polyester + Synthetic rubber
	Carrier wheels	Neoprene + Zinc
	Rubber mat fasteners	Synthetic rubber + Nylon
	Syringe needles	Stainless steel + PVC
	Felt-tipped pens	Polyacetal + Gold plating
	Dolls	Soft PVC + Soft PVC

5. ThreeBond 1797 - an adhesive primer for hard-to-bond materials (for instant adhesives)

Even in today's fast-developing world of chemistry, no adhesive has yet been developed for securely bonding polyethylene, polypropylene, and fluoroplastic materials.

One method for bonding these hard-to-bond materials is to activate the substrate surface temporarily by acid, thermal, or radiation treatment before applying the adhesive. However, all three methods are impractical as they pose health hazards, require a specialized facility, and involve complicated procedures. In this section, a simple pre-treatment method using a primer will be introduced for securely bonding hard-to-bond materials while avoiding the above-cited difficulties.

5-1. Outline

ThreeBond 1797 is a specialized primer for securely bonding hard-to-bond materials-such as polypropylene, polyethylene, polyacetal, and EPT rubber - using instant adhesives in the TB 1700 series.

The conventional method of bonding polypropylene, polyethylene, etc. involved pre-treatment by strong acid, strong alkalis, or heat, to give the adhesiveness. However, these treatments were considered impractical in application as they involved complicated, time-consuming, and hazardous procedures. ThreeBond 1797 is an adhesive primer that enhances bonding performance at room temperature, and was developed in order to eliminate the workload for such pre-treatment processes.

5-2. Characteristics

1. It displays high adhesive performance with polypropylene, polyethylene, and polyacetal materials. It is also significantly effective in bonding EPT rubber, polyurethane, and soft PVC materials.
2. Since it is quick-drying, bonding may be performed immediately after surface application.
3. It also acts as a curing accelerator, so that setting time is reduced.
4. It cures quickly at room temperatures and increases the speed and productivity of the assembling process.
5. It can be used with all instant adhesives of the TB 1700 series.

5-3. Properties

Items \ Product name	ThreeBond 1797
Color and appearance	Lemon yellow liquid
Viscosity (cP/25°C)	0.85
Specific gravity (25°C)	0.80
Main constituent	Amine accelerator

5-4. Performance

(a) Setting time (for bonding between the same materials and between different materials) (seconds)

Materials \ Materials	Polypropylene	Polyethylene	Polyacetal	Iron
Polypropylene	5	5	5	10
Polyethylene	-	5	5	10
Polyacetal	-	-	5	10
Iron	-	-	-	15

(b) Shearing adhesive strength (for bonding between the same materials and between different materials) (kgf/cm^2)

Materials \ Materials	Polypropylene	Polyethylene	Polyacetal	Iron
Polypropylene	45.6*	39.0*	49.6*	28.1
Polyethylene	-	33.0	36.5	21.5
Polyacetal	-	-	47.1	31.2
Iron	-	-	-	130.5

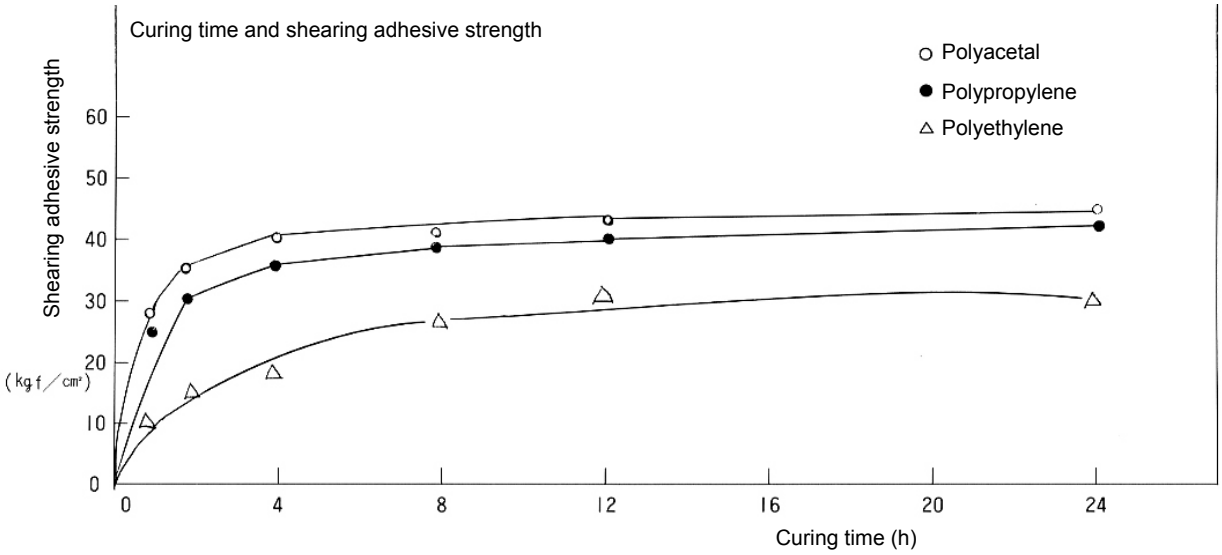
* Material fracture

25°C × 24-hour curing

(c) Curing time and shearing adhesive strength (kgf/cm^2)

Materials \ Time (h)	1	2	4	8	12	24	72
Polypropylene	25.1	30.4*	35.3*	38.7*	41.4*	45.6*	46.0*
Polyethylene	11.1	17.0	20.0	27.2	33.0	32.5	33.0
Polyacetal	28.1	36.2	40.2*	41.5*	45.2*	47.1*	46.2*

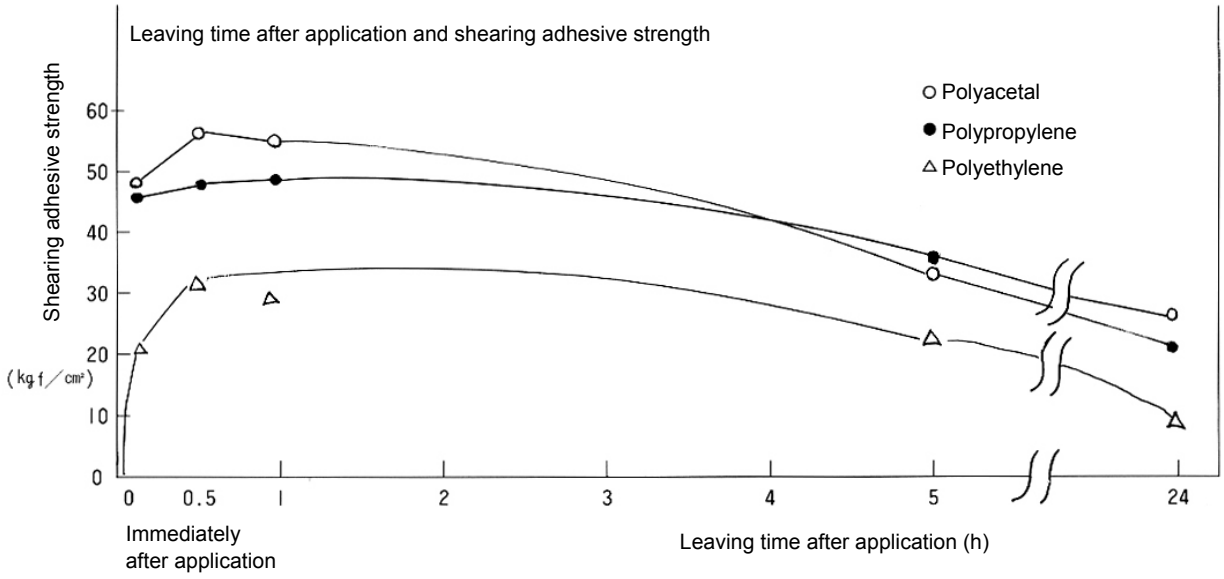
* Material fracture 25°C curing



(d) Leaving time after application of TB 1797 and shearing adhesive strength (kgf/cm^2)

Materials \ Time (h)	Immediately after application	0.5	1	5	24
Polypropylene	45.6*	48.4*	49.4*	35.2*	21.3*
Polyethylene	21.5	31.6	30.0	21.0	10.6
Polyacetal	47.1*	56.7*	55.0	34.7	24.8

* Material fracture 25°C × 24-hour curing



(e) Amount of application and shearing adhesive strength (kgf/cm^2)

Materials \ Application method	A	B	C	D	E
Polypropylene	24.1	27.3	37.3*	42.1*	46.0*
Polyethylene	16.4	19.8	32.3	39.4	42.1
Polyacetal	61.0*	58.2*	49.4*	45.2*	14.2

* Material fracture 25°C × 24-hour curing

Application method

A: A single stroke with cloth soaked in TB 1797
B: Two strokes with cloth soaked in TB 1797
C: Three strokes with cloth soaked in TB 1797
D: Five strokes with cloth soaked in TB 1797
E: Dipped in TB 1797

Increasing application amount

(f) Heat resistance test and shearing adhesive strength

Allowed to stand at 80°C, measured at room temperature (kgf/cm^2)

Materials \ Time	1	4	8	12	24
Polypropylene	42.1*	41.3*	47.6*	52.1*	47.2*
Polyethylene	39.1	40.2	42.2*	42.1*	41.3
Polyacetal	48.2*	56.1*	55.3*	48.6*	48.0*

* Material fracture 25°C × 24-hour curing

Peeling test

Materials	Peeling adhesive strength (kgf/25mm width)
Polypropylene	3.5*
Polyethylene	1.4*

* Material fracture

(g) Handling instructions

1. Wipe contact surfaces clean using solvents or the like.
2. Keep a cloth or brush dipped in TB 1797 at hand; apply 1-2 strokes of TB 1797 on the surfaces. After drying, bond the surfaces using an instant adhesive of the TB 1700 series.
3. When bonding hard-to-bond surfaces such as polyethylene and polypropylene with easy-to-bond surfaces such as iron and copper, use the adhesive primer only on the hard-to-bond surface.
4. Be careful not to apply either excessive or insufficient amounts of TB 1797, as this will result in reduced bonding strength.
5. The TB 1797 coating on the contact surface will remain effective for one hour.

6. ThreeBond 1739 (Gel-type instant adhesives)

6-1. Outline

Unlike conventional liquid instant adhesives, ThreeBond 1739 is a new, gel-type instant adhesive.

Its performance is comparable to that of conventional liquid types, except that its thixotropic properties enables use on vertical surfaces and ceilings. Through combination with curing accelerators, it becomes possible to use TB 1739 as filler for pits.

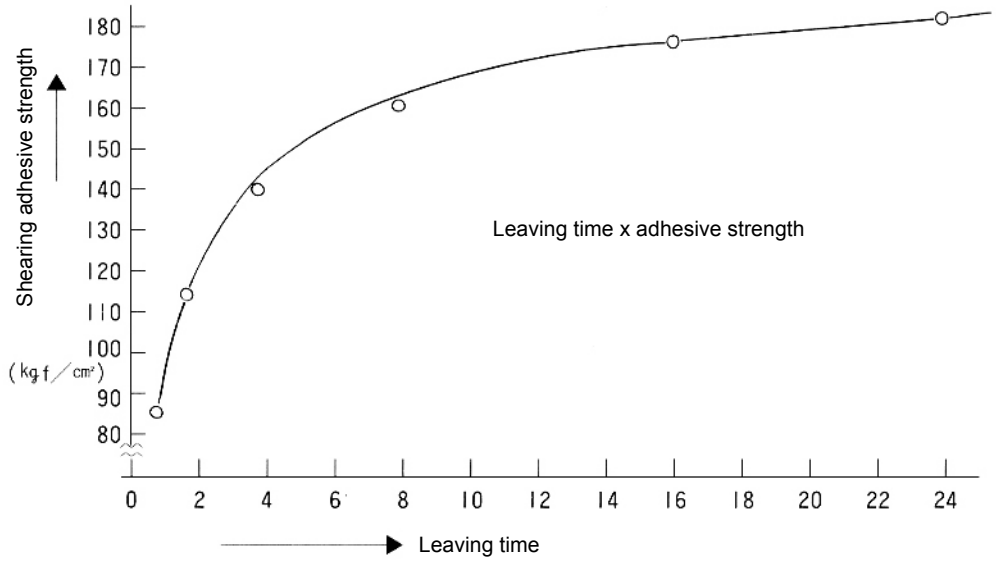
6-2. Properties and basic performance

Test items		
Color and appearance		Clear and colorless liquid
Viscosity		23,000 cP
Thixotropic index		3.5
Specific gravity		1.03
Setting time	NBR	35-40 seconds
Setting time	Fe/Fe	30-35 seconds
Shearing adhesive strength	Fe/Fe	180kgf/cm^2

6-3. Performance

(a) Leaving time and adhesive strength (RT: shearing adhesive strength) Fe/Fe

Leaving time	1h	2h	4h	8h	16h	24h
Strength	85	115	143	162	178	180



(b) Shearing adhesive strength and setting time for various materials

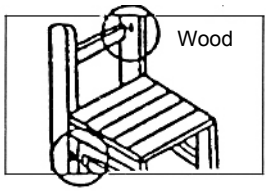
Materials	Setting time (sec.)	Shearing adhesive strength (kgf/cm^2)
Fe/Fe	30 to 35	180
sus-sus	45 to 50	150
Al-Al	20 to 30	130
Cu-Cu	10 to 15	165
Glass-Glass	10 to 15	*
Hard PVC-Hard PVC	20 to 25	80*
Polycarbonate-Polycarbonate	20 to 25	70*
Nylon-Nylon	20 to 25	65*
Natural rubber-Natural rubber	30 to 35	*
NBR-NBR	35 to 40	*
EPT-EPT	35 to 40	*

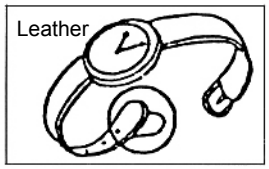
* Material fracture

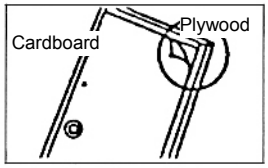
(c) Purposes

(1) Fixing of components on printed circuit boards and lead wires
(2) Adhesion and patching of parts for automobiles and machinery
(3) Adhesion for wood and paper products
(4) Adhesive in hobby crafts such as plastic models
(5) Filling and adhesion by combining with curing accelerators

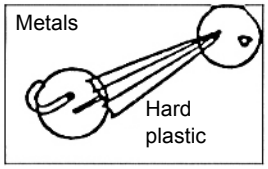
Examples of application

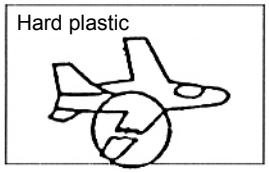


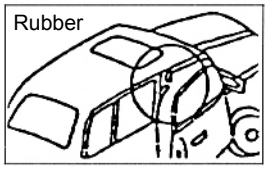




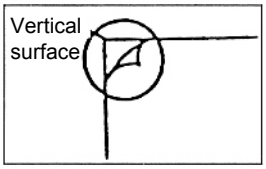
For metals, hard plastics, and rubber due to its high bonding strength

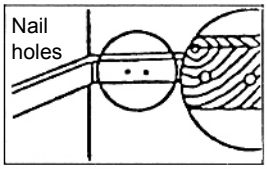


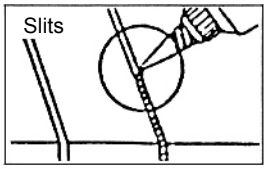




For vertical surfaces, slits, and uneven surfaces due to its thixotropic properties







Conclusions

Instant adhesives are easy to use due to the instant bonding that results from the structure and reactivity of these substances. However, because of their low impact, heat, and water resistance, these adhesives are less suitable as bonding agents relative to epoxy or acrylic adhesives for structural (or semi-structural) components. It is believed that these disadvantages may be overcome by the addition of new chemical groups to the molecular structure of instant adhesives, or by combining instant adhesives with elastomers, and that an improved product will be available on the market in the near future.

Furthermore, instant adhesives may enjoy wider application in the field of electronic and electrical fields once electrical conducting properties are added to the instant bonding properties of these adhesives. Also, the development of products with superior qualities such as low odor and low bleaching will improve a wide range of work environments, enabling the transformation of these adhesives into versatile and essential products.

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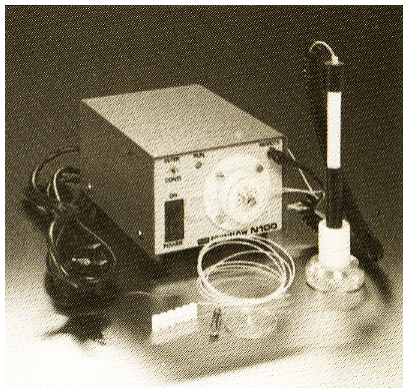
Easy-to-use, waste-free, and stress-free adhesion

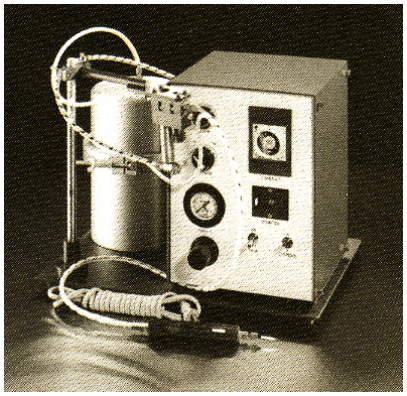
Automatic Instant Adhesive Coater

Even after selecting quality products to use in your work, you may not be able to make the most of these products if the conditions are not right. Superior products can make your job less labor-intensive, saving time and cost, with the proper handling conditions. Three Bond has thus developed easy-to-use, automatic applicators, which have met with high acclaim by our customers.

■ Fan Flow N100

A tube is inserted into a container of adhesive; pressing a button on the pen-type dispenser causes the adhesive to be drawn out of the container and ejected through the tip of the pen. This mechanism requires no air source; only a source of electrical power. Since it adopts a tubing pump method, precise ejection volumes can be obtained continuously.





■ ThreeBond Coater S

An adhesive container is placed inside a container; pressing a button on the pen-type dispenser causes the adhesive to be expelled by air pressure and ejected from the tip of the pen. It is easy to make fine adjustments in ejection volume without error, preventing excessive application. It is suitable for manual applications in its current form and can be incorporated into production line systems with the addition of several adaptor parts.

ThreeBond TECHNICAL NEWS

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