ThreeBond
TECHNICAL NEWS

ThreeBond Technical News
Issued January 1, 2011

77

NEW PRODUCTS
Microdrop Coating Equipment for Instant Adhesives

Introduction

Adhesives come in many types and forms. Many of you are likely familiar with instant adhesives, found at home improvement stores and other stores for convenient home use. ThreeBond offers many instant adhesive products for industrial use.

In recent years, the manufacturing trends have moved from the once-booming heavy-thick-long-big approach to the light-thin-short-small approach. Advancing technology has also led to smaller components, which naturally increase the use of adhesives for assembly or for holding components into position. The amount of adhesive required to hold these components in place is often 100 µL or less, but demand repeat precision. Production times must also be reduced. As such, the adhesive coating equipment must meet a number of challenges.

In particular, adhesives that cure in seconds, like instant adhesives, are more widely used now than ever before. This issue introduces equipment capable of reliably coating trace amounts of such adhesives.

ThreeBond is abbreviated “TB” hereafter.

Contents

Introduction 1
1. Background 2
  1-1 Conventional coating equipment 2
  1-2 Pinch valve 2
  1-3 Tubing pump 3
  1-4 Diaphragm valve 3
  1-5 History of development 4
2. Features of new product (TDV) 4
  2-1 Ability to apply extremely small amounts 5
  2-2 Durability 6
  2-3 Storage stability 6
  2-4 Preventing curing in nozzle tip 7
3. Example of use 7
  3-1 Instant adhesive (TB7700 series) 7
  3-2 Anaerobic sealant (TB1300 series) 7
Conclusion 8

1. Background

1-1 Conventional coating equipment

While instant adhesives are widely used at home, ThreeBond offers various instant adhesive products for industrial use. Some offer special properties, like impact resistance, UV curing, lack of odor, low bleaching, fast curing, or slow curing. Products with diverse viscosity are also available, ranging from ones with low viscosity, like water, to those that do not drip when applied to a wall (Figure 1).

Figure 1: Various instant adhesives

When we think of using instant adhesives at home, we think of something like the following: piercing the tip of the container; holding the container; and applying the adhesive to the part to be bonded. When the adhesive is rarely used and if the amount of coating is not strictly specified, manual coating is fine. But when tens of thousands of products are manufactured or tens of thousands of bonding operations are repeated daily, manual coating is inadequate. Manual coating also tends to lead to varying amounts of coating. For such applications, ThreeBond provides coating equipment that automates adhesive coating. Typical examples of coating equipment mechanisms are shown below.

1-2 Pinch valve

A major aspect of mechanisms for instant-adhesive coating equipment involves avoiding contact between the adhesive and the driving part of the equipment. This is because instant adhesives cure instantly across narrow gaps, due to their nature. A pinch valve implements this mechanism quite simply.

A pinch valve blocks the flow path of the adhesive by using a plunger to squeeze the tube in which the adhesive is flowing (Figures 2 and 3).

The coating operation adds pressure to the adhesive in the tank, and the pressure lifts the plunger to supply the adhesive. Since this is a simple mechanism that moves the plunger up and down at a rapid rate, a pinch valve can open and close the flow path quickly. It is also characterized by a mechanism wherein adhesive only flows in the tube if it is to be issued from the nozzle.

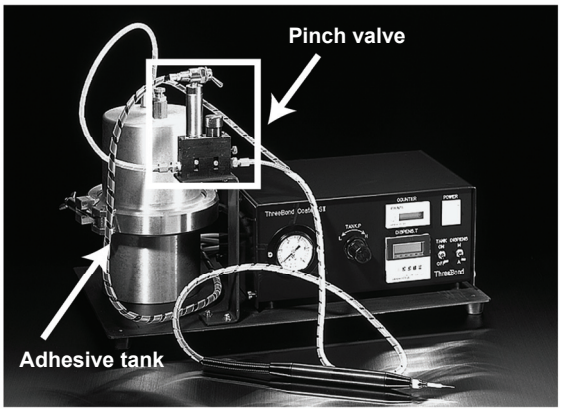

Figure 2: Pinch valve

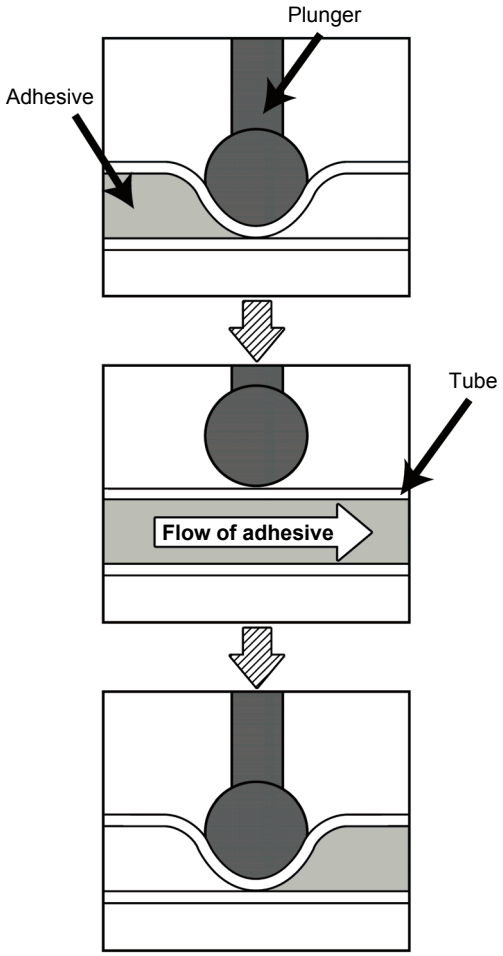

Figure 3: Mechanism of pinch valve

1-3 Tubing pump

A tubing pump is a coating device with a mechanism similar to a pinch valve (Figures 4 and 5).

A tubing pump blocks the flow path of the adhesive using a component called a “rotor” to squeeze the tube from which the adhesive is flowing.

In the coating operation, the rotor rotates and acts as a pump. A tubing pump simultaneously aspirates the adhesive and transfers the adhesive in the tube between two rollers out toward the nozzle.

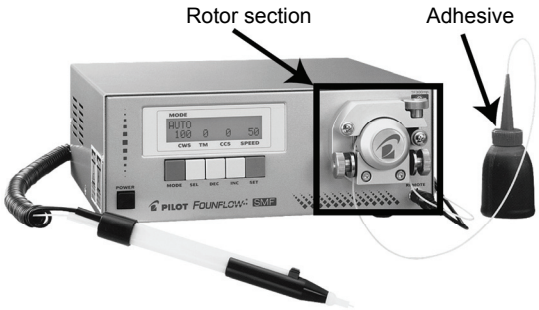

Figure 4: Tubing pump

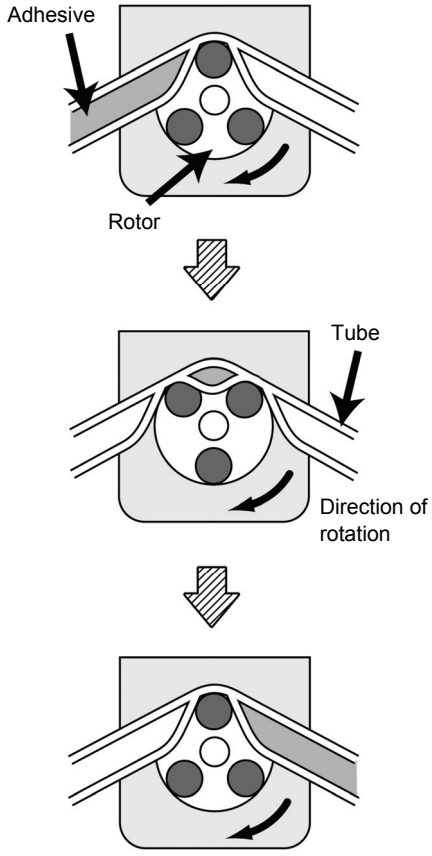

Figure 5: Mechanism of tubing pump

A tubing pump can be operated using just a 100-VAC power supply. Thus, with the simple operation of turning on the switch, one can easily coat the adhesive even in locations not equipped with a compressor to provide compressed air. As with a pinch valve, the adhesive in this mechanism only flows in the tube if it is to be issued from the nozzle.

1-4 Diaphragm valve

A diaphragm valve has a configuration similar to a pinch valve. It maintains the adhesive in a pressurized state and applies the adhesive by opening and closing the flow path.

A diaphragm valve differs from a pinch valve in that while a pinch valve blocks the flow path by pinching the tube, a diaphragm valve blocks the flow path using a membrane called a diaphragm (Figures 6 and 7).

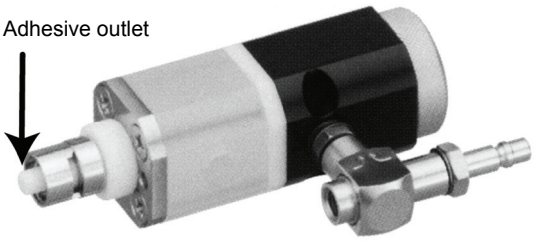

Figure 6: Diaphragm valve

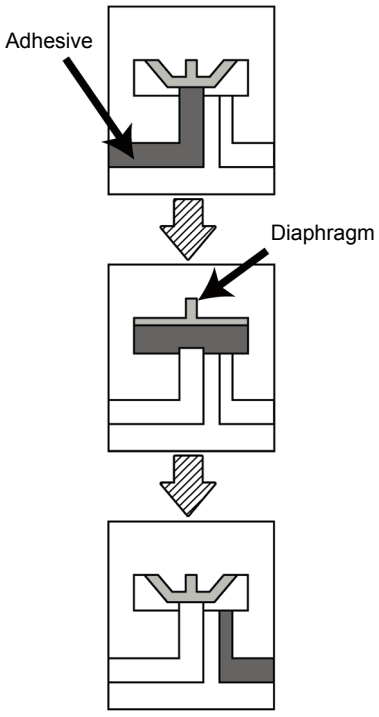

Figure 7: Mechanism of diaphragm valve

Since a diaphragm valve uses a membranous diaphragm, it remains durable even in applications requiring repeated opening and closing, in contrast to applying equipment that directly presses the tube, like pinch or tubing valves.

The devices conventionally used as instant-adhesive coating equipment all have distinctive features, and users select one or another based on requirements. However, for recent manufacturing needs, such conventional coating equipment often fails to satisfy requirements.

The change in industrial formats and advances in adhesives now require new product developments in instant-adhesive coating equipment.

1-5 History of development

Components in production lines are designed to use as little adhesive as possible to reduce manufacturing costs. Instant-adhesive coating equipment must be able to control the amount applied in units of 10 μL.

If several million components are produced monthly, production occurs under strict process control, and working time for applying the adhesive to a component is often limited to a window of seconds.

In addition, if the monthly production volume increases, the number of operations of the coating equipment also increases. If the components used in the coating equipment experience significant wear, they must be replaced more often, reducing production efficiency. For this reason, coating equipment must be highly durable.

Stable and repeated coating of highly reactive instant adhesives means we have to suppress curing within the coating equipment.

Current production lines pose the three main requirements below for instant-adhesive coating equipment:

(1) Applications of extremely small amounts
(2) Durability
(3) Storage stability

To develop coating equipment that meets these requirements, we have devised a mechanism suitable for applying extremely small amounts of instant adhesive.

2. Features of new product (TDV)

We developed this coating equipment in response to production line requirements. It meets these requirements using a mechanism significantly different from conventional coating equipment (Figures 8 and 9). In addition to the diaphragms used to open and close the flow path, the new product uses a diaphragm-based volume-change measurement mechanism to allow application in extremely small amounts, an area generally associated with significant variations. Table 1 gives the specifications of this product.

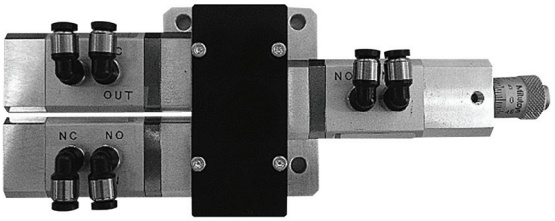

Figure 8: New coating equipment (TDV)

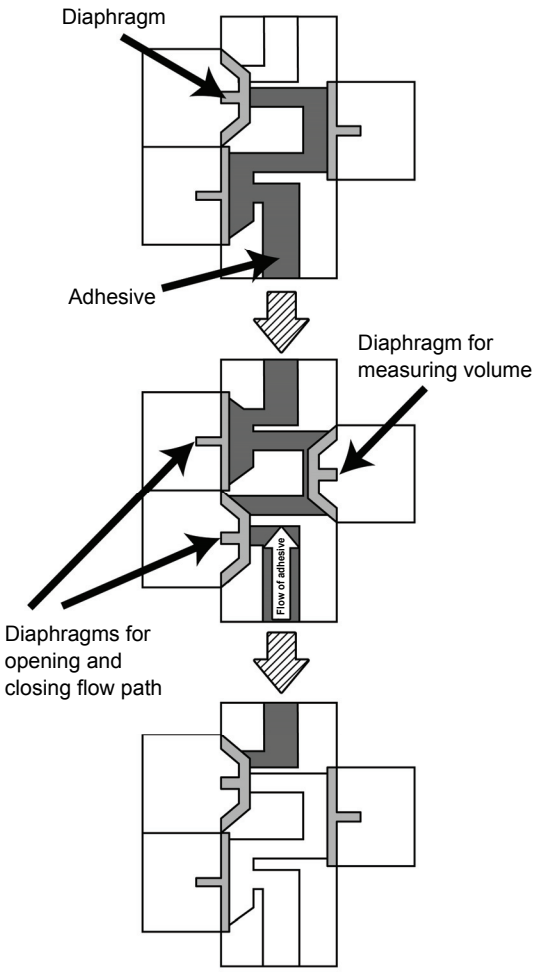

Figure 9: Mechanism of new product (TDV)

Table 1: Specifications of new product (TDV)

Item	Specifications	
External dimensions	W160 × D40 × H90 mm	
Weight	650 g	
Drive source	Dry air 0.3 MPa to 0.5 MPa	
Recommended material pressure	No pressure	
Operable pressure	Atmospheric pressure -0.1 MPa * Air vent at 0.05 MPa.	
Air connectors	Cylinder open (NC)	M5 *φ4 tube connector is supplied.
	Cylinder closed (NO)	M5 *φ4 tube connector is supplied.
Material inlet and outlet	Inlet	1/4”-28 UNF female screw
	Outlet	1/4”-28 UNF female screw
Operating mechanism	Three sets of double-acting air cylinders move the diaphragms to aspirate and dispense the material.	
Control of dispensed volume	Micrometer	Dispensed volume controlled by changing the air cylinder stroke
Air vent	Control by dedicated controller	
Amount of stroke	0 to 2 mm	
Ejection volume	Approximately 10 to 30 μL	
Range of usage environments	Temperature	5°C to 45°C (The range in which the valve is mechanically operable.)
	Humidity	70% or less (No condensation)
Durability	Approximately 10 million operations (varies depending on the material and conditions used)	
Consumable supplies	Diaphragms, main body block	
Applicable materials	TB1700 series or TB7700 series instant adhesive	

2-1 Ability to apply extremely small amounts

Figures 10 and 11 below compare the ability of the conventional product and with that of the new product to apply extremely small amounts, one of the major features of the performance of the new product.

A pinch valve or a tubing pump cannot maintain the initial amount applied, since the tube becomes deformed after repeated use. The amount applied also changes significantly depending on the pressure applied to the adhesive, making it difficult to control operation conditions.

The newly-developed coating equipment supplies the material through a valve and does not require continuous pressure on the adhesive. This reduces the number of control items required and keeps the flow path from deforming after extended use, making it possible to maintain the initial amount applied.

Comparisons between the conventional product and the new product show the variation in the amount applied differed significantly when we repeatedly measured 10 μL applications. The new product improves the standard deviation, σ, which indicates variation, by roughly 30%.

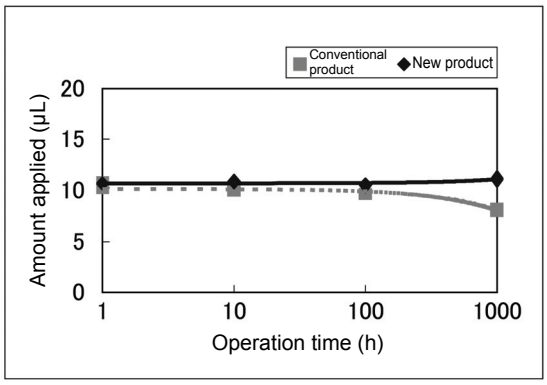

Figure 10: Operation time and amount applied

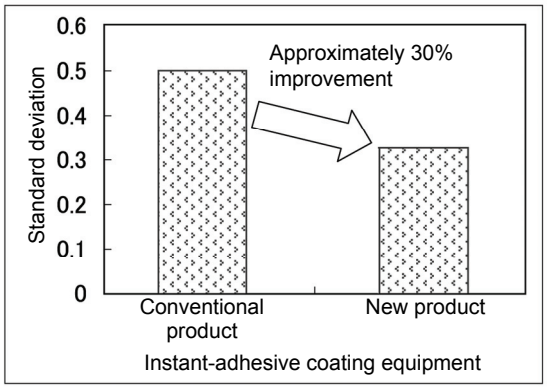

Figure 11: Comparison of ability to apply extremely small amounts

The newly-developed coating equipment incorporates a volume-change measurement mechanism that allows users to set the amount applied in units of 10 μL, even within the range of extremely small amounts. The mechanism adopts a flow path shape that reduces air bubble retention and achieves stable coating performance.

2-2 Durability

The second requirement for adhesive coating equipment on production lines is durability. Figure 12 below compares the durability of core components of conventional and new products.

Durability is evaluated by assuming the following condition: 1 million items are produced monthly, with 20 operating days monthly and 24 operating hours per day.

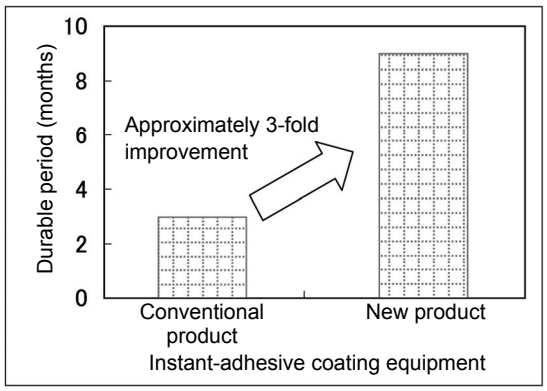

Figure 12: Comparison of durability

The new products offer durability approximately three-fold better than conventional products.

The reason for the high durability is the diaphragm mechanism shown in Figure 7 in the section for opening and closing the flow path. This mechanism generates low wear in repeated operations for significantly higher durability than conventional products.

The mechanism shown in Figure 7 also eliminates gaps in the section contacting the adhesive, where the instant adhesive can enter. This reduces the risk of instant adhesive curing within the coating equipment.

2-3 Storage stability

Figure 13 below compares the storage stability of the adhesive within the coating equipment. Storage life was examined as the time during which the requirements below are satisfied in an environment with a temperature of 25°C and humidity of 50% RH.

<Requirements>

(1) The adhesive does not cure within the valve.
(2) Coating is possible.
(3) The amount applied is maintained.

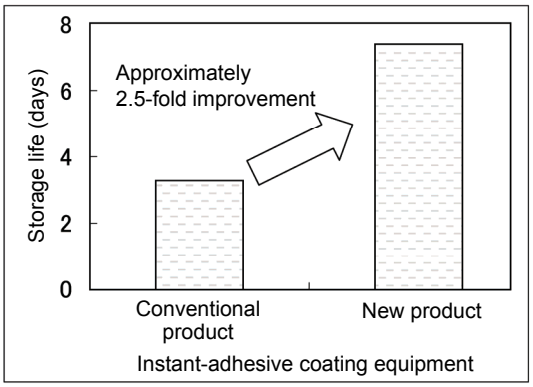

Figure 13: Comparison of storage stability

Polyacetal (abbreviation: POM) is a plastic material widely used now in mechanical parts (Figure 14). It is widely used because it provides both easy machining and high chemical resistance against many chemicals.

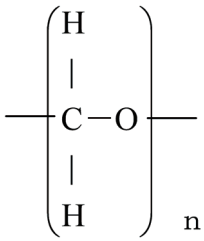

Figure 14: Structural formula (POM)

However, coating equipment for adhesives that readily undergo curing reaction even with slight moisture, like instant adhesives, requires low water absorption and high bonding resistance in materials contacting the adhesive.

For this reason, we use polytetrafluoroethylene (abbreviation: PTFE) as the material for the new product. It offers relatively low water absorption and high bonding resistance against many adhesives among plastic materials suitable for machining (Figure 15).

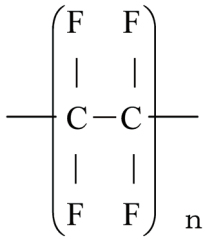

Figure 15: Structural formula (PTFE)

In an environment with a temperature of 25°C and humidity of 50% RH, we improve storage life roughly 2.5-fold compared to the conventional product.

2-4 Preventing curing in nozzle tip

This subsection introduces a new measure to address the phenomenon wherein the adhesive cures in the nozzle tip, thereby disabling application, a serious problem in instant-adhesive coating equipment.

Since instant adhesives react readily with airborne moisture, adhesive left in the nozzle tip quickly cures in the tip, preventing application.

Since reaction to moisture is the cause of curing in the nozzle tip, by immersing the nozzle tip in a liquid named “cure-prevention liquid” and isolating it from the moisture in the air, we can prevent curing in the nozzle tip for 24 hours or longer (Figure 16).

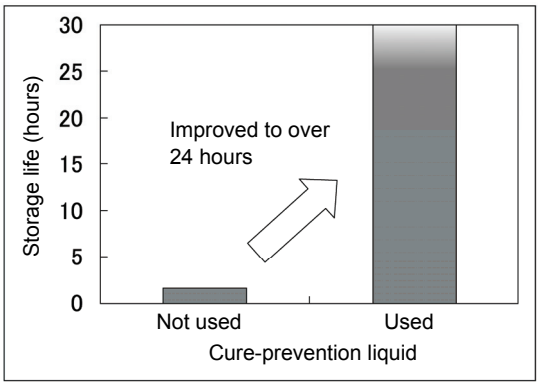

Figure 16: Comparison of storage life in nozzle tip

The only conventional measure replaced is the cured nozzle. However, cure-prevention liquid can reduce the frequency of nozzle replacement.

In short, using the cure-prevention liquid eliminates the need to replace the nozzle each time we stop the equipment, thus reducing costs. It also reduces the time required for adjustments after the equipment is stopped, reducing labor costs associated with nozzle tip replacement. These improvements are critical when installing automatic instant-adhesive coating equipment on an automated assembly line, where installation is often quite difficult.

3. Example of use

3-1 Instant adhesive (TB7700 series)

ThreeBond’s product line of instant adhesives consists of the standard-grade TB1700 series and the high-grade TB7700 series. The ultra-fast-curing-grade TB7780 series, most recently developed, is increasingly used in the eclectic component market and in the precision machinery market.

3-2 Anaerobic sealant (TB1300 series)

Coating equipment with excellent instant adhesive handling can be deployed as stable microdrop coating equipment for anaerobic sealants and UV curing resins.

The transport market and the thread lock market, which both have significant demand for anaerobic sealants, also require application methods that do not waste adhesive. Demand will expand significantly for equipment that allows stable application of extremely small amounts.

Conclusion

In contrast to UV curing resins or epoxy resins, adhesives like instant adhesives and anaerobic sealants do not require UV exposure or heating, and thus reduce the man-hours required for production. For this reason, future demand is expected to increase. ThreeBond will continue to provide adhesives that meet customer needs and provide coating equipment that enables effective use of adhesives through capitalizing on its unique coating technologies.

<References>

ThreeBond Co., Ltd.
- TB1700 series instant adhesives and related products (Figure 2)

Pilot Corporation
- Founflow general catalog (Figure 4)

Iwashita Engineering Inc.
- Valve system catalog (Figure 6)

Tomoki Okawa
Energy-Saving Development Division
Energy-Saving Equipment Department
Headquarters and R&D Laboratory
ThreeBond Co., Ltd.

ThreeBond TECHNICAL NEWS
THREE BOND CO., LTD.
1456 Hazama-cho, Hachioji-shi, Tokyo 193-8533, Japan
Tel: 81-426-61-1333