Technical Bulletin

Choosing the Right Valve for a Selective Robotic Conformal Coating Application Process

We have considered the Design Rules for Selective Conformal Coating and they are straightforward.

Now, we need to consider the right system and valve combination for the material and circuit board combination. This is the final stage in ensuring that the right tools are there to allow the process engineers to set up the right process and the technicians can operate a successful conformal coating process.

The Right System

A selective conformal coating system should comprise essentially of three main components:

1. The valves and fluid system, which deliver the conformal coating material in the required areas on the printed circuit board.
2. The robot platform itself, responsible for delivering the valves to the correct location accurately and in an extremely repeatable fashion.
3. A software interface that enables simple programming by an operator, that controls both the robot and the fluid system, to ensure that the coating material is consistently dispensed in the specified locations, and areas required to be left coating free, are indeed left coating free.

This article will focus on the features to look for when selecting the valves that will be used to dispense your conformal coating material(s).

The Choice of Valves

The areas we have covered in the previous articles are all very important but they pale in comparison to the importance of valve technology.

The conformal coating valve is the heart of the machine and is the single most important tool in determining if a coating process is going to be successful, reliable and repeatable. Get this part of the process right and you have a great chance of creating the optimum process. Get it wrong and it could be a disaster.

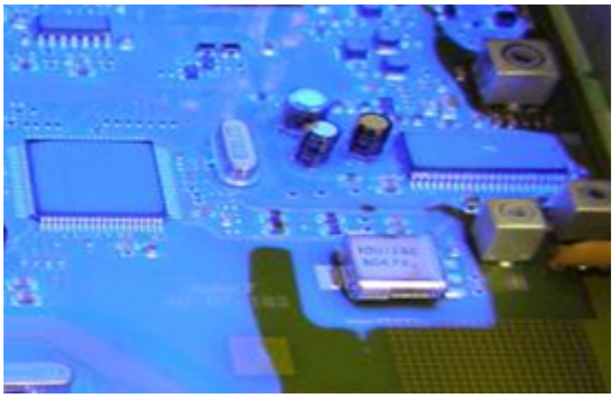

Figure 1: A Printed Circuit Board that has been selective coated by a robot

The Types of Valve Available

Ideally a valve should be able to be used with a wide variety of materials. There are three main types of valves used in conformal coating applications:

1. Airless Spray Valves commonly referred to in this industry as 'film-coat' valves.
2. LVLP (Low Volume Low Pressure) Atomised spray valves).
3. Dispense valves (Contactless or regular needle style)

However, all valves have some common points that should be considered.

Important factors include valve design and it should be simple, durable, and easy to repair. Material type is important and the valves should have stainless steel fluid sections. This allows the user to put any material or solvent through the valve without regard to corrosion or contamination.

The valves should have a divorced design that means the air section and fluid section is separate. If a valve leaks, the material will not contaminate and clog the air section of the valve. Ideally the valves should also have a minimal number of spare parts and be easily repaired.

Some manufacturers of spray valves do not use a divorced design. The only thing that separates the fluid and air sections is a very weak gasket seal. When the seal is worn out, coating passes by the seal and the entire valve need rebuilding.

Also, due of the limited payload of some machines, the manufacturer is often forced to reduce the payload using some parts in the spray valve from light weight plastic, which makes the valve less durable. These valves can also have a large number of spare parts that make the valve very difficult and time consuming to repair.

A major problem associated with any valve is its ability to close and this has a tendency to clog or block. Ideally a valve should be 'tip seal' design. The needle and seat come together to close the valve at the furthest point of the fluid section. In fact, the needle should if possible protrude through the seat to give a very positive shut off that keeps the valve from leaking and completely seals the coating away from air. Finally, some valve designs do not close at the end of the fluid section. This leaves the end of the fluid section exposed to air, which can lead to excessive clogging.

The Individual Values

Airless Spray (Film) Coating

This type of valve design relies on generating sufficient fluid pressure to force the valve through a shaped valve opening to form a leaf-shaped fan pattern (Figure 2).

What you get, if several other conditions are near perfect, is a wide fluid stream with a well-defined edge as seen in Figure 3.

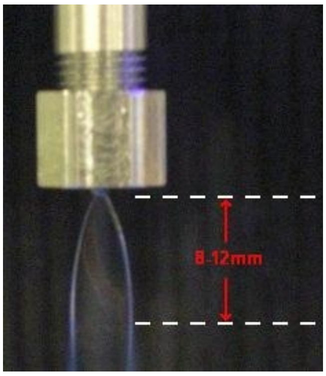

Figure 2: Airless Spray Pattern "leaf shape"

Figure 3: Airless Spray Pattern using a film pattern for selective conformal coating

This type of valve design works well with low-viscosity, solvent-based coatings, with viscosities less than 100 cPs. This due to the fact that these materials have a low solids content and surface tension which enables them to form the required pattern, which will not form with more viscous or higher solids materials.

With low solids solvent-based coatings, typically 80%+ of the applied material is solvent which evaporates to yield a film of suitable thickness.

Airless spray valves must have a minimum capability of rotating through 90° by the use of a pneumatic actuator to enable stripes to be applied perpendicular to each other for all but the most simple board designs. When combined with a servo driven 4th or theta axis rotation of the valve, the user has the ability to apply stripes quickly at virtually any angle.

This valve design also applies a thick wet-film, which means that the robot must move quickly to prevent flood coating. Typical speeds are in the range 300-450mm/s.

The speed with which this valve design is required to move makes it the fastest known method for applying conformal coating to a circuit board and it is difficult to beat the cycle times offered by these systems. However, the physics of applying a large volume of material, at high speed and under high pressure can lead to the material having a significant degree of momentum, which when it hits the side of a component can cause uncontrollable splashing.

Also slight changes in viscosity, fluid flow rate or material solids content can dramatically alter the coating spray pattern. Therefore, constant monitoring of viscosity, coating to solvent ratio and material flow rate is needed. When relying on factory air pressure to pressurise the fluid, small fluctuations in air pressure can lead to changes in the width of the stripe, leading to voids or encroaching into keep-out areas, thus it is often necessary to use a pump to regulate the fluid pressure in critical applications.

With the orifice in the nozzle being extremely small for airless valves these types of valve can be more prone to clogging and can be more difficult to clean out.

Finally, the high volume of low-viscosity material applied can make this type of application much more prone to capillary and other unintended forms of material flow, through via's and into keep-out areas including the back-side of the board.

However, for simple boards where cycle time is the prime requirement, it is difficult to beat airless spray as a selective coating technique as long as good process control is used.

Atomised Spray Valves

Atomised spray valves rely on mixing the material with air, to break it into small, discrete particles and shape the resulting spray pattern to form a well defined pattern.

Atomised spray valves used for selective conformal coating applications generally fall into two main categories, either High Volume (of Air) Low Pressure (HVLP) or Low Volume (of air) Low Pressure (LVLP).

HVLP style valves generally need more atomizing air at greater air pressure than LVLP valves to generate atomization and therefore the spray patterns tend to be less well defined.

The LVLP style of valve is also very good at turning viscous liquids into particles. With this type of application technology it is very possible to spray almost anything that is vaguely liquid and somewhat self-levelling and even some materials that are not.

Figure 4: HVLP and LVLP spray valves for selective robotic conformal coating

With the coating market moving more and more towards non-solvent based 100% solids coating this valve is often the most suitable solution for applying these materials.

However, HVLP spray valves do provide a wider spray pattern, which means they can provide a faster cycle time compared to LVLP.

This faster rate can compensate for the general slow movement rate that atomised spray has to use compared to film coating due to the limitations imposed by the process.

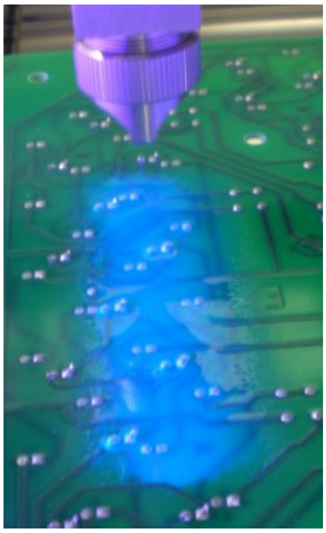

Figure 5: HVLP Spraying

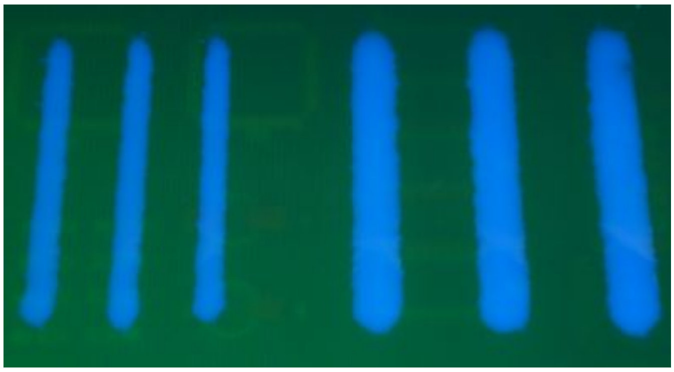

Figure 6: LVLP valves generate atomisation and therefore the spray patterns tend to be less well defined than Airless Spray

Dispensing Valves

Dispensing Valves usually fall into either a traditional needle style or contactless style.

Contactless Valves

As the name implies, these valves typically operate between 2-10mm from the surface onto which they are dispensing and can apply very small dots or well defined lines and can be used to coat critical areas or discrete components. These types of valves generally work best with materials with some degree of thixotropy and medium apparent viscosities. These valves do rely on unhindered access to the coating area and are most suitable for SMT technology.

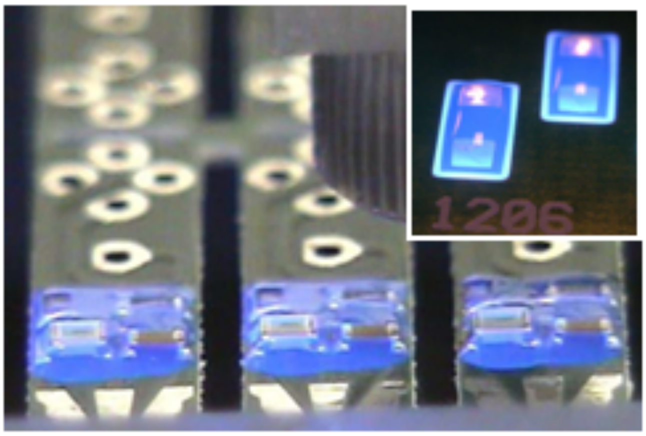

Figure 7: Contactless Dispensing

Needle Dispensing

This style of valve can be used to dispense more or less any material, from a no-flow gel to a water-thin consistency and the length of the needle used can help to ensure access between very tall components for example.

Figures 8 & 9: Dispensed lines of coating from a needle from an automated dispensing system

Note that because the needle is in contact with the material and close to the surface being dispensed, the dispense speed is limited as a function of the materials extrusion flow characteristics, often meaning needle dispensing is a relatively slow process.

Further, depending upon the rheological properties of the material being dispensed, you can sometimes see a dog bone dispense shape as above when dispensing high viscosity materials, with more material being applied at the start and the end of the pattern. This can in theory be compensated with offsets but can be a technical challenge.

Summary

Reviewing the three standard valve technologies, it can quickly be seen that choosing the wrong valve(s) set up can quickly lead to problems. In fact, the coating valves are, in many respects, the most important part of any coating system.

As modern boards continue to increase in complexity and component density, and machines become less dedicated to single product production, it could increasingly become necessary to require a minimum of two valves and quite often more on a machine to avoid compromising on quality and giving flexibility by using the best valve for a particular material and application.

Related Documents by SCH Technologies that may be of interest:

Designing Circuit Boards for Selective Robotic Coating Application

Conformal Coating Selective Spraying and Automated Robotic systems

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