Conformal coating improves the reliability and life of solar inverters

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While the solar and photovoltaic industries have a long history, the industry size is rapidly expanding. Looking at existing technologies used in other electronics industry applications can offer solutions to some of the manufacturing needs the solar and photovoltaics industries now face.

Conformal coating has been used for many years in the electronics and automotive industries to protect the electronics from environmental factors such as moisture, dirt and chemicals. New methods of selective coating and process control make this technology easily adaptable to protect the electronics in solar inverters from harsh environmental factors. This leads to improved reliability and longer inverter life for the photovoltaic (PV) system in the solar industry.

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Introduction

The solar inverter is an essential part of every photovoltaic system. Its purpose is to change the direct current (DC) of electricity from a photovoltaic array to alternating current (AC) to power home appliances or a utility grid. Reliability is one of the most important aspects of the solar array. However, solar energy is still expensive. To make it more competitive with other forms of energy, and thus more affordable and accessible for general use, it is necessary to drive the cost down. In an effort to reduce cost, however, care must be taken not to sacrifice the reliability of the photovoltaic systems.

Inverters in solar installations are exposed to the sun, so there are moisture, humidity, temperature and contamination concerns. Inverter reliability is important, so maximum power can be pulled from the solar cells and converted to electricity. The life expectancy of the solar cell is 25-30 years, so it makes sense for the inverter that operates a solar cell to be reliable for that duration. Poor reliability can damage a manufacturer's reputation.

Using conformal coating, an existing, proven technology, is an efficient, cost-effective method to achieve that reliability.

The conformal coating process

Conformal coating can be used to coat the printed circuit board, wiring and soldering between power switches and discrete components of the inverter as well as those components themselves. The coating is applied during the manufacture of the inverter by an automated conformal coating system designed for precision coating of small electronic parts. Although several types of coating materials can be used, silicones, urethanes or acrylics are the ones generally used for a PV inverter.

Historically, non-selective spray coating and dipping were the first conformal coating processes, but had to be used in conjunction with masking to shield components that could not be coated. These processes were done manually or using automated equipment. Coating was used for large areas where precision and accuracy weren't required because of the masking processes and board layouts; typical masked components would be displays, connectors, and test points. However, electronics have shrunk in size and, especially in the automotive and telecommunications industries where parts were small, there were more components, and the space between components was tight. Placement of the fluid had to be more exact. Speed became a factor as boards needed to keep up with the volumes in these industries. Automated in-line coating solutions became a requirement. Accommodating smaller areas of coating became a challenge, along with developing new, selective coating applicators.

To meet these demands, manufacturers of conformal coating equipment developed new technologies and processes. One major technology development was jetting, which enables automated selective, precision coating at high speeds. Selectivity is important due to the process improvements in not having to mask sensitive components. It means the coating will be dispensed exactly where intended. In older coating methods, the coating was sprayed through an atomized gun with a large spray area, so it was difficult to control where the fluid landed. Masking was needed to cover the parts that didn't need coating. The masking process is labor intensive, time consuming and expensive, and because it is removed after the coating operation, it does not add value to the final product. It involves making a mask to keep certain parts covered while exposing the parts that need coating. Precision jet dispensing eliminates the need for masking.

Jetting is a form of dispensing that has been around since 1983. It is a non-contact method of depositing fluids. Jetting is the process where fluid is rapidly ejected through a nozzle and uses the fluid momentum to break free from the nozzle. A discrete volume of material is ejected with each jetting cycle. Jetting is fast because when moving from one dispense location to the next there is no Z-axis that has to move up and down. High flow rates can be achieved, fluid can be deposited in tight places with much smaller keep-out areas, and the ability to use a wide range of fluids that are deposited in a vast number of configurations allows for flexibility. In inverters, where there are components of different heights and irregular component placement, using a jetting system makes it possible to easily accommodate the coating requirements while working with the selectivity requirements of closer component placement.

Several different types of applicators are available for high volume coating platforms, so the correct applicator can be matched to the material being dispensed. For additional precision without compromising throughput, applicators with multiple modes of operation or multiple applicators on the same system can be used.

Advancements in conformal coating systems

Today's conformal coating systems provide up to 30 percent faster throughput than just a couple of years ago, and options include vision systems, closed-loop process controls, traceability and advanced integrated software for high quality and increased productivity. Advanced monitoring enables the manufacturer to keep the coating process in control and allows for statistical process control (SPC). Fluid and air pressures are set and monitored through software-controlled electronic regulators, allowing traceability and flexibility for these critical parameters. Data logging and automatic adjustments of other parameters such as fan widths, fluid temperatures, and flow rates, further ensure the quality of the coating process. Regulator knobs and controls are being removed from the equipment so critical parameters can't be changed without engineering approval. Having the controls programmed through the software maintains a consistent process and eliminates constant tweaking of the parameters. The process and material parameters that are specified are stored with each program for each product to maintain engineering level control of optimized parameters.

Vision systems help to ensure that the work-piece is properly placed and aligned and the coating hits the correct target. They make programming easier and dispensing more accurate. Process control and feedback systems result in better quality, higher reliability, and reduced variation in the coating process. Today's conformal coating systems enable better process control as systems include technologies to control and maintain the viscosity of the fluid and monitor its flow. Having closed-loop process control and traceability during the coating process provides a record of the conditions and settings used in the conformal coating process. System control reduces wasted time and fluid, increases yield, and results in a lower total cost of ownership.

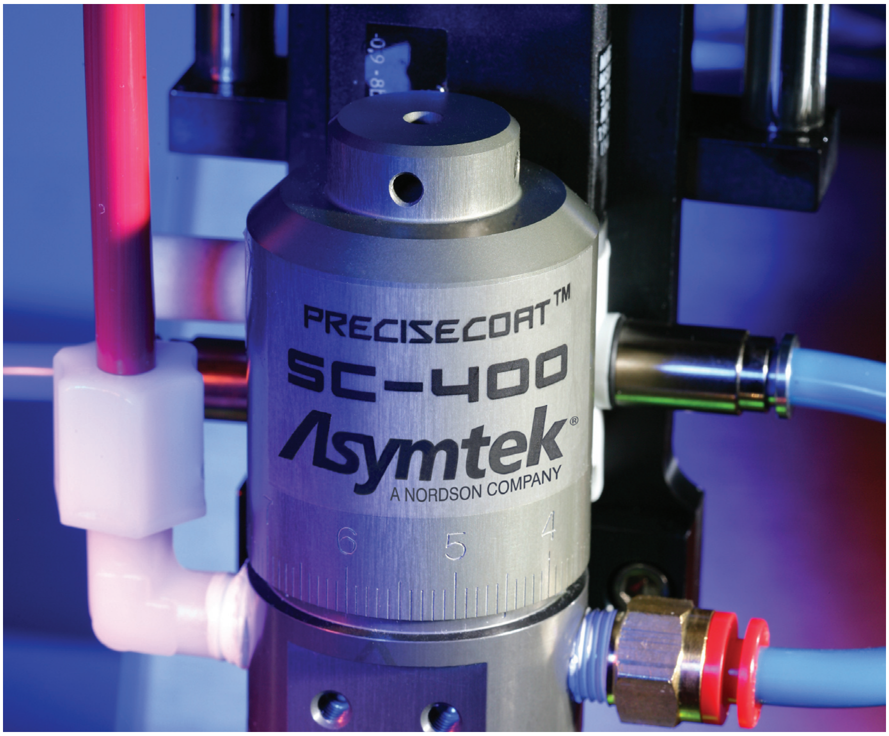

Figure 1. Conformal coating jet for applying coating materials to highly selective areas.

Additional dispensing and coating applications in the PV industry

Jet dispensing and conformal coating have found a place in several other solar and PV applications. Coating has been used to coat thin-film PV materials on substrates, as protection materials for the solar cell edges and concentrating optics, and for the electronics around the solar cell. This has been accomplished with a dual valve system, which can be used to apply two separate fluids during the manufacturing operation. Glue can be dispensed to attach the concentrating optics onto PV chips. Solar etch materials can be applied as can silver contacts and electrolytes which can be used to dye the solar cell.

While the solar and photovoltaic industries have a long history, the industry size is rapidly expanding. Looking at existing technologies used in other electronics industry applications can offer solutions to some of the manufacturing needs the solar and photovoltaics industries now face. Decreasing cost doesn't have to mean decreasing reliability. Conformal coating is an easy and effective way to get that reliability in photovoltaic inverters.