Dispensing and coating processes in the photovoltaic industry

High-quality module production

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The challenge in the production of solar cells and the subsequent assembly of modules, among other things, is to reduce production costs without sacrificing quality. The parallels to the semiconductor industry are unmistakable, and photovoltaics is at a crucial turning point in regards to its methods of production. In the place of manual and small batch production, manufacturing is turning more and more towards automated mass production. In order to produce a cost-effective, high-performance module, one must reduce material costs, optimize production processes and, at the same time, increase the reliability and durability of the modules.

In many cases, one can apply proven technologies from the electronics and semiconductor industries to the photovoltaic industry. This eliminates the need to develop new methods with their correspondingly high costs and the associated risks of "special" procedures.
For example, selective protective coating has long been used with success in the electronics and automotive industries to protect sensitive electronics from premature failure due to environmental influences such as humidity, temperature changes, dirt or the like. Such high environmental demands are made in photovoltaics with solar inverters, which can have a significant impact on the system's efficiency. Besides efficiency, reliability is one of the most important aspects for the entire PV system. The production of solar energy is still relatively cost-intensive and return on investment takes a number of years. Precision coating systems can reduce these costs because of the increased reliability and quality they bring to the photovoltaic manufacturing process. In addition, they offer all the throughput and repeatability advantages of an automated system and equipment can be scaled from batch processes to volume manufacturing.

Automatic fluid dispensing system

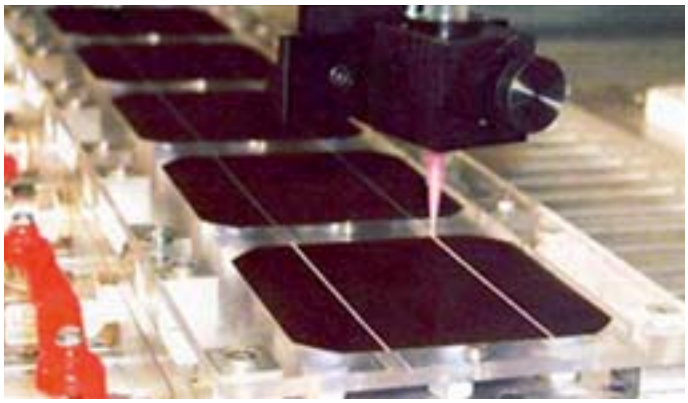
Coating for protection

In order to improve the weather resistance capabilities of solar energy, as compared to other forms of energy, it is necessary to reduce costs and to improve reliability. The inverter plays an essential role in attaining long-term and reliable efficiency, but also suffers from high climactic exposure stresses. By coating the inverter with protective layers, the dielectric properties, mechanical resistance and tracking resistance of the assemblies are substantially improved. It brings extra insurance against premature failure due to factors such as moisture, migration, pollution and other contaminants. Structural conditions require the application of a uniform thickness and reproducible patterns, in addition to a selective application of the coating. Nordson Asymteks coating equipment and the process regulation developed with it have the ability to apply protective layers automatically and selectively in critical areas of the inverter. This can ensure a significantly higher reliability, creating a longer lifetime, while at the same time reducing failures and downtime that improves the efficiency of the PV equipment.

Coordinated solutions

Especially useful for this application are the jet valves, which apply the coating without contact, similar to an ink-jet printer. By using pulse width modulation and control capabilities, flexibility is significantly improved. It is possible to move to a defined position and stop to apply fluid to the targeted, small areas in order to achieve maximum selectivity. Depending upon how many pulses are controlled by the valve, dot size and thickness can be adjusted while conforming to individual needs. Jetting also enables coating of complex geometries, lines or larger surfaces at higher speeds. In these cases, the valve is driven at a constant speed and controlled with a predetermined frequency. This can be applied in adherence to a programmed travel constant and without contact to individual points of the coating material on the surface of the printed circuit board assembly. Dot diameters and spacing can be set via the software so that different points are kept from touching each other, thus forming a homogenous

Jet valve



Conductor lines

Soldered connective sockets

and uniform protective layer.

There are also many other processes in the earlier stages of solar cell production where liquid or coating material must be applied with utmost precision. For example, adding conductive adhesives for conductor lines. By using the selective application to jet flux, soldering can be performed without causing contamination, thus increasing the reliability of the solder joint. In the concentrator cells, by using coating, semiconductor surfaces are saved and the cell efficiency rate is significantly improved because the coating protects sensitive areas from the heat produced as the sun is concentrated through the lenses. In the concentrator, the semiconductor material is often affixed with special adhesives. On finished modules, the connector wires are usually equipped with electrical connectors. Choosing the correct fluid and application procedures for encapsulation and final dispensing is not easy because of stringent requirements for the final product. The complexity is often underestimated at the beginning of development. Working with a manufacturer of automated fluid dispensing and coating equipment in the design phase helps to ensure a successful process. In another application, expensive cuts need to be manually inserted into the housing grooves, which are then bolted down in order to form a housing seal for junction boxes. Instead, to reduce manufacturing costs and automate the process, a liquid seal could be applied to the housing groove in an automated fashion. In order to fulfill requirements in regards to reliability, consistency and to exactly replicate applications, it is necessary to employ a precisely coordinated solution. Traditional procedures can quickly reach their limits. Only by ensuring a precise interplay of platform, software and dispensing valve can reliable production and processes be developed.

Assured process

In order to keep the dispensing and coating processes stable over a longer period of time and to gain significant traceability data requires intelligent systems to capture and automatically compensate for changes. While many systems use closed metering systems to achieve the required positioning accuracy, in most cases the closed loop system used is not accurate for dispensing processes. Due to changes in material characteristics, such as elasticity, viscosity, and flow behavior, it is often very difficult to keep the process stable over a given time period. Changes in viscosity that can be caused by time, temperature or humidity, can have an impact on classic dispensing procedures by directly affecting the flow rate and therefore the volume and geometry of the fluid. It is obvious that without additional regulation with such a process, a secure and reproducible application cannot be ensured. Using non-contact jetting and coating processes, many different fluids can be applied in many parts of the photovoltaics manufacturing process. During the process with the DispenseJet valve the material is fed into the jet valve at low pressure. This low pressure serves only to fill the valve, and is not used for measuring the needed volume of fluid. A special ball seat is used as a locking mechanism. By controlling the valve, the ball is lifted out of its seat, the material flows but does not yet come out of the nozzle. Only in the closing process is a defined volume determined as the space is displaced by the returning ball and the substance is "jetted" to the respective substrate. This operation significantly improves reproducibility. Depending upon the application, a smaller or larger distance between the nozzle and the substrate can be selected. A major advantage for jetting is the increased speed; in addition, there is no contact with the substrate. In application, the cycle time between the two doses is approximately six milliseconds. This makes it possible to have significantly higher dispensing performance. It is useful to determine the actual flow rate and to monitor it in order to ensure a stable, long-term process. The patented dispensing system uses an automatic routine in the jetting program, and therefore also delivers important information which is useful for static process data capture and traceability functions. There is also a high-resolution precision scale in the dispensing platform and the software can trigger the individually-set intervals automatically with which the actual flow rates are set in the jetting valve. Then a comparison is done automatically to check to see that the measurement value is still within the given tolerance range. All measurement values are automatically recorded with date and time in a log file, making it possible to ensure seamless tracking and process monitoring. Once deviations to the original value are detected, compensation is automatically made to ensure that the process is kept stable within the limits set. If the measurement shows that the tolerance range is exceeded, or if an error message is generated, further processing is suspended in order to prevent the manufacture of faulty products.

Nordson Asymtek dispensing and coating equipment can be set and configured exactly to individual specifications and therefore easily integrated into existing photovoltaic production processes. Precise controls and innovative processes control dispensed fluid volumes, and coating is achieved with extraordinary precision and reproducibility, making it possible to achieve higher material utilization, a more efficient production process and to assist in improving the reliability and quality of PV modules, ultimately reducing costs.

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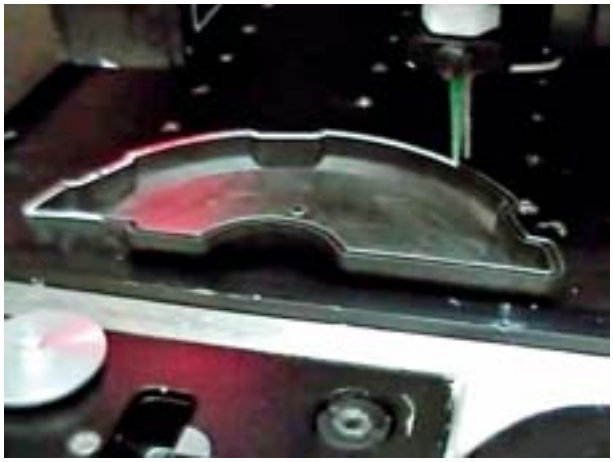

Direct application of a housing seal