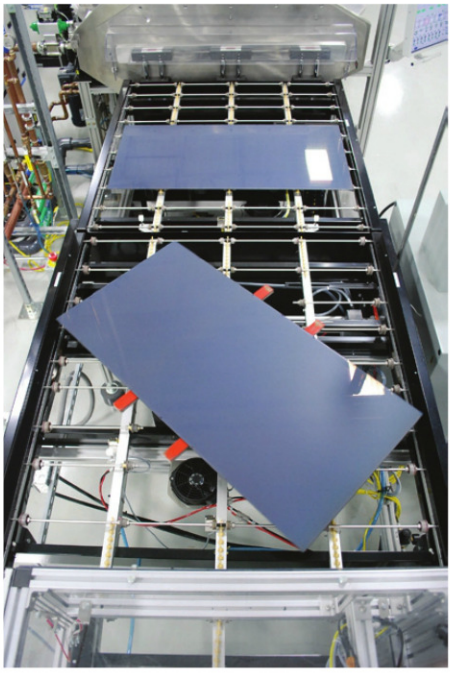

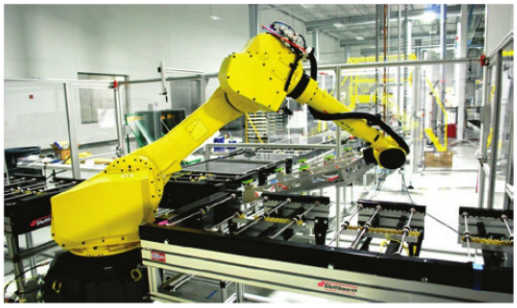

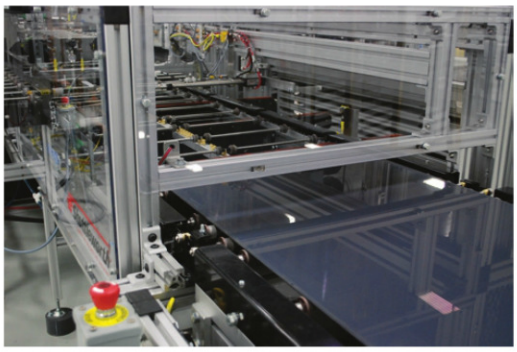

Thin-Film CIGS Manufacturing

Streamlining material handling systems

By Jim McMahon

DESPITE PHOTOVOLTAICS (PV) being one the fastest-growing energy technologies, the sharp decline of price levels in the worldwide solar module market has forced manufacturers to re-engineer production processes and streamline their operations to stay competitive.

The most promising of the thin-film PV materials in the industry of late is CIGS (Copper Indium Gallium Selenide), which has demonstrated lab efficiencies on par with traditional crystalline silicon technologies—while having the potential to substantially reduce costs. CIGS has also shown potential for higher energy yield response to cloudy and diffuse light circumstances. Lab results have demonstrated CIGS to achieved performance levels of 20.1% efficiency (as reported by ZSW of Stuttgart, and verified by Fraunhofer ISE).

Even with the best materials, however, efficiency is required. Today, thin-film PV manufacturers require highly automated systems to achieve the cost-effectiveness needed to compete on the world market. Thin-film PV manufacturing processes must provide continuous high-speed throughput, while maintaining zero defect rates, and be capable of shifting production volumes quickly with minimal set-up times.

A chemical reaction

To succeed in today's solar market, innovation and efficiency is imperative. Effectively streamlining the manufacturing process of CIGS modules has proven successful for some companies. One manufacturer, in particular, has weathered the market shift by developing a proprietary advanced CIGS manufacturing process. Implementing a two-stage reactive transfer process that separates chemical deposition from synthesis has proven quite worthy in producing more practical and economical solar panels.

This unique process relies on the chemical reaction between two separate films to form CIGS. These films are brought into close distance, and rapidly reacted under pressure in the presence of an electrostatic field as heat is applied. The use of two independent thin-films provides the benefits of independent composition and flexible deposition technique optimization, eliminating pre-reaction prior to the synthesis of CIGS.

The separation of the deposition process from the synthesis step further offers an ability to control key parameters required for quality material performance, resulting in the efficient absorption of a broadband of the solar spectrum. The process uses a fraction of the expensive semiconductor material utilized in silicon modules. The monolithically interconnected modules mean no cost-cutting, testing, binning, or stringing of cells. The modules are true PV integrated circuits (PVICs).

Streamlining movement

To produce any high-quality panel, especially one that involves monolithically interconnected CIGS, requires the right equipment. Streamlining CIGS manufacturing and throughput means all aspects of material handling must be considered.

Transporting CIGS panels to the production processes throughout a plant, and providing precision in-feed and take-away of the glass panels for these systems requires an integrated flow of material handling systems to accomplish seamless throughput.

Case in point: to design and implement the material handling system for the CIGS manufacturer previously mentioned, more than 1,000 linear feet of automated conveyor systems were custom-designed and installed into the CIGS plant. This was done so as to interface with the facility's robots and automated production equipment. A multitude of custom devices and mechanisms were incorporated throughout the system to stop, buffer, transfer, rotate, and raise and lower the four-foot by two-foot panels.

The conveying system utilizes an open roller and roller-shaft surface design, incorporated throughout the facility. This allows devices to easily be positioned from underneath, providing a clean design and the ability to move CIGS panels without interference. Product stops, product positioning clamps, and photo eye sensors were all mounted below the roller surface and came up underneath the rollers to access the panels.

Lift-and-rotate (LAR) devices are used to change the orientation of the panels on the conveyors. The LAR devices rest just below the roller surfaces until activated. The CIGS panel is conveyed to a product stop, which positions it over the LAR device. The LAR, activated by a sensor, then lifts the panel above the roller surface before rotating it to the desired orientation. The LAR device then lowers the CIGS panel to the conveyor surface where it's conveyed in its new orientation.

Lift-and-transfer (LAT) devices installed in the material handling system are used to provide a smooth and accurate CIGS panel-transfer, at a 90-degree angle to the original transport direction. The LAT mechanism is mounted within the conveyor frame, and consists of two or more mini-belt conveyors that reside below the roller surface when deactivated. Upon activation, the LAT device lifts the product above the conveyor surface and transports it 90-degrees in either direction to a pre-determined point. Lift-and-transfer devices can transport panels very precisely to multiple conveyor lanes based on the panel/order identification tracking system.

Equipped with a special form of conveyor technology, which provides low-line pressure throughout the continuous-motion accumulation conveyors, it allows for precise product placement and virtually eliminates CIGS panel damage by creating low back-pressure. Should the line need to slow or stop, the conveyors can continue to take panels from the upstream line for a specified period of time instead of stopping the line. A low-pressure accumulation buffer absorbs irregularities in the production flow, and provides a smooth, even flow on the line.

Conclusion

Producing high-quality materials for the solar industry is a must to be successful in today's market. But, more than simple quality is quality and speed in manufacturing. To compete, products must be durable, reliable, and ready for use. Streamlining production with a material handling system that works fast can make or break a solar manufacturer's business.

Jim McMahon writes on material handling automation.

HelioVolt Corporation is a manufacturer of high-efficiency thin-film solar modules for the commercial rooftop and utility markets. The company's rapid manufacturing process produces high-efficiency modules at low-cost.

Shuttleworth is a designer and manufacturer of solutions that solve company's material handling challenges.

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