News

» Conveyors for wafer thin PV cells

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Photovoltaic (PV) production is the world's fastest-growing energy technology, increasing by an average of 48 percent each year for the past six years.

Evolving wafer-based photovoltaic technologies demand specialized machinery to accommodate these fragile and ever-thinning PV cells.

Automated PV cell manufacturing equipment must provide continuous and high-speed transport and processing while maintaining low breakage rates.

Manufacturers must be capable of shifting production volumes quickly, such as ramping up to higher volumes and increasing throughput, while minimising product damage and striving to reduce costs to manufacture the cells.

Manufacturing efficiencies and costs must be addressed from the wafer to the solar cell module, and to the solar panel level.

A key, but sometimes neglected material handling area is machinery infeed and take-away conveyors.

One such system developed by Shuttleworth Inc. for a PV solar cell test unit which was designed and built by Owens Design, features low back-pressure accumulation on the conveyors to minimise photovoltaic cell damage, and multi-lane throughput on each conveyor for high-volume, consistent product movement on a reduced footprint.

This system represents an excellent process solution to the production throughput challenges encountered in wafer-based photovoltaics.

Owens Design, Inc. (Owens) designs and manufactures custom, complex capital equipment for companies in the semiconductor, solar, hard disk and related industries.

The company combines its expertise in electro-mechanical design, motion control and program management to create innovative systems for its clients.

Its in-house mechanical, electrical and software engineering groups integrate with its manufacturing teams to provide smooth development cycles and reduced product costs.

Owens has extensive experience building customized machinery for photovoltaic manufacturing processes, handling both very thin, fragile wafers and cells, and thin-film applications under high-speed processing and test conditions.

Photovoltaic Cell Testing The equipment that Owens developed is an automated work unit which characterises PV cell efficiency using a current-voltage (I-V) test.

The I-V test subjects a PV cell to a calibrated light source to generate electrical current at different voltages. Using this data, the cell's efficiency can be characterised.

The system then sorts the PV cells according to eight different efficiency ratings for subsequent use in solar panels where cells with similar efficiencies are grouped to maximise the overall panel efficiency.

The system works like this:

Magazines containing PV cells are loaded onto one of two input conveyors, which advance the magazines into the system.

Integrated clamping mechanisms clamp the magazines precisely over an elevator which indexes the cells upward. The fragile cells measure 6" x 6" and a very thin 150 to 300 micrometers in thickness.

Each cell is then robotically picked from the elevator, placed on an indexer and moved under the light source. The cell is flashed to capture the current-voltage plot.

When completed, the PV cell is picked up by an output robot and placed in the appropriate output elevator. When full with cells, the elevator is lowered and the cells are removed on one of eight take-away conveyors, completing the testing and sorting cycle.

Multiple functions are being executed simultaneously making the system a continuous process. As one PV cell is moved to the next step, another is put into position every 3.6 seconds.

1,000 cells can be conveyed into the system, tested, sorted by eight different efficiency requirements, and then conveyed out of the machine each hour.

Multi-Lane Infeed and Take-Away Conveyors supplying the machine are two double-lane, 4-1/2 linear-foot external infeed conveyors, and four double-lane, take-away conveyors of the same size which are handling the magazines.

The two multi-lane infeed conveyors, designed and built by Shuttleworth, provide a unique segmented roller surface that allows the PV cell magazines to travel down two separate aisles on the same conveyor, and to convey and accumulate independently from one another.

This surface design saves on floor space and reduces costs that would be incurred by using multiple conveyors running products in independent lanes.

"We can load the left lane and have an accumulating product – a full left lane – while we are still loading the right lane," says Tony Smith, Engineering Manager with Owens Design.

"By using accumulation conveyors, we greatly reduced the number of motors and controls required by an alternative approach, such as segmented belt conveyors.

"This proved to be a significant cost savings."

The take-away conveyors work similarly, but using four double-lane conveyors, for a total of eight lanes handling the output magazines – depending on the cell efficiency values.

The conveyors are also equipped with Slip-TorqueÒ technology by Shuttleworth, minimizing magazine and PV cell damage by creating low back pressure.

Low line pressure throughout the continuous-motion accumulation conveyors allows for precise product placement.

Should the testing machine need to slow or stop, the conveyor can continue to take production from the upstream line for a period of time instead of stopping.

A low-pressure accumulation buffer absorbs irregularities in the production flow, and provides a smooth, even flow on the line.

Slip-Torque utilizes individually-powered rotating roller shafts and loose-fit rollers, which become the conveyor surface, powered by a continuous chain to control the drive force for the PV cell magazines.

The size and weight of the magazines determine the driving force and roller selection. When the magazines stop on the surface of the conveyor, the segmented rollers beneath the cells also stop, generating low back-pressure accumulation, minimising magazine and cell damage.

The control system for the tester consists of a touch screen HMI running Windows XP, a Mitsubishi PLC providing control of the cell and magazine handling systems including the infeed and take-away conveyors, and an I-V flash test module that generates the data for each tested PV cell.

Because of the open roller and roller-shaft surface, the conveyors allowed devices to easily be positioned from underneath, making for a very clean design.

Product stops, product positioning clamps – such as three-sided positioning to accurately position the magazines into and out of the elevators, positioning centers and photo eye sensors were all mounted below the roller surface and came up underneath the rollers to access the magazines.

"We worked collaboratively with Shuttleworth to integrate stops, clamps, and clearance for our intake and discharge elevators, along with other conveying features," Smith explains.

"This joint engineering allowed us to rapidly prototype an extremely functional and smoothly-integrated system."

About Shuttleworth

Shuttleworth, Inc. designs and manufactures conveyor systems that accumulate, flip, stack, rotate, push, divert and index products between manufacturing processes.

For more than 46 years, Shuttleworth has partnered with customers in a variety of industries, designing, building and integrating conveyors to increase productivity, optimise machinery and reduce downtime.

The company builds system solutions for manufacturers in many industries including electronics, solar, medical, pharmaceutical, food, printing, automotive and health.

For more information t.eckert@shuttleworth.com.