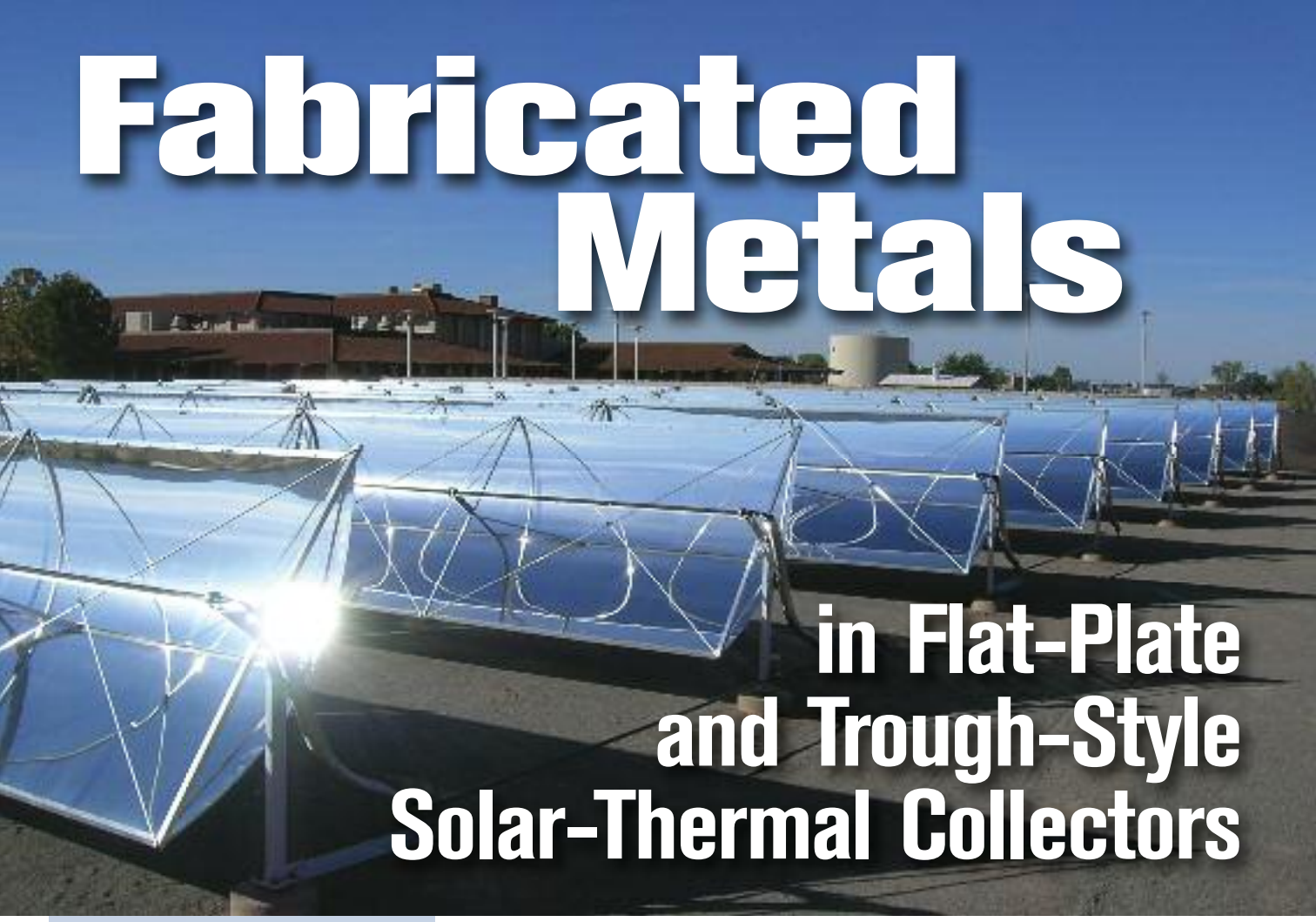
Fabricated Metals in Flat-Plate and Trough-Style Solar-Thermal Collectors



Pay attention: The solar-thermal energy market—which converts the sun's energy into hot fluids or steam—is set to take off. North American metalworkers already are benefiting, fabricating frames, collector panels and absorber fins.

BY BRAD F. KUVIN, EDITOR

Crews at a solar-energy field in Arizona are installing 32,000 frames, each measuring 12 by 5 m, while another 20,000 frames are going up at a field in the Mohave Desert, and those projects are just at the cusp of what could become a booming industry in the next year or two in the United States. One concentrated-solar-power field can consume as much as 6 million sq. ft. of sheetmetal. Using thin-gauge aluminum-alloy reflective panels shaped into parabolic trough collectors, they use the sun to heat water or to generate steam for a variety of industrial process applications such as food preparation. Or the steam can drive power-generating turbines to make electricity.

Just within the last couple of months, the U.S. Dept. of Energy granted a $1.37 billion loan guarantee to Brightsource Energy that is expected to clear the way for more than 15 gigawatts of solar projects in California. Says industry expert and manufacturers' representative Rick Hames of Global Sourcing Solutions, who represents some 10 solar-energy companies: "There are several huge solar-thermal projects in the prototype stage right now that we expect to close later this year and early in 2011. So while many solar applications are still using solar panels with photovoltaic cells that convert sunlight directly into electricity, there is a small but rapidly growing group of manufacturers using the more cost-effective solar-thermal design. The systems employ a sheetmetal substrate with a thin-film reflective surface to capture solar energy. Manufacturers that can process the millions of square feet of sheetmetal and fabricate and assemble the frames for these systems will have plenty of opportunities in this industry very soon."

Cosma and Tower Already in the Game

Big automotive-industry suppliers already are supplying solar OEMs, so it's only a matter of time until opportunities

Parabolic trough solar-thermal collectors like those shown here will soon appear in huge solar fields throughout the western United States. One concentrated-solar-power field can consume as much as 6 million sq. ft. of sheetmetal, in addition to the fabricated aluminum frames that support the collectors.

To manufacture absorber fins for flat-plate solar-thermal collectors, Alanod-Westlake Metals' laser-welding line joins coated 0.5-mm-thick aluminum, slit to 120-mm wide, to 10-mm-dia. copper tube. Strip and tube feed from coils simultaneously through the 60-ft.-long production line that runs continuously at 7.5 m/min.

open up for others in the supply chain. Magna's Cosma stamping facility in Troy, MI, has adapted its press lines and robotic resistance-welding cells to manufacture and assemble reflective racking and structural components for OEM manufacturer Skyline Solar, Mountain View, CA.

Likewise, Scottsdale, AZ-based OEM Stirling Energy Systems contracts with Tower Automotive to fabricate metal support structures and stamp aluminum substrate to which it attaches mirror facets. Again, heat collects at the mirror surface, and then is reflected into a power-conversion unit that converts the heat to drive a generator.

Summing up this expanding market, Hames adds that, "during just the last two years, this industry has installed more than 40 million lb. of extruded-aluminum frames for solar applications, and we're only at the tip of the iceberg."

Solar-Thermal on a Smaller Scale

Solar-thermal systems on a much smaller scale, for water heating in homes and businesses, including community swimming pools, also have gained a foothold. And in my hometown of Cleveland, OH, one metal-service center has carved a substantial niche in the market, processing specialized sheetmetal and then laser-welding the material to fabricate collector fins.

German-based Alanod-Solar has begun to manufacture its Miro-Fin absorbers at a metal-processing facility it purchased late in 2007—Alanod-Westlake Metal Industries, in North Ridgeville, OH, just a few miles west of Cleveland. Alanod, which takes a different approach to collecting solar energy by offering systems that absorb rather than reflect the sun's rays, made its name in the lighting industry by marketing reflective-aluminum fixtures for the energy-efficient T5 lamps that have taken over the market. And, likewise, for several years Alanod-Westlake Metals has enjoyed—and continues to do so—tremendous success turning the specially coated coils of aluminum into blanks for light-fixture OEMs all over the United States.

Now Alanod-Westlake Metals is accompanying its parent company on a venture to expand the solar-thermal industry in North America, hoping to mirror the success it's had in Europe with its absorptive solar collectors.

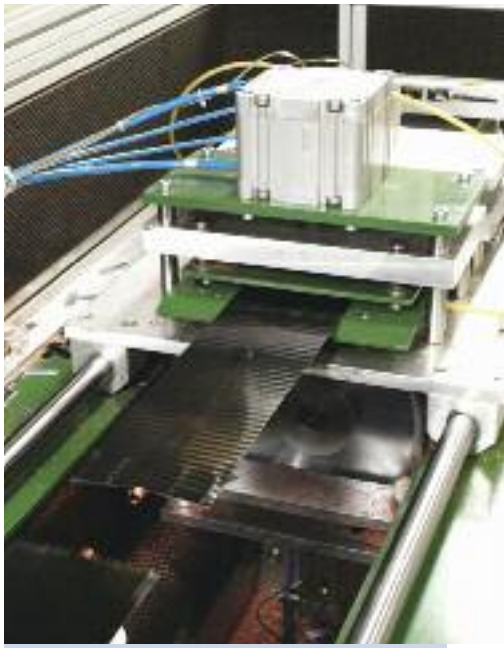
"The company recognized starting in 2000-2001 that its retrofit lighting products had probably a 10- to 15-yr. run in the market, as large companies changed over their lighting fixtures to become more energy efficient," says Alanod-Westlake Metals vice president Frank Lee. "When they learned that the PVD coating process they use to apply the reflective material to aluminum also could be used to apply an absorptive coating to aluminum as well as copper substrate, it quickly made a move into the solar-thermal industry. Its solar-energy presence in Europe has grown tremendously since then, and now Alanod looks to do the same here."

Alanod-Westlake Metals historically has specialized in processing light-gauge prepainted steel and coated aluminum—blanking and slitting primarily, with a bit of stamping and fabricating thrown in. Nearly all of its work is surface critical.

"We got into that work in the late '70s and through the '90s primarily for the appliance industry," says Lee. "In the mid-'90s Alanod began contracting us to blank its coated reflective material for lighting OEMs, and in 1999 asked us to install a slitter specifically to support its lighting customers. By 2007 we were slitting more than 1 million lb. of the material per month, accounting for 60 percent of our overall throughput. Finally, in November 2007, Alanod acquired 75 percent of the company."

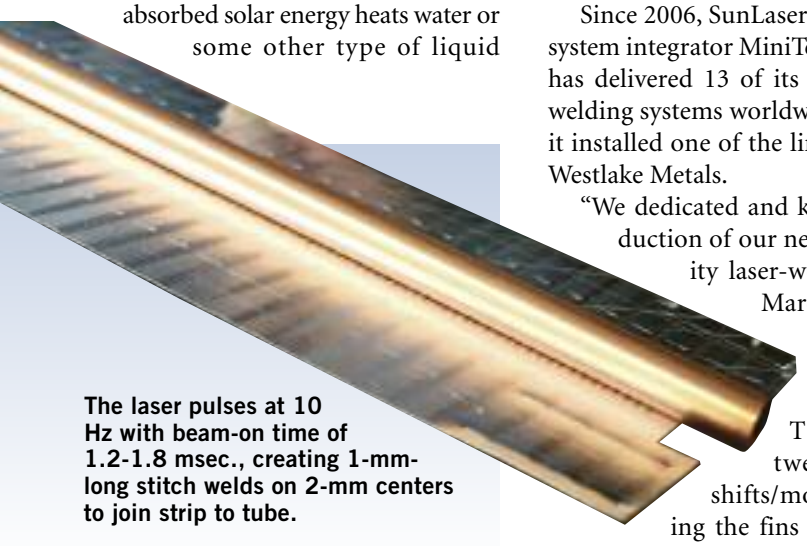
Solar-Fin Production Line the First in North America

When the parent company sought an entry point to the North American market for its solar-thermal collector materials, called mirotherm (coated aluminum sheet) and sunselect (coated



A flying cutoff die cuts welded fins to length. Note the gentle corrugation pattern to the strip to add rigidity. A protective film on the top of the strip maintains the critical surface integrity during processing.

copper sheet), its Ohio entity was the obvious choice. Fabricating the coated sheet into absorber fins (called Miro-Fins), which then are marketed to flat-plate collector manufacturers, requires laser welding the sheet to copper tube. Once the collectors are installed—on top of your house, for example—absorbed solar energy heats water or some other type of liquid flowing through the copper tube.



The laser pulses at 10 Hz with beam-on time of 1.2-1.8 msec., creating 1-mm-long stitch welds on 2-mm centers to join strip to tube.

To enable mass production of the laser-welded fins, Alanod Solar worked with Swiss company SunLaser Consulting GmbH to develop an automated laser-welding line that in 2008 was declared by the European solar industry as "the new industrial standard."

Since 2006, SunLaser, working with system integrator MiniTec Schweiz AG, has delivered 13 of its turnkey laser-welding systems worldwide. In March, it installed one of the lines at Alanod-Westlake Metals.

"We dedicated and kicked off production of our new high-capacity laser-welding line on March 9," says Lee, "with great fanfare and expectations. The line runs twelve 10-hr. shifts/month, processing the fins at 7.5 m/min. and accounts for about 15 percent of our overall sales. The hope is that, as it has done in Europe, SunLaser will eventually install its laser-welding production lines in several facilities throughout North America. That would allow us then to focus on providing slit mirotherm and sunselect coils to numerous collector-production facilities," says Lee.

The market potential is definitely there, as the solar-thermal industry grows and collector manufacturers become more automated and productive. "Most U.S. collector manufacturers assemble the units manually," says Lee, "at a rate of 20 to 25/day. Automated lines in Europe produce as many as 30 collectors/hr."

Tube Straightening, Strip Profiling

The laser-welding line joins coated 0.5-mm-thick aluminum or 0.2-mm copper strip, slit to 120-mm wide, to copper tube either 10-mm or 12.7-mm dia. The strip and tube feed from coils simultaneously through the 60-ft.-long

production line that runs continuously at 7.5 m/min.

Tube runs through a straightener as the strip feeds over the top of the tube and through a punching die that punches a rectangular pilot hole. Next, as the tube and strip come together at the laser-welding booth, guide rolls center the copper tube underneath the strip; downward roll pressure keeps a tight weld joint at the tangent point. Laser welding occurs at both sides of the tube simultaneously.

The welded material then feeds through a roll-profiler that imparts a gentle corrugation pattern to the strip to add rigidity; a protective film on the top of the strip maintains the critical surface integrity during processing. Finally, a cutoff die, signaled by presence sensing of the punched pilot hole, cuts the absorber fins to length, anywhere from 4 to 10 ft.

Laser Stitch-Welding Sheet to Tube

At the heart of the system is a 500-W pulsed-Nd:Yag solid-state laser (an FLS N-Series model from Lasag Industrial Lasers, Buffalo Grove, IL) outfitted with a beam splitter to deliver a beam to each side of the weld joint. Fiberoptic cables deliver the beams to the welding heads fixtured on each side of and underneath the feeding strip and tube.

Weld-joint position tolerance is ±3 mm. Cameras installed on each side help line operators set up the line and ensure good fitup. During production, the laser pulses to create 1-mm-long stitch welds on 2-mm centers.

Each hour or so—at the beginning and end of each shift and every time it changes coils—operators cut off samples from the production line to test weld strength in a tensile-test setup.

"The industry standard for weld strength is 100 N/cm," says Lee. "We're getting 180 to 200 N/cm or more." **MF**

U.S. at the Ground Level in Solar Water Heating

In 2008 (the last year for which data is available) U.S. solar-thermal collector manufacturers sold 30,000 units for residential hot-water heating, according to Alanod -Westlake Metals' vice president Frank Lee. Typically at 64 sq. ft. (or 6 sq. m) per installation, that equates to about 180,000 sq. m.

Worldwide, solar installations for hot-water heating totaled 37 million sq. m., "so we're at the ground level here in the United States," Lee says. "The solar-thermal process is five-times more efficient than photovoltaic production. There's a lot of marketing to be done, but if the incentives remain in place and productivity at the manufacturers continues to improve to bring costs down, industry growth should be significant for a long time to come."