Quick Facts

At about a quarter to half the cost of a standard thermal furnace, the Optical Cavity Furnace (OCF) is poised to boost the solar cell manufacturing industry in the United States by helping produce solar cells with higher quality and efficiency at a lower cost.

NREL and its private-industry partner—AOS Solar Inc. of Rancho Palo Verdes, California—are building a manufacturing-size OCF capable of processing 1,200 wafers per hour.

The furnace's process times are significantly shorter than conventional furnaces.

NREL has cooperative research and development agreements with several of the world's largest solar-cell manufacturers, all of which are intrigued by the OCF's potential to boost quality and lower costs.

NREL researchers continue to improve the furnace and expect it to be able soon to hike the conversion efficiency of solar cells by 0.5%, a significant improvement in an industry that operates on razor-thin margins.

NREL and AOS Solar shared a 2011 R&D 100 Award for the furnace. The award, from R&D Magazine, honors the most important technological breakthroughs of the year.

Breakthrough Furnace can Cut Solar Industry Costs

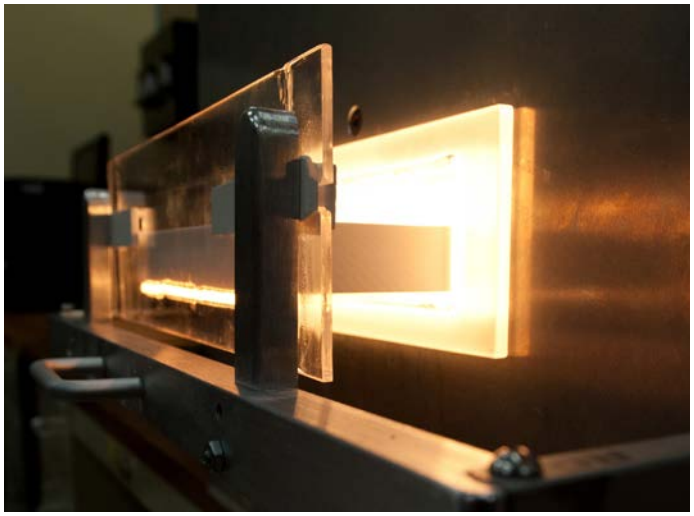
A game-changing Optical Cavity Furnace (OCF)—developed by the National Renewable Energy Laboratory (NREL) with funding from the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy—uses optics to heat and purify solar cells at unmatched precision, while also boosting the cells' efficiency.

As solar cells move through a manufacturer's production line, they must be oxidized, annealed, purified, diffused, etched, and layered. Heat is an indispensable ingredient in each of those steps, and that's why large furnaces dot the production lines of all the solar cell manufacturers. Until now, the state of the art has been rapid thermal processing furnaces that use radiant or infrared heat to quickly boost the temperature of silicon wafers.

In contrast, NREL's OCF uses only light, enclosing an array of lamps within a highly reflective chamber to achieve an unprecedented level of temperature uniformity. The combination of visible and infrared light uniformly heats the crystalline silicon wafers, especially at the edges, which are prone to cooling or heat loss. The OCF design virtually eliminates energy loss by lining the cavity walls with super-insulating and highly reflective ceramics and by using a complex optimal geometric design.

The OCF is versatile. Each step in the solar cell manufacturing process typically requires a different furnace configuration and temperature profile. However, with the OCF, a solar cell manufacturer simply tells a computer (using NREL proprietary software) what temperature profile is necessary for processing a solar cell. This means the OCF can perform five different process steps without the retooling and reconfiguration required by the furnaces used today. This will help industry cut manufacturing costs while incrementally improving the sunlight-to-electricity conversion efficiency of each solar cell.

The OCF can be used to remove impurities (a process called "gettering"), form junctions, lower stress, improve electronic properties, and strengthen back-surface fields in solar cells. In addition, a slightly different configuration of the OCF uses its optics to eliminate mechanically inferior wafers, ensuring that manufacturers only process the wafers that are strong enough to withstand the stresses imposed along the manufacturing line.



The cavity inside the OCF glows white hot during a simulated firing of a solar cell.

Photo by Dennis Schroeder, NREL 19755

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