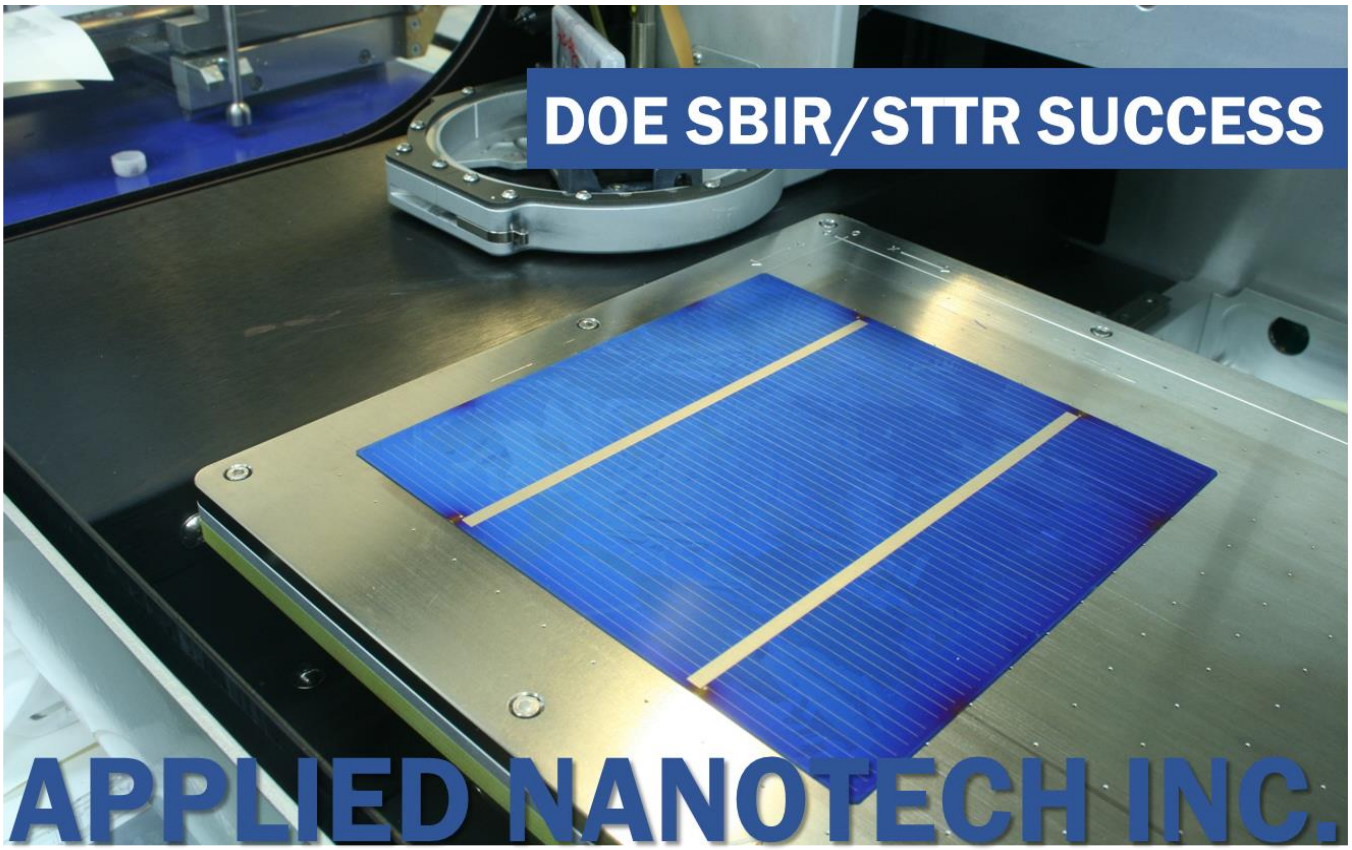
SBIR·STTR America's Seed Fund

U.S. DEPARTMENT OF ENERGY | SBIR/STTR Programs Office



DOE SBIR/STTR SUCCESS

APPLIED NANOTECH INC.

There are two crucial factors preventing our society from harnessing more of the Sun's unlimited energy and from developing a future free from our current environmental concerns—the solar cells' manufacturing costs and their low electrical efficiency conversion rate. The two are interrelated and an improvement in efficiency, even when resulting from a remarkable innovation, might also require a more expensive manufacturing process, precluding a net gain in cost.

FACTS

PHASE III SUCCESS
Commercial revenues in the form of technology licensing and private sales for a total of nearly $4.5M over a 3 year period.

IMPACT
ANI nanoparticle ink technology offers an inexpensive alternative to depositing front or back contacts on solar cell wafers 180-micron-thin or less yielding 30% efficiency increase.

DOE PROGRAM/OFFICE
Solar Energy Technologies Program, Office of Energy Efficiency and Renewable Energy (EERE).

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One approach to render solar power more competitive is to keep the constituents of a solar cell unchanged, while devising innovative ways to optimize performance without increasing manufacturing costs. The deposition of current collecting electrodes on the cell's surface is itself efficiency-limiting because the electrodes reduce the area of the solar cell available for collecting sunlight. The scientists at Applied Nanotech, Inc. (ANI) both improved this processing step and reduced its cost, resulting in increased efficiency and millions of dollars in savings by solar panels' manufacturers.

Every solar cell needs electrical contacts or electrodes to carry the charge produced by the photovoltaic (PV) effect and transmit the electricity to the power grid. This is why the face of a solar cell shows grid lines, typically made of silver and deposited through screen printing. When introduced, screen printing itself was an innovative, efficiency-increasing technology as compared to older electrode deposition techniques. However, screen printing, which forces a silver paste through a patterning screen pressed onto the solar cell, has numerous drawbacks in the manufacturing process and ANI non-contact technology was able to eliminate most of them.

Instead of conventional silver powder, ANI printing technology uses inks made of nanoparticles of various less expensive metals dispersed in an organic medium. The ink can be "painted" on the solar cell using the inexpensive and widely available ink-jet printing technology. With ink-jet printing, there is no applied pressure on the solar cell and very thin silicon wafers (180 microns or less) can be used. Reducing the thickness of Si wafers is an ongoing trend in the PV industry because the wafer cost accounts for nearly 50% of the solar cell cost, and thinner cells can potentially achieve higher open circuit voltages, translating in higher efficiencies.

In addition to enabling electrical contacts on thinner Si cells, ANI printing technology has other advantages. The ink is engineered to provide superior adhesion to the solar cell's surface and to provide high density for the printed circuit which decreases the electrical resistivity of the collecting electrodes. The metal lines on the cell grid can be made narrower, thinner, and still be more effective in collecting the charge. They also require a lower curing temperature to burn out the organic matrix. These features mean increased efficiency and lower costs. ANI ink-printing technology can also be adopted for the more challenging configuration when the collecting electrodes are only deposited on the back of the wafer, resulting in a larger, up to 30% improvement in efficiency as compared to more conventional electrode configurations.

ANI, a PEN Inc. company, is the PEN Design Center focused on developing new products for the PEN family of companies using nanotechnology approaches. The DOE SBIR grant funded by the Solar Energy Technologies Program within the Office of Energy Efficiency and Renewable Energy (EERE) was "an invaluable opportunity to leverage Applied Nanotech's advances in nanomaterials to address a specific need in the Si solar cell industry." explained Dr. Richard Fink, President of ANI. "The SBIR funds made it possible for ANI to perform the R&D needed to tailor the composition of the nanoparticle ink and optimize the printing technology for Si solar cells", Dr. Fink continued. The technical success of this project, which started in 2007 and continuing through 2012, gave rise to commercial revenues in the form of technology licensing and private sales for a total of nearly $ 4.5 M. In particular, licensing rights were purchased by a rapidly growing materials supplier to the solar industry. The same company made a strategic investment of $ 2.5 M in ANI early in the effort. ANI continues to innovate through internal

R&D and collaborations with National Labs and other companies and universities. ANI business plan includes production and sales as well as technology development in the fields of consumer electronics, medical industry, and research accelerators. Other nanoparticle inks that ANI has developed include copper, nickel, aluminum and copper-nickel alloy inks for printing thermal and mechanical sensors. ANI is excited by the potential for its nanotechnology to supply further savings and energy cost reductions in the future, especially in areas of additive manufacturing.

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