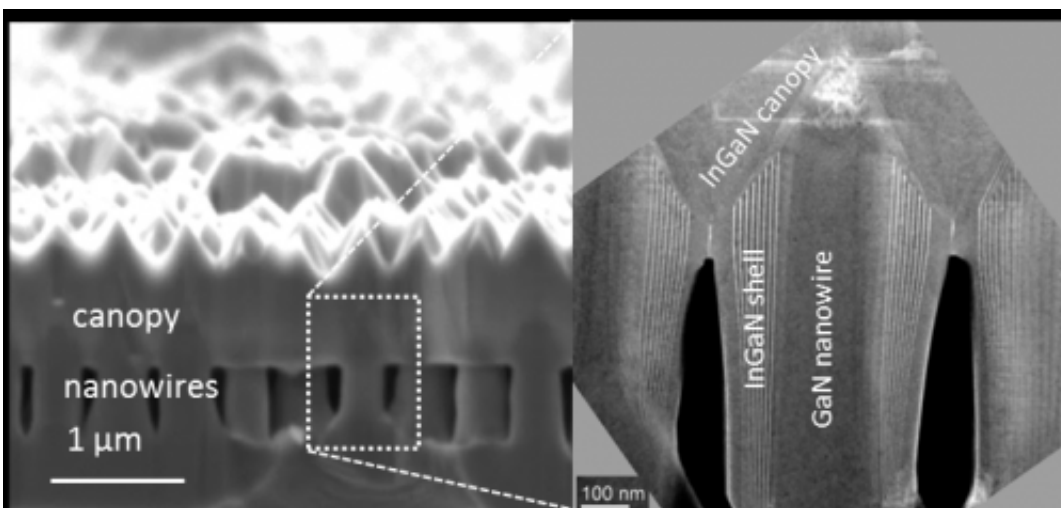


# Solar nanowire array may increase percentage of sun's frequencies available for energy conversion

June 18 2012



Cross-sectional images of the indium gallium nitride nanowire solar cell. Credit: Sandia National Laboratories

(Phys.org) -- Researchers creating electricity through photovoltaics want to convert as many of the sun's wavelengths as possible to achieve maximum efficiency. Otherwise, they're eating only a small part of a shot duck: wasting time and money by using only a tiny bit of the sun's incoming energies.

For this reason, they see indium [gallium nitride](#) as a valuable future material for photovoltaic systems. Changing the concentration of indium

allows researchers to tune the material's response so it collects solar energy from a variety of wavelengths. The more variations designed into the system, the more of the solar spectrum can be absorbed, leading to increased solar cell efficiencies. Silicon, today's photovoltaic industry standard, is limited in the wavelength range it can 'see' and absorb.

But there is a problem: Indium gallium nitride, part of a family of materials called III-nitrides, is typically grown on thin films of gallium nitride. Because gallium nitride atomic layers have different crystal lattice spacings from indium gallium nitride atomic layers, the mismatch leads to structural strain that limits both the layer thickness and percentage of indium that can be added. Thus, increasing the percentage of indium added broadens the solar spectrum that can be collected, but reduces the material's ability to tolerate the strain.

Sandia National Laboratories scientists Jonathan Wierer Jr. and George Wang reported in the journal *Nanotechnology* that if the indium mixture is grown on a phalanx of nanowires rather than on a flat surface, the small surface areas of the nanowires allow the indium shell layer to partially "relax" along each wire, easing strain. This relaxation allowed the team to create a nanowire solar cell with indium percentages of roughly 33 percent, higher than any other reported attempt at creating III-nitride [solar cells](#).

This initial attempt also lowered the absorption base energy from 2.4eV to 2.1 eV, the lowest of any III-nitride solar cell to date, and made a wider range of wavelengths available for power conversion. Power conversion efficiencies were low — only 0.3 percent compared to a standard commercial cell that hums along at about 15 percent — but the demonstration took place on imperfect nanowire-array templates. Refinements should lead to higher efficiencies and even lower energies.

Several unique techniques were used to create the III-nitride nanowire

array solar cell. A top-down fabrication process was used to create the nanowire array by masking a gallium nitride (GaN) layer with a colloidal silica mask, followed by dry and wet etching. The resulting array consisted of nanowires with vertical sidewalls and of uniform height.

Next, shell layers containing the higher indium percentage of indium gallium nitride (InGaN) were formed on the GaN nanowire template via metal organic chemical vapor deposition. Lastly, In<sub>0.02</sub>Ga<sub>0.98</sub>N was grown, in such a way that caused the nanowires to coalesce. This process produced a canopy layer at the top, facilitating simple planar processing and making the technology manufacturable.

The results, says Wierer, although modest, represent a promising path forward for III-nitride solar cell research. The nano-architecture not only enables higher [indium](#) proportion in the InGaN layers but also increased absorption via light scattering in the faceted InGaN canopy layer, as well as air voids that guide light within the nanowire array.

**More information:** [energy.sandia.gov/?page\\_id=8229](https://energy.sandia.gov/?page_id=8229)

Provided by Sandia National Laboratories

Citation: Solar nanowire array may increase percentage of sun's frequencies available for energy conversion (2012, June 18) retrieved 27 April 2024 from <https://phys.org/news/2012-06-solar-nanowire-array-percentage-sun.html>

<p>This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.</p>
--