Less can be more: Semiconductor nanowires for flexible photovoltaics

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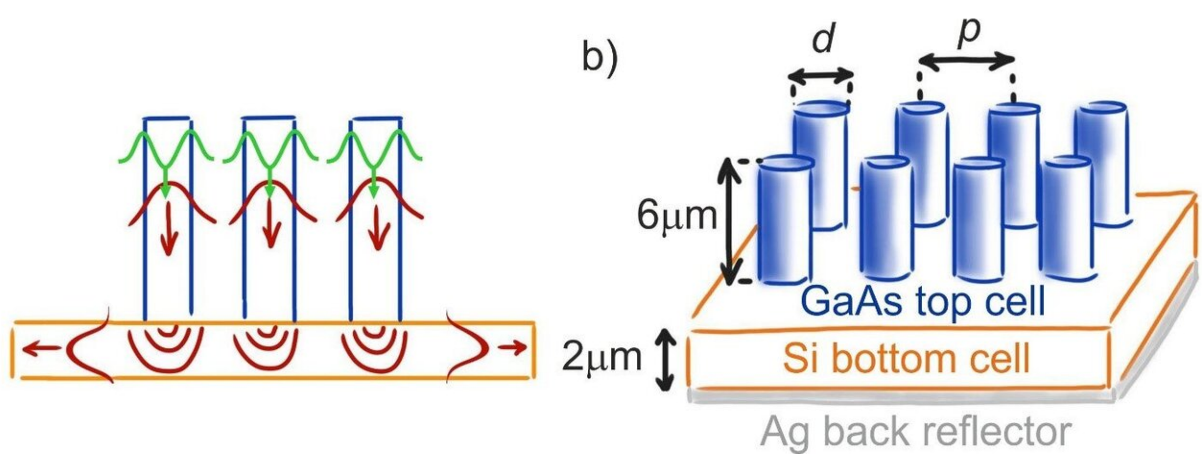

Optically coupled tandem of GaAs nanowires (6um tall) on silicon ultrathin film (2um). Sunlight is efficiently absorbed in each nanowire, and the array will transmit infrared light to be trapped into silicon film. Credit: source AMOLF

Capturing and manipulating light at nanoscale is a key factor to build high efficiency solar cells. Researchers in the 3-D Photovoltaics group have recently presented a promising new design. Their simulations show that vertically stacked nanowires on top of ultrathin silicon films reduces the total amount of material needed by 90 percent while increasing the efficiency of the solar cell. These promising simulation results are an important step toward next-generation solar cells. The results have been published on May 23rd in *Optics Express*.

A strategy to reduce cost and rigidity of photovoltaics is to combine ultrathin silicon photovoltaic films with semiconductor nanowire solar cells. The mechanical flexibility and resilience of micrometer thin cells make them well suited to apply on curved surfaces.

The idea is to optically couple the two materials stacked on top of each other as a tandem cell: a gallium arsenide (GaAs) nanowire array on top of an ultrathin silicon (2um-thick) film. GaAs vertical nanowires are well-known semiconductor components in photovoltaic applications. Earlier experimental research in the 3-D photovoltaics group showed that such nanowires are able to absorb light 10 to 100 times their geometrical cross section. Silicon, the second material in the tandem cell, is a highly desirable component thanks to the mature understanding of its optical and electronic properties as well as its widely available fabrication technologies. The challenge researchers typically encounter when trying to downscale silicon to a few micrometers in thickness is that it compromises the solar cell's performance due to poor absorption of infrared light. Light management strategies are therefore needed to compensate. The research team decided to add vertically standing nanowires on top of silicon film and thereby make it up to four times more efficient in trapping infrared light in the silicon bottom cell.

More information: Nasim Tavakoli et al. Combining 1D and 2D waveguiding in an ultrathin GaAs NW/Si tandem solar cell, *Optics Express* (2019). DOI: 10.1364/OE.27.00A909

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